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**Azagba-nyako, J.**

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**PUBLIC HEALTH NUTRITION INTERVENTION TO EVALUATE THE  
NUTRITIONAL IMPACT OF THE GHANA SCHOOL FEEDING PROGRAMME  
IN LOWER MANYA KROBO (LMK) DISTRICT, AND ENHANCING ITS  
EFFECTIVENESS THROUGH A NUTRITION INTERVENTION.**

**BY**

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MEDICAL RESEARCH,  
FOOD RESEARCH INSTUTITE, GHANA AND THE FOOD SCIENCE  
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## ABSTRACT

School feeding interventions like many other donor dependent nutrition interventions in low-income countries have often been described to be ineffective or unsustainable because they are designed with donor specific nutritional interests, which often do not reflect the indigenous dietary preference and patterns of target populations. In Ghana, over half a million school children depend on the school meals as their main stable source of food for the day however there have been several reports of lack of nutritional impact of the due to the dependence on non-indigenous foods. The aim of this study was to develop school meals (SCm) for the Ghana School Feeding Programme (GSFP) in the Lower Manya Krobo District by employing local agricultural produce as food-to-food fortification. The study is based on the tailored functional food recipe concept that seeks to enhance the effectiveness of nutrition interventions by employing indigenous knowledge of food composition and food processing to improve micronutrients profile of local available foods without compromising palatability. Maize, sweet potatoes, soybeans, *Moringa oleifera*, palm nut oil, anchovies were processed using traditional methods. Each SCm was formulated using nutrition data from FAO West African-Food-Composition-Table to contain at least 40% DRI for protein. AOAC (2009) methods were used to analyse the nutritional content of the SCm and two sets of sensory tests were performed to determine acceptability. In all, five SCm were developed and per 100g of each SCm, carbohydrate (with crude fibre) and protein content ranged from 68.07g to 49.18g and 16.32g to 27.52g respectively whilst fat content ranged between 4.1g and 19.4g. Calcium content ranged from 284mg to 960mg whilst iron and zinc contents range between 7.17g to 11.17g and 0.97g to 1.59g respectively. In the sensory test, SCm coded FSM123, FSM101 and FSM579 had highest mean overall acceptability scores of  $7.58 \pm 0.56$ ,  $7.74 \pm 0.81$  and  $7.71 \pm 0.70$  respectively. The efficacy and effectiveness of the SCm were tested in a 6 months pilot nutrition n (180) and 9-month scale-up intervention (n=330) together with a control group and a GSFP group. After initial deworming and malaria screening, the intervention the GSFP group received the normal school meals, the control group received three portions of fruit as incentive the SCm group receive 15g weight bases of SCm meal together with nutritional education. The results showed that participants in the SCm treatment group had an average 3.24% increase in height ( $p \leq 0.05$ ) and 13.08% increase in weight ( $p \leq 0.05$ ) over the intervention periods. There was also a 17% decrease in anaemia prevalence compared 11% decrease in the control and 9% decrease in GSFP. The results illustrate that the application of indigenous knowledge, and innovation in of nutrition could be a plausible tool in enhancing the nutrient content of school meals. The SCm seems to provide some leverage and resilience against further malnutrition and when combined with deworming, malaria treatment buttressed with behaviour change communication provided greater nutritional impact on height and weight relative to the other groups in the study.

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## ABBREVIATIONS

- AOAC- Association Of Analytical Communities
- GDHS- Ghana Demographic And Health Survey
- GDP- Gross Domestic Product
- GHS-Ghana Health Services
- GSS- Ghana Statistical Services
- GOG- Government Of Ghana
- MDG Millennium Development Goals
- NEPAD New Partnership for African Development
- NGO Non-governmental Organisations
- SC<sub>m</sub> - S-COOL Intervention Meals
- SDG Sustainable Development Goals
- SEND GHANA- Social Enterprise Development Foundation Of West Africa
- SFP School Feeding Programme
- SFP- School Feeding Programme
- SIC- School Implementation Committee
- SIGN- School Feeding Initiative Ghana Netherlands
- SNV -Netherlands Development Organisation

## **AUTHOR'S DECLARATION**

I declare that all the materials contained in this thesis are my own work and was carried out in accordance with the Guidelines and Regulations of the University of Westminster. The work is original except where indicated by special reference in the text. I certify that, to the best of my knowledge, my thesis does not infringe upon anyone's copyright nor violate any proprietary rights, and that any ideas, techniques, quotations, or any other material from the work of other people included in my thesis, published or otherwise, are fully acknowledged in accordance with the standard referencing practices. I declare that this is a true copy of my thesis, including any final revisions, as approved by my Examination Board and the Graduate Studies office, and that this thesis has not been submitted for a higher degree to any other University or Institution. Any views expressed in this work are those of the author and in no way represent those of the University of Westminster.

**FULL NAME:**

**SIGNED:**

**DATE:**

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*Out of the fullness of His grace He has blessed me, giving me one blessing after another. John 1:16*

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## **DEDICATION**

*This work is dedicated to all the strong women in my life who always find ways to break down barriers and set the pace... This is for you, Mummy, Auntie Sabina, Anorkor, Auntie Yaa, and Maame Afua. Thanks for being my support system.*

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# CHAPTER ONE

## INTRODUCTION

In the last three decades, the global health sector has made considerable strides in the field of preventive medicine by promoting health through multi-sectorial collaborations with agricultural, educational and technological sectors. Across the globe, there has been an annual decline of 2.1% in stunting among children less than 5 years. Similarly, there has been a 36% decrease in global incidence of underweight whilst wasting has decreased by 11% from 58 million in 1990 to 52 million in 2011 (WHO /UNICEF, 2011).

Despite these tremendous strides made in health, nearly 200 million children go to bed hungry every day, and poor nutrition causes nearly half (45%) of deaths (3.1 million deaths) in children under five each year (USAID, 2013). In all, an estimated 66 million primary school-age children attend classes hungry across the developing world, with 23 million in Africa alone (WHO, 2015).

This trend has been attributed to the ever increasing economic cost of living and its resultant soaring world food prices (Gustafson, 2013). The high cost of food on the world market has translated into an increased availability of cheap energy dense - low micronutrient foods across the developed and the developing world (UNICEF, 2009). The result is a population of children who may be well fed (calories), but lack the essential micronutrients for optimal growth. The trickle-down effect is an increasing record of childhood obesity among undernourished children (Johnson, 2002; Garrett and Ruel 2005; Prentice 2006). In Ghana, there has been an increase in childhood obesity prevalence, from 1% in 1998 to 5% in 2008 (GDHS, 2008).

The coexistence of obesity and under nutrition in the same population presents a double burden of disease. The complexity of treating both conditions simultaneously greatly aggravates the stress on the limited health resources present in most developing countries (GSS, 2010).

Global health policies and programmes in the last decade have directed a lot of efforts into promoting nutrition improvement in primary sectors to ensure good health (Edelstein, 2010; Pelletier 2013). The majority of such efforts have been focused on the need to ensure optimal nutrition throughout the life cycle of an individual. However, with increased awareness of foetal origins of adult disease, global interest in nutrition has been refocused towards prevention of malnutrition in the first 1000 days of life (Gillman and Rich-Edwards 2000; Bundy et al 2009; UNICEF 2015; Mamei et al 2016).

In some environments however, where early childhood interventions prove to be inadequate, school-based nutritional interventions (including School Feeding Programmes) have offered an avenue to address malnutrition at childhood level and offer an excellent opportunity for promoting catch up growth (UNICEF 2007).

For most governments, especially those in developing countries, provision of daily school meal as a strong incentive to encourage school attendance is not solely to promote optimal nutrition but forms part of their commitment to achieving Millennium Development Goals, in particular, the eradication of extreme poverty and hunger (MDG1), achievement of universal primary education (MDG2) and (MDG4) reduction of child mortality (UN, 2015)

### **Background of *Ghana School Feeding***

In Ghana, the national School Feeding Programme (SFP) was initiated in 2005 by the Government of Ghana (GOG) with aid from NEPAD and the Dutch Government (SNV), with the aim of providing school children with one hot, “nutritious” meal per day, using locally sourced farm produce. The Ghana School Feeding Programme (GSFP) involves stakeholders and partners from various governmental sectors (Appendix1) and its design seeks to enhance increasing school attendance and retention, improving health through nutrition whilst encouraging consumption of local farm produce to ensure household food security. The strategy was to feed school children with one nutritious meal made from locally sourced food in order to

cut down on agricultural post-harvest losses and provide a ready market for local farm produce.

The success of GSFP in achieving some of its aims has been highly documented by both international and local donors (NGOs and government) over the years (GOG, 2006, 2008, 2009; SEND Ghana, 2009; Abotsi, 2013). With an initial 10 pilot schools, the programme has extended its coverage to over six hundred thousand children in one hundred schools across one hundred and thirty-eight districts. The GSFP has helped increase primary school enrolment ratio (Abotsi, 2013) and net primary school attendance and retention level in participating schools (GOG, 2006).

That notwithstanding, after nearly two decades since its inception, GSFP continues to be challenged with increasing expectations from the food supply on one hand, and fundamental gaps in nutritional framework. Also, the heavy dependency on retail food instead of local agriculture (as stipulated by its plan of action) has led to a low sustainability rate due to the high cost of operation vis-a-vis cost purchasing food (Casely et al., 2010; Hauwere, 2010).

To date, there exists very little plausible empirical evidence that meals provided by the GSFP exert any nutritional impact on pupils in beneficiary schools. The absences of national nutritional standards and guidelines for operation, together with all aforementioned factors have raised donor concerns about the nutritional impact of the GSFP.

Several donors have suggested that there is a need for government to redirect efforts towards improving nutritional impact by incorporating complementary programmes such as micronutrient supplementation, food fortification, deworming and increased nutritional education in schools (Van den Berg, 2008; Danquah et al, 2012).

Both local and international partners suggested that there is an urgent need to enhance the GSFP nutritional framework. Some have recommended the adoption of a comprehensive supplementary approach to attenuate the lack of nutritional impact in the GSF programme. These recommendations are based on the notion that supplements in the form of micronutrient powders and nutrient tabs provide the fastest reliable improvements in the micronutrient status of children (HGSFP, 2013, Aliyar,

2012). The current SCm study believes otherwise and assert to the notion that local foods-based solution hold the key to long-term impact.

Certain schools of thought have argued that although supplementation might be effective in nutritional emergency situations by providing the necessary short-term answer to acute micronutrient adequacies in a population, food-on-food fortification (Home-Grown SFP model) is an effective medium to long term alternative solution (Bhagwat et al., 2014, GAIN, 2007).

Major SFP donors (WFP, FAO) have shown increased interest in home grown SFP modules to curb the dependency on food aid and reduce operational cost (PATH, 2009). Home grown SFP does not only promote adequate caloric intake with emphasis on adequate micronutrient intake and the incorporation of other complementary health benefits, but also extends to interventions that place priority on using local resources (agricultural and technological) to promote good nutrition and increased nutritional sensitivity. The focus on long-term nutritional-sensitive approach has greatly shifted global nutrition intervention focus from the previous predominantly nutrient supplementation to interventions that focus on promoting health through food on food fortification mechanisms.

## **OUTLINE OF THESIS**

The first chapter provides a brief discussion of the background which encompasses the problem of malnutrition among children with special emphasis of prevalence among children of school going age and how food for education programmes seek to address this prevalence school. This chapter also provides an introduction to the concept of Tailored-Food Recipes and how the SC<sub>m</sub> products are conceptualized from farm to fork.

Chapter 2 encompasses a literature review of information on global stakeholders in the field of school-based intervention as well as key products and intervention methodologies employed in the fight against childhood malnutrition in which the School Feeding Programme is a major element. The study's research questions, aim and objectives, hypotheses are stated under this chapter

Chapter 3 gives a detailed discussion of all the methods used in three phases of the study with details of specific activities undertaken under each phase. This chapter also has a section the sustainability plan for the study.

Chapter 4, details all the analyses and evaluation of all the results consist of discussion and detailed comparison of the different impact levels of each treatment. This chapter draws on the new knowledge contributed by this study, as well as results that confirm previous works in school feeding intervention.

Chapter 5 gives the authors critical views on the entire project and Chapter 6 consist of conclusion and recommendations for further work.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Scope: Malnutrition Childhood malnutrition: Global facts and figures**

Across the globe, a billion people go to bed hungry daily, out of which 200 million are children (USAID, 2013). The most common form of malnutrition is protein-energy (carbohydrates, fats and proteins) malnutrition. Protein-energy malnutrition is the main cause of growth retardation in children and children deprived of protein-energy stores are usually underweight (low weight for height) or/and stunted (height for age) or wasted (weight for age).

In 2011, an estimated 165 million children under-five were stunted globally representing an annual decline of 2.1% from the estimated 40% recorded in 1990. The WHO and UNICEF (2012) also indicated a 36% decrease in global incidence of underweight when compared to the 1990 estimate of 159 million whilst wasting has decreased by 11% from 58 million to 52 million.

Although the figures mentioned above show progress, analysis of the dataset suggests that progress is not uniform across continents. Progress in reduction of stunting and underweight is relatively higher in the Caribbean and Asia (51%-40%) compared to a relatively moderate reduction of about 15%-22% recorded for the Africa and Oceania (WHO/UNICEF, 2011).

In our understanding, the moderate reduction experienced in Africa and Oceania is not due to lack of progress in malnutrition management, but solely due to the increasing number of under-five population in these regions. The increase in population of under-five children counteracts the progress being made in reducing stunting and underweight thereby creating stagnation.

The stagnation in turn distorts the prevalence levels by increasing the burden of disease attributed to malnutrition in these areas. Several

researchers have stipulated that measures need to be put in place to overcome this stagnation and accelerate the rate of decline if the Millennium Development Goal target of 40% reduction in stunting by 2025 and halving underweight are to be achieved (Copenhagen Consensus, 2008; WHO/UNICEF, 2011).

The dataset from WHO/UNICEF (2011) also shows an increasing prevalence of micronutrient malnutrition in both the developed and underdeveloped world. Following the advancement of cell level study and increased knowledge of cell level nutrition, there has been increased recognition of the vital role micronutrients play in disease susceptibility, epidemiology and severity.

The salient effect of suboptimal levels of micronutrients in the human metabolic system makes micronutrient deficiencies, some of the most important risk factors for many diseases and can contribute to high rates of morbidity and even mortality. All together the four most common forms of micronutrient malnutrition (iron; vitamin A, zinc and iodine) are ranked among the 15 leading cause of under-five mortality. These deficiencies contribute to one third of the global burden of disease with an average of 0.8 million deaths annually (SOFI, 2012).

At present, an estimated 47,000 out of every 100,000 children between 12-24 months have iron-deficiency anaemia. Whilst 140 million children in the world are vitamin A deficient and close to five hundred thousand vitamin A-deficient children go blind annually out of which half die within the first year of going blind (WHO, 2012). Iodine deficiency also affects over 740 million people out of which 500 million are likely to have had some degree of mental impairment due to insufficient iodine intake. Zinc deficiency contributes to growth failure and weakened immunity in young children and results in some 800,000-child deaths per year (UNICEF 2004 and 2007).

In Africa alone, over 50 million school-age children suffer from iron deficiency anaemia. On an average, 12 million African school-age children are estimated to suffer from iodine deficiency whilst 9 million suffer from

vitamin A deficiency (UNICEF 2004 and 2007). A subsequent 6 million children of school age in African suffer from helminths infections, which affects their nutrient absorption and nutrient utilisation (WHO 2005; WFP 2008)

### **2.1.1 Epidemiological data: Ghanaian facts and trends**

With respect to Ghana, there is very limited reliable published data on the malnutrition prevalence throughout childhood. Therefore, for the purpose of this study, the main reference for malnutrition prevalence will be the Ghana Demographic Health Survey (GHDS) dataset 1988-2008. The dataset is limited to the malnutrition in children under five.

The trend in national average malnutrition prevalence between 1998 and 2003 shows that stunting prevalence increased from 26% to 30 %, underweight and wasting prevalence decreased from 10% to 7% and 25% to 22% respectively for that same period. Since 2003 stunting levels have dipped to 28% underweight has decreased slightly from 18% to 14% whilst wasting remained relatively constant during the same period from 8% -9% (GDHS, 2008).

The period between 2003 and 2006 is of great interest as national prevalence of stunting from decreased 29.4% to 22.4% and underweight also declined from 21.8% to 17.8% in a period of three years. This drastic decline can be attributed to improved efforts in the health sectors. At the beginning of that period, the government of Ghana had just started implementing the National Plan of Action on Nutrition Policy (NPLAN) as well as Ghana Health Services “Health for Wealth” policy (GHS 2013).

Programmes under these policies promoted maternal-infant health, nutrition, regenerative health and growth monitoring. Thus projects pertaining to maternal nutrition pre and postpartum, 6 months exclusive breastfeeding, continuous infant growth monitoring, the fortification of local weaning and nutrient supplementation were enforced. The results of these activities may have translated into the decline in overall national stunting rates.

The decline can also be partly attributed to the increased economic wealth of Ghana during that period. Poverty has a cause and effect interaction with malnutrition; poverty is a predictor of malnutrition and malnutrition also known to be one of the most significant of indicator poverty status (Black et al., 2008).

As per the period (2003-2006), Ghana experienced an accelerated economic growth through the initiatives like the IMF's HIPC initiative. From 2003 to 2006, GDP per capita increased an average of 1.8% per annum with an all-time high of 7.8 in 2010 (Trading Economics, 2013). The heightened economic progress brought with it increased investment in the agricultural sector which in turn increased food production and decrease the number of people below the poverty line. This resulted in a rise in the standards of living, including nutrition status and dietary patterns in the Ghanaian population. It is this change that is reflected in the lower national stunting rate in the 2008 GHDS survey.

At regional and district levels, Ghana's economic gain did not seem to translate directly into improved malnutrition status. Aside the capital region (Greater Accra) which recorded a stunting rate of 14% all the other nine regions recorded an average stunting prevalence of 25% at least 3% higher than the national average of 22.1%. The percentage reduction in stunting prevalence from 2003-2006 was substantially lower among the disadvantaged: children in rural areas (18%), whose mother has no formal education (21%), girls (18%), compared to those in urban areas (34%), whose mother has at least secondary education (30%), and boys (29%).

A similar trend was observed in 2008 where children in rural areas like Eastern Region were three times more likely to be stunted than children living in urban areas in the Greater Accra region (38% vs. 14%). Children of mothers with no education are almost twice as likely to be stunted as children of mothers with a secondary education or higher (30% vs. 18%). The heterogeneity of stunting distribution gives an indication that the nutrition intervention like NPLAN were centralised in the urban areas than the rural areas. In light of this, there is a need for health policy planners and

intervention programmes to start focusing on rural populations in order to even up the progress in malnutrition reduction.

Epidemiological data on Ghana provided by GHS (2013) and GLS (2008) also indicate the 40% of all deaths during childhood are directly or indirectly linked to malnutrition. Malnutrition status is therefore one of single most important predictors of child mortality in Ghana. This implies that, efforts need to be made to sustain the nutritional gains made in the first 1000 days of life and points towards the need to increase efforts to promote optimal nutrition throughout the lifecycle of the child.

## **2.2 Malnutrition and the burden of childhood disease.**

Poor nutrition during childhood and its associated comorbidities continue to be the primary health problem facing children in this decade (DSM, 2013). The nutrition and disease (infection) are intricately linked through a continuous loop of cause and consequence as illustrated in figure 2.1. The dynamics of this interaction indicate that individuals whose diet do not provide adequate nourishment (calorie and nutrient) for the normal physiological mechanisms, mobilize energy by decreasing their bodies' nutrient demands and depleting the nutrient reserves.

The depletion of the body's nutrient reserves for normal body function results in severe immunosuppression and ultimately distorts the body's ability to respond exposure to disease-causing organisms. Inversely, the presence of infection or disease causing parasites results in proper digestion, absorption and metabolism utilization of nutrients in the body (Scrimshaw et al., 1968) Once the disease sets in, malnutrition plays a significant and independent role in determining morbidity and/or mortality by magnifying disease severity and the frequency disease/infection episodes (Calder and Jackson, 2000). As the rate of complications increases and the length of each episode increases, a vicious cycle of recurring disease/infections, reduced immunity, and deteriorating nutritional status is created (Figure 2.1).

During childhood, the adverse effect of the vicious cycle of malnutrition can have long lasting effects on the health status of children

from infancy to school going age through to adult life (Barker 1993; Gillman et al., 2000). The subsequent paragraphs briefly discuss the effect of malnutrition on school children.

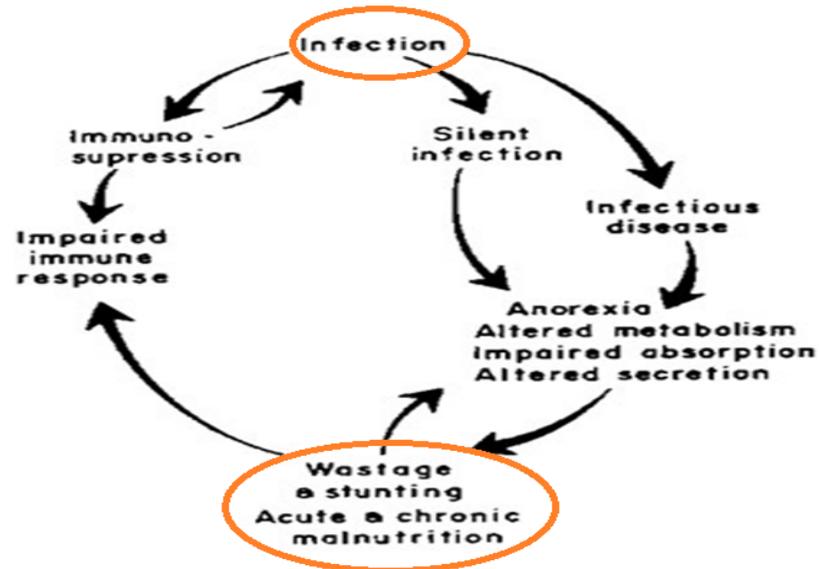


Figure 2.1 Continuous interconnecting relations between malnutrition and disease  
Source: UN, 2009

### 2.2 .1 Reduced productivity

The childhood is characterised by several periods of growth spurt that require protein, calcium, iron and iodine for cell division and cell growth as well as higher energy stores to sustain the increase in physical activity levels (Rogol et al., 2000). The absence of optimal levels of micronutrients during the first 1000 days of life, results in repressed linear growth (small height for age- stunting) and lower energy levels in children. Stunting predisposes the child to low productivity during adult life (Barker 1993; Gillman et al., 2000).

Stunted children grow into short adults with reduced physical capacity for work. Globally, it is estimated that productivity in physical labour declines by 1.4% for every 1% reduction in adult height (FANTAII, 2010). Ghana is said to likely to lose up to US\$41 billion per lifetime earning

as a result of stunting related productivity loss (GHS, 2013). At present 34% of adults currently living in Ghana have not attained their full potential as a result of childhood potential (COHA, 2016). The economic loss is further increased by the health cost associated with the treatment of malnutrition and its related co-morbidity.

### ***2.2.2 Increase susceptibility and severity of infection***

Poor nutrition leads to impaired immunosuppression, which increases risk of disease susceptibility (Gupta et al., 2009). Nutrients, especially vitamins and mineral serve as modulators and cofactors of enzymes that form an integral part of the defence mechanism and are required in the immune function (Rodríguez et al., 2011). Suboptimal levels of all or some of these nutrients weaken immune-competence and increases disease susceptibility hence malnourished children are more at higher risk of infection than well-nourished children.

On the other hand, exposure to infantile infections whether asymptomatic or not, is usually associated with the loss of nutrients as a result of appetite loss, anorexia, elevated metabolism of energy, malabsorption and nutrient diversion for immune function (Adelman et al., 2008). The loss of nutrients leads to further impaired immune response which in turn increases incidence and severity of disease and infection, plunging the body into a continuous recurrent cycle of disease (Gupta et al 2002; Rodríguez et al., 2011). For instance, vitamin A maintains the integrity of the epithelium in the respiratory and gastrointestinal. Absence of optimal vitamin A levels increases the severity of respiratory tract infections and diarrhoea in children.

### ***2.2.3 Decreased academic performance and cognitive ability***

The presence of vitamins (vitamins B, C, D, and E) or minerals (calcium, iodine, iron, magnesium, selenium, and zinc) deficiencies in school children are consistent with impaired hearing/visual perception, visual-motor coordination intelligence quotient and general cognitive ability (Ahmed, 2004).

These in turn, affects the overall school performance by reducing learning aptitude, and lowering school performance as well as attendance which may eventually cause severe mental retardation in extreme cases (Kleinman et al, 1998; Dunifon and Kowaleski, 2003). Data from the Save the Children survey (2013) reported that malnourished children were found to score 7% lower in maths tests than healthier children, 19% were less likely to be able to read a simple sentence aged 8, and were 13% less likely to be in the appropriate grade for their age at school and earn 20% less in later life than non-stunted children.

#### 2.2.4 Double burden of disease

For the past 20 years as the world becomes a global village, several populations have adopted non-traditional dietary patterns, coupled with changes in physical activity levels, which have resulted in dietary changes and subsequent changes in nutritional status and disease trends and patterns experienced (Tzioumis and Adair, 2014). Nutrition transition couple other factors urbanization, demographic shifts, sedentary lifestyles and the liberalization of markets (availability of cheap energy dense crop options) have contributed to the double burden of disease (Figure 2.2)

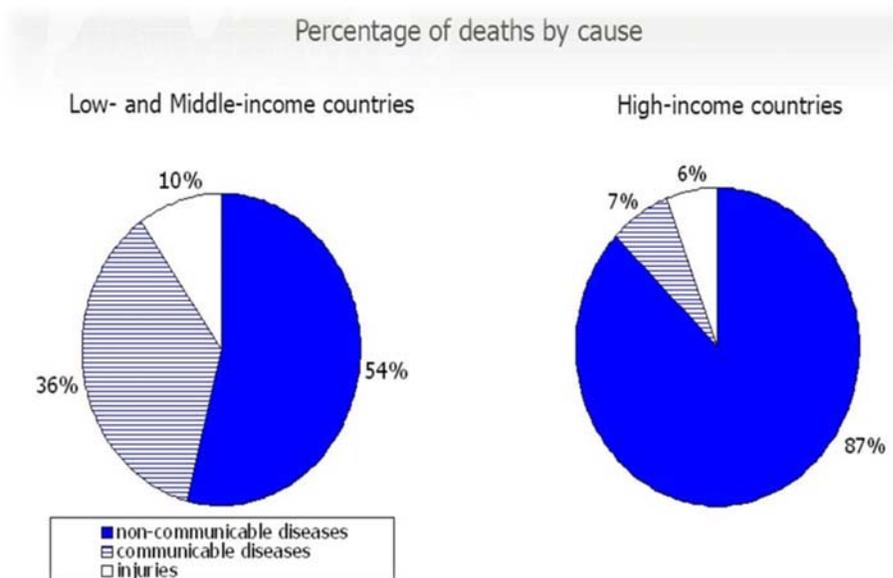


Figure 2.2 Pie chart illustration of the mortality rates (%) attributed to double burden of disease in low and high income countries (Source: Kinsella and He, 2009)

There is growing concern about increasing record of childhood obesity among undernourished children in developing countries (Garrett and Ruel 2005; Prentice 2006). In Ghana, prevalence of overweight among children appears to be on the rise; prevalence of overweight has increased from 1% in 1998 to 5% in 2008 (GDHS, 2008). The coexistence of obesity and under-nutrition presents double burden of disease. The complexity of treating both conditions simultaneously aggravates the stress on the already limited health resources in developing countries (GHS, 2013).

This phenomenon is fuelled by the ever-increasing world food prices, increased availability of cheap low nutrient processed food and increased cost of living (UNICEF, 2009). Parents in their quest to attenuate short-term hunger, feed their children with cheap high caloric low nutrient foods. The resultant is a population of children who are well fed (calories), but lack the essential micronutrients (Johnson, 2002). Therefore, nutrition interventions should be designed with strategies that promote adequate caloric intake with emphasis on higher micronutrient whilst lowering the incidence of common infections among children through deworming and malaria treatment exercises.

## **2.3 Global strategies to combat malnutrition**

In the first part of this century, efforts of many global health care activities were comprehensively towards tackling hunger, treating infectious disease and malnutrition through distribution of vaccines, medication and food aid. Till date, donor driven food aid remains an integral part of the global nutrition strategies for the world's poorest with WFP being the leading name in nutrition related interventions (Mclellan, 2014; WFP, 2012; Wahlberg, 2008).

In the last two decades, the increased interest in epigenetics and the growing body of work surrounding foetal origins of adult disease has resulted in a vast portion of public health has been refocused to preventive intervention with nutritional intervention taking a pivotal role (Fan and Pandya-Lorch, 2012; FAO 1992). The current public health strategies favour tackling malnutrition (subsequently health) by ensuring optimal nutrition throughout the human life cycle with the first 1000 days of life (window of opportunity) being the most crucial period (Barker, 2007: Barker et al., 1993 and 1986).

### **2.3.1 Life cycle approach to malnutrition**

The life cycle approach is a preventive strategy that ensures optimal nutrition from the time of conception by ensuring that pregnant women are well nourished throughout pregnancy, through to exclusive breastfeeding leading to appropriate weaning then to (Rai et al., 2015). The optimal nutrition during this entire period continues to benefit the child throughout life; while any nutritional inadequacies may lead irreversible repercussions extend throughout a lifetime (as shown in Figure 2.3).

The notion is that the conditions (biological, environmental) at each phase of the human life cycle are interconnected to the next phase through a continuous loop of cause and effect. In that any nutritional and health deficits or gains made at any point in an individual's life can result in positive or negative repercussion in subsequent phases of life and probably translate into positive or negative outcomes in the next generation.

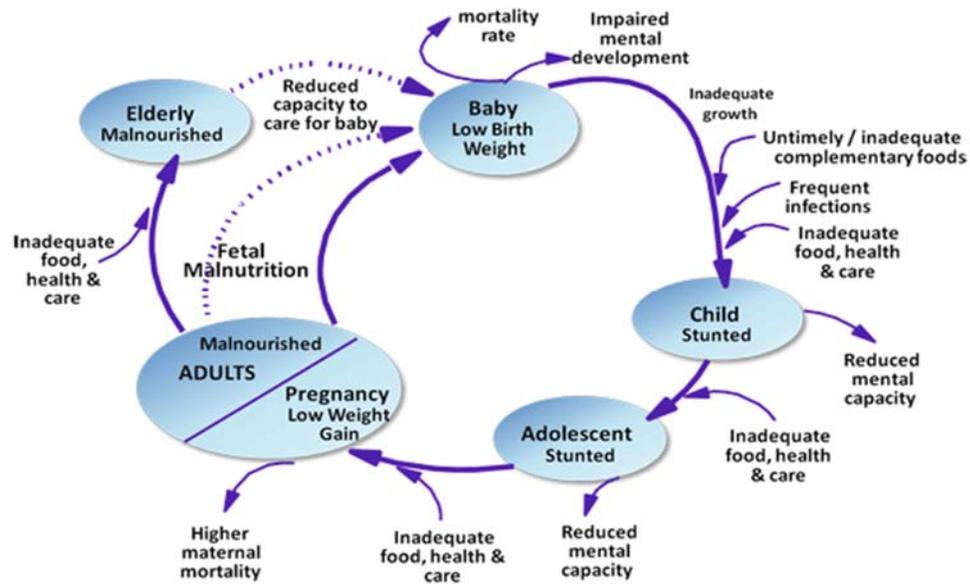


Figure 2.3: Lifecycle approach to health and nutrition (Source Adapted from the ACC/SCN-appointed Commission on the Nutrition Challenges of the 21st Century)

Malnutrition during pregnancy results in foetus growth restriction and development impairment, which in effect results in low birth weight. Low birth weight increases the risk of congenital abnormalities increases the risk of infection due to weakened immunity (Royal College of Obstetricians and Gynaecologists 2012: Vikse et al., 2008; Walden, 2007). Weaken immunity results in increase episodes of disease during childhood may subsequently affect education attainment, cognitive ability and productivity (as described in Figure 2.1& 2.2), Therefore consolidating nutritional effort right from conception starts the foundation for a healthier childhood and adulthood (Vikse et al., 2008; Walden, 2007, Barker, 1993).

Early life nutrition recommends optimal nutrition from the onset Pregnancy through to infancy, which is the most critical period of development in an individual's life (Barker, 1993). Interventions start from micronutrient supplementation during pregnancy to ensure the wellbeing of the mother, prevent anaemia and promote optimal foetal growth to ensure healthy birth weight, which is crucial in determining the survival of the growing baby (Barker et al., 2007). Early life interventions also extend to 6-months exclusive breastfeeding and continued breastfeeding with

appropriate complementary foods till 2 years onwards to ensure adequate intake of vitamins and minerals (WHO, 2016: WHO, 2004).

Optimal nutrition should be sustained to throughout childhood to ensure children remain strong, healthy and free of disease. Nutritional efforts during this period are often buttressed with initiatives that promote clean water and sanitation, which are key factors that affect nutrient absorption and diarrheal episodes (Komarulzaman, Smits and de Jong, 2017: Lilje, Kessely and Mosler, 2015).

The life cycle approach extends to adolescence through to pregnancy. Adolescence is period is a growth stage marked by growth spurt accompanied by phenomenal changes in hormonal levels, which can deplete the energy and nutrient stores of an individual and cause enormous deficits (Carlson, 2004; Spear, 2000; Forbes, 1987). Hence ensuring optimal nutrition, especially adequate micronutrient supply during this critical time is essential to break the vicious cycle of malnutrition.

Well-nourished adolescent girls are likely to grow into well-nourished women and mothers who are likely to withstand the nutritional stress of pregnancy and give birth to healthier well-nourished babies. However, with the increased awareness of the foetal origin of disease, there has been an increased priority in nutrition interventions directed towards prevention of malnutrition in the first 1000 days of life (Gillman and Rich-Edwards, 2000; Bundy et al., 2009).

Many indicators in research attest to the fact that no single nutrition-intervention strategy post the “window of opportunity” can effectively reverse the deletions made by poor nutrition the first 1000 days of life (Barker et al., 2007). In environments where early life nutrition interventions are inadequate, school based nutrition interventions offers a vital opportunity for promoting catch up growth, disease prevention and sustaining nutrient stores (UNICEF, 2007)

### **2.3.1 School Based Nutritional Interventions**

Ensuring adequate nutrition is a fundamental right of each child, hence intervening at each point in the human life cycle is crucial to accelerate and consolidate positive change in health outcomes.

There is an increasing body of research that demonstrates that in children of school going age, who may not receive optimal nutrition in early, provision of meals at school presents an avenue to address malnutrition, prevent disease and possibly promote catch-up growth (Ashworth, 2005). SFP may not provide leverage for malnourished children by reversing deletion made in earlier life, but provides them with a fight chance at disease prevention.

SFP is multispectral approach with the aim of Identifying and addressing/eradicating childhood hunger, reducing incidence of malnutrition and its related comorbidities. Effective School Feeding Programmes are participatory initiatives involving nutrition stakeholders at various levels (regional, district and school) aimed at providing an opportunity for addressing the critical factors affecting childhood nutrition and serve as avenues for consolidating efforts of the education and health sector in meeting the Millennium Development goals by 2015 and subsequently attaining the Sustainable Development Goals by 2030.

#### **2.3.1.1 Brief History**

The earliest SFP recorded in history was in 1790 in Germany, where soup kitchens were created in municipal areas and school were encouraged to send their pupils there at noon as part of a Count Rumford's international campaign against vagrancy in Munich (Bryant, 1914).

But perhaps the most documented SFP programme is the British School Meal, which was started formally in 1906 when the Liberal Government of Britain authorised local councils to give free meals for children from poor families. By the year 1914, over 158,000 children were fed free meals once daily.

The introduction of Education Act in 1944 in England made it an entitlement for pupils to receive a free school meal (Bryant, 1914). Worldwide, the WFP is the most prominent implementer of SFPs, serving an average of 22 million children in schools in 70 countries, to support efforts to achieve the Millennium Development Goals of halving the proportion of hungry people and to ensure that all children are able to complete a full course of primary school.

### **2.3.1.2 School Feeding Programme Strategies and inputs**

With the exception of extreme famine and severe disasters, the burden of disease attributable to malnutrition and its related comorbidities varies in every population but the common risk groups are women and children. Poverty and food insecurity remain the main predictors of malnutrition, the intricate population specific determinants vary depending on the at risk group. Hence adequate knowledge of population specific needs as well as at-risk specific factor is required in malnutrition intervention to ensure maximum impact and cost effectiveness.

Over the years, various agencies have targeted schools (including day care centres) as the new gateway to integrated primary health care services. Schools currently serve as avenues for the provision of malnutrition related preventive and curative services (nutrition rehabilitation) such as meals, vaccination, nutrition education and growth monitoring. The various strategies and target schemes in tackling malnutrition in schools including the following.

#### ***Supplementation programmes***

Supplementation programmes are often characterised by the provision of highly concentrated of individual/mixtures of (usually synthetic and lipid based) vitamins and minerals in the form of powders, capsules, pills or liquids (separately from the diet) typically to treat specific micronutrient deficiency diseases or to boost micronutrient sources in

vulnerable groups in a given populations (Allen and Gillespie 2006; Allen et al 2001).

In nutrition emergency such as famine and wars, where time is of the essence, its application is ideal to deliver a rapid nutritional solution. In such situations the programmes usually involve the administering of nutrients in oral or injection form as a short-term measure in malnutrition alleviation as part longer-term health care programmes or whilst planning for long term nutrition specific programmes (FAO, 1993, EU, 2013).

Traditionally, supplementation activities are usually carried out in forms of community outreaches and /or as part of primary health care programmes without prior assessment of their individual need. Through the years, supplementation programmes have targeted schools and nurseries as it provides a unique access to large number of children and the education structures gives room for continuous monitoring and evaluation. Supplementation programmes in schools (usually micronutrient such as iron, calcium, folic acid, vitamin a, zinc) are mainly targeted to cover high-risk groups: nursery school toddlers, adolescent girls and girls of childbearing age (Allen and Gillespie 2006; Maleta, 2006).

Provision of individual or mixture of Iron and folic acid supplements remains some of largest and most commonly supplementation programme campaigns in schools (WHO, 2001). The greatest advantage of supplementation programmes is cost-benefit effect. The World Bank estimates that the per capital cost per unit is low: for instance a dose of vitamin A cost between USD 1.00 and USD 2.5 per capital whilst the cost is put at between USD 0.5 and USD 3.17 per capita.

Although supplementation campaign activities for at risk groups provide excellent opportunities for treatment on a large scale, the success rate of various blanket supplementation programmes that target entire populations are not always effective (Webb, 2014; Sphere Project, 2011: Navarro-Colarrado, 2011). In most emergency areas in the world, supplementation intervention is vital, but truth be told vast the majority of at risk population (Africans and south Asian) are not in emergency state or

suffering from the strains of natural disaster. Hence, for the vast majority at risk population in Africans and south Asian is crucially unsustainable.

Also the focus on a single nutrient supplement instead of food diversity and healthy eating greatly reduces impact. In health promotion, a combination of micronutrients is required for optimal nutrition status improvement and no combination of supplemental vitamins, minerals, or other nutrients could possibly emulate the exact diversity of nutrients and compounds found in the food (NIH, 2007; Yetley, 2007; Rosenberg, 2007).

Therefore, consideration must be given to synergistic interaction between nutrients and other biological substance like hormones and enzymes that promote growth. Single nutrient supplementation therefore favours an increase intake of one nutrient at the expense of the other, thereby distorting the balance of nutrients and thereby altering the normal homeostatic required for optimal growth (Ward, 2014).

Certain supplementation programmes fail to give consideration to the presence of other conditions (hygiene, worms, malaria status) that may limit the individual's response to supplementation (Boni, 2016: Sommer, 1995). In areas where there is a high prevalence of parasitic infestation such as malaria and/or high incidence of infectious diseases, beneficiaries can have a negative influence on the effectiveness of supplementation programmes (Sommer, 1995). Such confounders may limit the individual's response in supplementation programmes. For instance, there has been observation where supplementation of iron increased the virulence of malaria in high-risk populations.

Supplement-diet interactions present another drawback. For instance, in most poor income populations where iron deficiency is most prevalent, dietary patterns tend to be saturated with meal with high polyphenol and phytate content (Chibarabada et al 2017). The presence of these compounds greatly affects the efficacy of iron supplementation in such populations because of polyphenol and phytic acids are natural inhibiting factors of Iron (Dar et al., 2012: Sotelo et al., 2010).

Health and consumer groups, argue that in contrast to perception that the population wide supplementation has a direct impact on health improvement, most supplementation campaigns are ineffective due to low compliance due to the lack of political commitment and financial support (Sommer 1995); socio-cultural and religious differences in beliefs systems of donor and recipients populations (Alonso, 2015; Jasti et al., 2003). Other systematic issues include poor sensory appeal (colour/taste) of supplements and inadequate education of recipients on dosage, diet and supplement interactions as well as undesirable side effects).

### ***Supplementary feeding programmes***

Supplementary feeding programmes in schools are usually in response to chronic food and nutrition insecurity and involve the distribution of fortified or specially formulated foods /meals (usually high nutrient read-to-eat –therapeutic meals) by donors, international agencies and or local governments (James et al., 2016: Rose 2008).

Supplementary feeding programmes in schools are primarily designed to distribute food among children in order to improve their nutritional status (promote catch-up growth) or to prevent deterioration in health and nutrition (FAO, 2012). Nutritional vulnerability and anthropometric measurements such as weight-for-age or weight-for-height indices are usually criterion, which forms the framework for the selection of eligible children (FAO 2012). The type of supplementary feeding provided are typical grouped under Ready to Use Therapeutic Foods (RUTF)/ Ready to Use Supplementary Foods (RUSF and fortified meals).

### ***Ready to Use Supplementary /Therapeutic Foods (RUTF)***

Ready-to-use therapeutic foods (RUTFs), are energy-dense, micronutrient-enriched pastes which are made by embedding the protein

and carbohydrate components of the food to in the lipid matrix (DFID, 2011; Rice, 2010). The nutritional profile usually supersedes what normal food intake provides and often consists of peanuts, oil, sugar and milk powder (Rice, 2010, Isanaka et al., 2009).

The positive aspect of RUTF is the fact is its long shelf life, which makes RUTF microorganism contamination resistant without refrigeration even at tropical temperature. Hence, this can allow a yearlong intervention, even in countries with hunger gaps. Targeted supplementary feeding programmes that focus on vulnerable groups like girls usually involve distributing take-home RUTF food rations through schools. Targeted supplementary feeding programmes are usually designed with other social agenda aside nutrition like promoting female education.

There is increasing evidence that take-home RUTF food rations motivate these social agenda however there is very little plausible data on the long-term effectiveness to the recipient (McClellan 2014). For instance, for supplementary feeding programmes that provide take home portion, are significantly affected by Intra-household leakage. Intra-household sharing of the supplementary food(s) reduces the impact of supplementary food. This is especially true in target population where families eat together; rations are usually split amongst the entire household without respect to at-risk individuals.

Key questions have also been raised about the impact of RUTF supplementation on nutritional status of school children and cost effectiveness. The argument is that administering of RUTF alone cannot result in improvements in nutritional status of children (Pradhan, 2016; McClellan, 2014; Yang et al., 2013). Non-proponents of the use RUTF in non-emergency settings believe that for the most nutritional vulnerable (poorest economies where the need is greatest), the dynamics malnutrition consists of other forms other than SAM and RUTFs are neither necessary nor appropriate long-term treatment (McClellan, 2014).

There are those who believe that donor external sourcing of blanket RUTF products does not adequately contribute to local food sovereignty and defeats the course of food security. The reliance on foreign manufactured product exponentially increases cost and raises ethical question concerning the commercialization of intervention food.

For instance, several donor (usually foreign donor) driven schools based RUTF interventions (usually part of large humanitarian programmes) tend to be monopolized sourcing from a handful of manufacturers (usually foreign) in order to put in place strict quality control measures on production and distribution. Such practice fails to consider indigenous food-based solution.

In doing this they fail to identify the unique dynamics of malnutrition of the Indigenous/local populations (McClellan, 2014). DFID (2011) suggests the need for food-based solutions like the SC<sub>m</sub> meals that deal with intrinsic determinants of food security, food safety and food distribution within the target population without any drastic change from indigenous food systems and practices.

Donor driven supplementary programmes tend to have a great mismatch between recipient needs/desires and the commodities donated by donors. Poverty remains the main risk factor for malnutrition hence often done not, the assumption is that poor people are incapable of nourishing themselves. Hence, most donors seek to address malnutrition with a one rule fits all resulting an increasing need for more aid and decreasing local food sovereignty and cultural food expression.

In an attempt to address such problems, measures have been instituted to ensure that the bulk of RUTFS are produced in recipient countries as seen in Sierra Leone, Malawi and Haiti (Table 2.1). This has to an extent boosted local manufacturing industry, however, there are still issues with quality control as well.

*Table 2.1 Examples of RUTF available on world market*

<i>RUTF</i>	<b>Donor/Manufacturer</b>	<b>Main Constituent</b>	<b>Calories Per Pack</b>
<i>K-Mix 2,</i>	UNICEF	<ul style="list-style-type: none"> <li>• 3 Parts By Weight Calcium Caseinate</li> <li>• 5parts dried Skimmed Milk</li> <li>• 10 Parts Sugar</li> </ul>	n/a
<i>Plumpy'nut,</i>	NUTRISET France Innofaso, Burkina Faso	<ul style="list-style-type: none"> <li>• Peanut Paste,</li> <li>• Vegetable Oil,</li> <li>• Powdered Milk,</li> <li>• Powdered Sugar,</li> <li>• Vitamins, Minerals</li> </ul>	500 kcal per 92-gram \$65 for 150 packets
<i>Medika Mamba,</i>	Meds and Food for Kids in Haiti	<ul style="list-style-type: none"> <li>• Ground Roasted Peanuts</li> <li>• Powdered Milk,</li> <li>• Cooking Oil,</li> <li>• Sugar,</li> <li>• Vitamins And Minerals</li> </ul>	500 Kcal per 100g 150 packets \$50-\$70
<i>BP-100,</i>	World Health Organization GC Rieber Compact	<ul style="list-style-type: none"> <li>• Wheat Flour (Baked)</li> <li>• Oat Flour (Baked),</li> <li>• Vegetable Oil, Sugars,</li> <li>• Milk Proteins, Skimmed Milk Powder,</li> <li>• Vegetable Protein, Minerals,</li> <li>• Amino Acids, Vitamins</li> </ul>	300 kcal per 100g
<i>Nutribun</i>	United States Agency for International Development	<ul style="list-style-type: none"> <li>• Whole Wheat Flour,</li> <li>• Non-Fat Dried Milk Powder</li> <li>• Soy Flour,</li> <li>• Iodized Salt</li> </ul>	400 kcal per 100g

*Source: UNICEF SD, RUTF pre-bid conference manual, August 15, 2012*

### *Fortification of Foods*

Food Fortification involves the addition of macro/micro nutrient (natural or synthetic) at levels that are natural or near natural levels of nutrients in the naturally occurring food, product or ingredient (FAO, 2012).

To ensure that the target population benefits from the programme, fortification programmes are usually based on adopting an appropriate food vehicle (usually an affordable, widely consumed food staple) which is available throughout the year and does not require the target groups to alter their diet and dietary patterns (FAO, 2012; Samaniego-Vaesken, 2012; Dary and Mora 2002).

There is strong scientific evidence that on in school-based distribution of fortified food on a regular basis is likely to adequately replenish the body's nutrient stores more efficiently and effectively than intermittent administering of supplements in schools (Spiro and Buttriss 2014; Samaniego-Vaesken, 2012).

Fortification is suggested as more cost-effective than other strategies, especially if the technology already established with effective sustainable lines of food distribution system are already established (WHO 2011; Pouraram, 2010). For at risk school populations there often coexist multiple micronutrient deficiencies, hence there is a need for interventions that can tackle a cross section of deficiencies at the same time. Fortification offers an avenue to add several micronutrients simultaneously which may not necessarily be the case with supplements (FAO, 2014, Allen et al., 2006). It is usually possible to add one or several micronutrients without substantially changing the form or taste of the natural occurring food.

For growing children who need a sustained supply of micronutrients for growth and development, fortified foods provide an avenue for tackling the risk of the multiple deficiencies that result from seasonal gaps in the food supply or a poor quality diet (De-Regil et al., 2013).

Mandatory fortification for the general population has come under scrutiny in recent years (Samaniego-Vaesken, 2012; Bonner et al., 1999). Critics claim that large-scale food fortification of food favours industrial varieties of food over local food variety and gradually leads to loss of local variant (Ritu and Gupta, 2014; Khush, 2001). The introduction of fortified varieties of local foods presents a unique challenge for the survival of local

indigenous variety of crops. Population tends to favour purchasing of industrialised or fortified varieties, which affects local agricultural production of local varieties and slowly drives the use of local or indigenous food into extinction (Ritu and Gupta, 2014; Timothy and Eyzaguirre, 2006; Khush, 2001).

Large scale marketing campaigns run by mandatory fortification proponents tend to market the industrial fortified foods as best practice and much more nutritious than the local variety, hence large section of target population gravitate toward those types of foods as treatment rather than food (Ritu and Gupta 2014; Smith 2010; Khush 2001, World Resources Institute1992). This practice medicalizes the very human function gathering, cooking, eating food and gradually robs entire cultures of its own indigenous food identity and ethnobotany knowledge (Mayes 2014; Gracia-Arnaiz, 2007.). Such practices violate the International Covenant on Economic, Social and Cultural Rights states that the right to food implies food "free from adverse substances, and acceptable within a given culture" (FAO, 2014).

Critics also claim that while it is possible to add a mixture of vitamins and minerals to relatively any staple foods, there are concerns about dosage of fortificants, whether natural or artificial is required only in specific amount (below upper tolerance levels) for optimal body function (EFSA 2006). Consumer concern groups advocate that there should be a need to fully inform consumers of any possible interactions among nutrients that are added and nutrients already present in the food item so that consumers' food choice can be based on informed choice rather than blank distribution (FSA 2012, Institute of medicine, 1991; Heimbach, 1981).

The absence of detailed information on labels of fortified foods for school intervention complicates the estimation of how much of each nutrient is and raises ethical dilemmas concerning consumer choice. Proponents of fortification have suggested the need to establishment of stricter standards as well as the quality control and assurance and monitoring mechanisms for the production of fortified foods especially

fortified foods meant for vulnerable groups like school children (EFSA 2006).

Opponents of distribution and feeding of fortified meals in school feeding programmes believe that the supply of fortified products fails to identify many of the root causes of malnutrition in school age children and take a top-down approach to resolving child undernutrition (McClellan 2014). The efficacy of fortification based school feeding programmes in malnutrition treatment and control is not in doubt, however, the long-term effectiveness of such programmes are often flawed with the absence of clearly stated exit rules, or incorrectly applied/enforced exit rules (Sandberg 2015).

The inability to prioritize nutrition education and behaviour change in the implementation of nutrition centred intervention results in the majority of the target population do not follow on with the recommended practices once the programme is over (McNulty 2013; Brug, Oenema and Ferreira, 2005; Smith and Smitasiri, 1995). Therefore, interventions for long-term prevention and control of micronutrient deficiencies should be based on balanced diet and child education about how to choose foods that provide a balanced diet, including the necessary vitamins and minerals.

### ***Diet diversification***

Diet diversification is a sustainable approach to malnutrition prevention, which involves improving the nutritional density and dietary adequacy of a population/individual's food intake by promoting the simultaneous intake of micronutrient from various food sources (Gibson, Perlas and Hotz, 2006). The concept relies on the theory of food synergy that postulates that the consumption of a variety of nutrients from different food sources in adequate amount together can reduce antagonistic interactions and promote optimal nourishment (Gibson, 2014; Gibson and Anderson, 2009; Gibson and Hotz, 2006).

Diet diversification programme in populations, especially in schools are usually not target dependent, but involve the empowering individual and or populations at large to take charge over their own dietary needs through nutritional education, nutrition sensitive agriculture, which often translate into informed choice on how acquire, combine, process (cook) and eat (portion) local available food (Nair et al., 2016; Gibson and Hotz, 2006).

Current scientific knowledge on addressing nutrition problems seem to suggest that diet diversification is the most effective long term strategy for improving the health outcomes of SFP in resource-poor settings, starch-based diets (Gibson 2014; Allen 2003). When diet diversification is buttressed with adequate nutrition education the repercussion are children who are well nourished, well aware of the healthy food choices and are able make healthier food choice from the food available in their own community (Nair and Konapur 2016; Gibson 2014; Gibson and Anderson 2009; Gibson and Hotz 2006). The only downsized is that in order to reach different segments of the population who may have different dietary habits, hence dietary diversification messages must be tailored to the specific needs of a population

### **2.3.1.3 Nutritional interventions in school best practice and benefits**

Each intervention strategy discussed in the preceding section has its merit and can be applied to various population but the underlining principle is sustainability requires effective implementation guidelines which are based on evidence-based policies that address dietary deficits of a peculiar to population by drawing from the strength of multiple strategies. There is no one fits all set of rule for nutritional intervention as the dynamics and determinants vary from population to population (UN, 2010).

Each intervention strategy discussed in the preceding section has its merit and can be applied to various population but the underlining principle is sustainability requires effective implementation guidelines which are based on evidence-based policies that address dietary deficits of a peculiar to population by drawing from the strength of multiple strategies. There is no one fits all set of rule for nutritional intervention as the dynamics and determinants vary from population to population (UN, 2010). WFP (2004) recommends that the following SFP should

- be based on social/ cultural acceptable local foods that are nutritious accessible affordable
- based on sound nutritional policy and guideline on procurement, menu content, portion size
- promote nutrition education and local capacity building.
- incorporate complementary health service such as malaria screening and treatment, deworming and growth monitoring and
- promote environmental and water hygiene

A combination of all these factors contributes to meeting the unique nutritional needs of the target population (as shown in Figure 2.4). In recent years, the dynamics surrounding SFP have evolved. Many development partner agencies and organizations have embarked on programming initiatives begin by investing more nutrition sensitive agriculture, which translates into SFPs that provide nutritional adequate meals that curb short-term hunger and prevent disease.

Nutrition education in school feeding programmes is a key factor in promoting healthy food choices and food diversity which a pivot in enhancing the individual and national food security (McNulty, 2013; Brug, Oenema and Ferreira, 2005). Modern SFPs also serve as an avenue for the Administration of health interventions that directly address child health such as growth monitoring, immunization and deworming schemes. Within this context efficient SFPS have become idea long-term social development tools and serve as dispensable tools for ensuring national productivity, capital development and social protection.

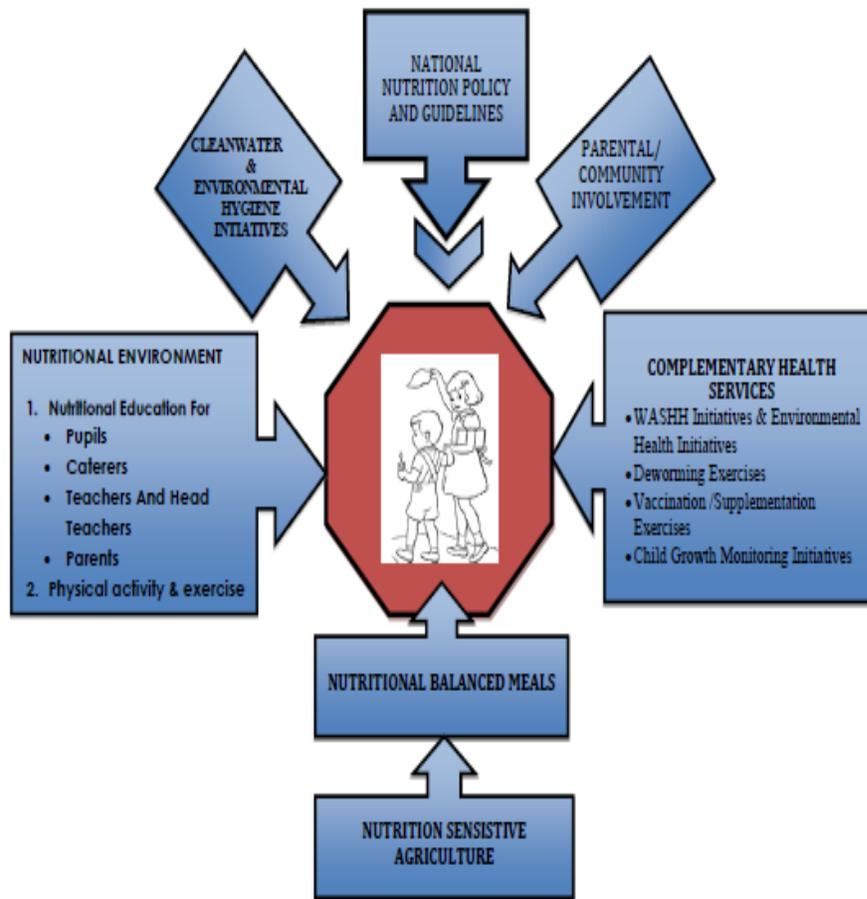


Figure 2.4: Visual adaptation WFP Framework for school feeding intervention design for SC<sub>m</sub> intervention team

### Health benefits

Provision of school meals enhances the dietary intake of school children and provides the needed energy for classroom activity. It also curtails short-term hunger, which in turn help children to concentrate on class activities. In schools where meals are planned to ensure dietary adequacy and nutrient balance, school meals significantly increase micronutrient intake for mineral and vitamins and help in anaemia prevention and treatment (Nair , Augustine and Konapur, 2015). Andaygo et al., 2007 and Adelman et al., 2008 both reported improvement in anaemia status as a result of school meals consumption.

SFPs with planned menus with well-balanced school meals have been reported to promote catch growth in malnourished children (Bennett, 2003; Adair (1999); Del Rosso and Marek 1999 and 1996). Bennett, 2003 reported evidence of micronutrient supplementation for the growth of school-age girls translating into reduction of childbirth complications in adulthood.

Other nutritional impacts include reduction of stunting (Powell et al., 1998), wasting (Powell et al., 1998) and underweight (Nkhoma et al., 2013). SFPs that make use of fortified feeds and tailored food recipes improve micronutrient levels in children and ensure nutrient diversity (van Stuijvenberg 1999; PATH 2009)

SFPs that provide fruits have been reported to significantly increase the vitamin C stores of children tend help to ward off and fight childhood disease and increase absorption of Iron from non-heme food sources. This is especially important for low-income countries (where the need is greatest) where proteins are mainly from non-heme sources (Yang et al ., 2016). For SFPs that integrate other complementary health care programmes such as immunization and deworming provide a wide spectrum of health impact and promote a holistic approach to the eradication of hunger and malnutrition (WFP/UNESCO/WHO, 1999; WFP2004).

The provision of nutritional education alongside nutritious meals helps to direct children towards healthy nutritional knowledge, eating habits, perceptions, attitudes and lifestyle. The benefit of developing healthy dietary and lifestyle patterns from an early age is crucial to ensuring good nutrition and healthy lifestyle throughout adulthood (Barker 2003 and 1996).

### *Educational / academic benefits*

In terms of educational outcomes, existing evidence indicates that the provision of meals at school has been associated increased attendance with improved attention (Grantham-McGregor, 1998; Lawson, 2012). In a Peruvian study (Pollitt, Jacoby and Cueto, 1995) similar to the Jamaica study (Grantham-McGregor,1998) mentioned in the earlier sections the effects of an iron fortified beverage and a baked grain product breakfast on cognitive performance, 23 malnourished and 29 well-nourished 9 to 11 year old boys. In both of the studies cited above there were improvements in short-term memory test and discrimination of geometric patterns. The effect was much more significant in the malnourished children (Pollitt, Jacoby and Cueto, 1995). Del Rosso, (1999) and Nkhoma (2013) both reported similar effects on cognitive ability and overall child educational output.

Research also shows that the feeling of satiety and reduction of short-term hunger results in a positive effect on behavioural changes in the classroom and on the playground (Murphy,1999; Kristjansson et al., 2006). These changes in psychosocial characteristics are more pronounced in children from poor backgrounds (Murphy,1999; Kristjansson et al., 2006; Buttenheim, 2011). That is, when children are fed adequately they are likely to behave better and are less likely to express negative coping strategies like fidgeting during lessons, fighting in the classroom or on playing fields.

Studies on SFPs in Jamaica, Kenya (Whaley et al 2003);, Bangladesh (Tan et al., 1998, the Philippines (Adelman et al., 2008 have all reported the provision of school meals also affected rate of attentiveness increased; children appear less distracted and show an interest in learning. As a result, such schools tend to report lower failure and repetition rates, higher test scores, with many of these programmes also demonstrating improved attendance and study skills (Ahmed, 2004, Juke et al., 2008)

## *Gender equality and social protection roles*

Programmes that reward families of girls with school take-home rations have been said to be an effective way to decrease gender inequality in areas in where education is male biased (WFP/ UNESCO, 1999). Several researchers have postulated that providing take-home rations will encourage families to keep girls in school. Girls who remain in school are likely to have better opportunities to enhance their quality of life, grow up to be healthier mothers and give birth to healthy children thereby decreasing malnutrition invariably (Murphy et al. 1998; Kleinman et al. 2002).

### **2.3.2 Nutritional interventions in Ghanaian schools**

#### ***History***

Over the decades, Ghanaian health sector's approach to childhood disease has been more curative medicine (treatment) than preventive medicine (GHS, 2013). Therefore, most large-scale nutrition interventions have been carried out by international agencies, NGOS and other religious organisations (Government of Ghana, 2006).

The Catholic Relief Service (CRS) has been running school feeding programmes since the 1950s and until 2006, they were the largest SFP implementers in Ghana. The CRS provides one meal to all children attending catholic primary schools/institutions and two meals for infants in catholic day care facilities nationwide, especially in the impoverished northern regions (Government of Ghana, 2006). The WFP has been providing food aid to Ghana over the last four decades.

However, in the period between 2006-2010, its activities intensified with the provision school based meals for primary school children (p1-p6) and take-home-rations for girls in primary four (P4) to junior high 3, as part of the Ghana Education Service's "Education To Benefit Girls" initiative. The take-home rations benefited over 42000 girls and 25

families in the all the districts of the three northern regions (Casely et al., 2010).

With the introduction of the new Ghana health policy entitled “Creating Wealth through Health” (2003-2006), focus of the health sector shifted towards addressing the broader determinants of health such as nutrition, physical activity and recreation/rest. This prompted a shift in governmental approach to health promotion. One of such governmental approaches is the Ghana School Feeding Program (GSFP).

### ***Ghana school feeding programme***

The Government of Ghana (GOG) initiated the GSFP in 2005 with aid from Dutch Government (SNV), with the aim of providing school children with one hot, “nutritious” meal per day, using locally sourced farm produce. The initiative seeks to enhance household food security and reduce hunger by increasing school attendance, improving health through nutrition and encourage local farming. The strategy was to feed school children with locally sourced food in order to cut down on post-harvest losses and provide markets for local farm produce. With an initial 10 pilot schools, the programme has extended its cover to over 600,000 children in 1000 schools across 138 districts (GOG, 2008, 2009; SEND Ghana, 2009).

In a whole, there is evidence of increasing benefits of the GSFP in terms of increased primary school enrolment ratio (Abotsi, 2013) and net primary school attendance and retention level in participating schools (Government of Ghana, 2006). Although it is too early for long-term health impact studies, there exist very little published data regarding the short-term nutritional impact of the GSFP on children in participating schools. In that, after almost 10 years of the programme GSFP continues to be challenged by increasing expectations from the food supply on one hand and fundamental gaps in the nutritional structure of the programme on the other plus constraints on the monitoring and evaluation of the programme impact.

## 2.4 Problem statement and rationale

While government is scaling up to increase investment in the GSFP, there is currently little evidence of measurable nutritional benefits arising from the current programme. Reports by World Food Programme (WFP) and other donor partners like School feeding Initiative Ghana Netherlands (SIGN) have raised concern about the nutritional impact of the programme (Casely et al., 2010; Hauwere, 2010).

Although the GSFP was developed as a nutrition specific intervention for Ghana, the political focus on increasing school enrolment has basically changed the objective to increasing school enrolment and retention. Reports from several evaluations (See table 2.1) rarely include the achievement of explicit nutritional goals among their conclusions.

There is a general assumption among implementers that the nutritional status of the participating children would automatically improve as a result of greater access to food thereby reducing food and nutritional insecurity in the long term. However, the lack specific nutritional objective means the programme does not adequately prioritize food content, methods of preparation, which in turn greatly impedes its nutritional impact. That notwithstanding, there has been some reports of reduction in short-term hunger (Martens, 2008) however these studies fail to indicate how the provision of meals actually add adequate calories and nutrient to the dietary intake of participating children's.

Despite progress made in increasing school enrolment levels, evaluations (Table 2.1) have the nutritional impact of GSFP is not sufficient to reduce the food and nutritional insecurity of the participating populations. A cross-sectional study conducted in the Central Region of Ghana indicated that although the school lunch significantly contributed to the diet diversity among children at GSFP schools, no differences were found between the whole day food consumption of GSFP children as compared to non-GSFP children (Van den Berg, 2008). In a similar population, Danquah et al., (2012) reported that the nutritional and health status of the children in the Ghana SFP schools was not improved by serving the daily hot meals. Although these results do not imply that the

programme does not confer any nutritional benefits, it suggests the absence of a standardised system for monitoring and evaluation of impact.

Several reports show (Table 2.2) that the GSFP lacks complementary health programmes that run simultaneously to ensure optimal absorption and utilization of nutrients. In most areas, the GSPF programme fails to address the fact that the principal factors that affect nutrition status of school children are quality and quantity of dietary intake as well as the physiological predisposition of the child (Hauwere, 2010).

Although GSFP may provide nutritious meals, the nutrients may not be assimilated due to the presence of parasites and infections. Implying that GSFP may be tackling the problem of poor dietary intake, however the absence simultaneous complementary strategy to eradicate endemic infections, very little nutritional impact is received by participating children (Nuako, 2007; Hauwere, 2010).

The synergic interaction between infections and nutrition as discussed in earlier section is a very vital factor to consider in child centred interventions, as presence helminths and malaria parasites can cause loss of appetite and nutrient loss due to malabsorption in the gut (Gupta et al., 2009), nutrient diversion for immune response (Muller et al., 2003) and diarrhoea (WHO, 1995). Therefore, health programmes such as malaria screening, deworming and immunization need to be integrated into the GSFP in order to attenuate the problem of nutrient loss and promote optimal conditions for nutrient absorption and utilization (WFP, 2004).

For any SFP to be efficient, WFP (2004) recommends that standard guidelines on food supply, food preparation, adequate health evaluation and monitoring have to be in place to ensure good practice and ensure optimum child growth and development

**Table 2.2 Studies conducted on the impact of Ghana school feeding programmes**

Reference	Type of study	Outcome measures	Key findings
1. Danquah et al., (2012)	Cross sectional study 234 pupils between 9 & 17	Anthropometric	<ul style="list-style-type: none"> <li>The programme did not impact the nutritional status of participants.</li> </ul>
2. Aullo et al, 2016	Clinical trial with 116 primary schools in 58 districts	Anthropometric Hb	<ul style="list-style-type: none"> <li>The analysis of the baseline data indicates that the random allocation process did not achieve statistically comparable treatment groups.</li> </ul>
3. Mohammed Sulemana Ilbrahim Ngah & M. Rafee Majid 2013	Review paper	Impact on School attendance , retention	<ul style="list-style-type: none"> <li>The findings showed that, whilst the programme has increased primary school enrolment, the major impediment to the implementation of the programme is cash flow constraints.</li> </ul>
4. Hauwere, 2010	Cross country review of the Pilot GSFP	Impact on Nutrition Agriculture	<ul style="list-style-type: none"> <li>“GSFP has not evolved in line with the programme document and fails to achieve its aim”</li> </ul>
5. SNV-SEND 2008	Programme donor evaluation in 50 districts of Ghana	Impact and project implementation evaluation	<ul style="list-style-type: none"> <li>“Weak institutions make for a weak safety net, school feeding program was not living up to its potential”.</li> </ul>
6. Aliyar et al., 2012	Literature searches using the Ovid MEDLINE databases	implementation evaluation	<ul style="list-style-type: none"> <li>There are no legislated or advised nutritional guidelines</li> </ul>
7. Buhl, 2012	Review paper	Impact on nutrition School attendance , retention	<ul style="list-style-type: none"> <li>Insufficient supply of food to schools, creating inadequate/irregular food portions.</li> <li>Varying degrees of linkage to local farmers/local food supply for food procurement.</li> </ul>
8. Abotsi 2013	Cross section study and observation	Impact on School attendance , retention	<ul style="list-style-type: none"> <li>National school feeding program implemented in Ghanaian basic schools included in this study showed positive effects on school enrolment and school academic performance, but less remarkable impact on attendance over an extended period of 3 years.</li> </ul>
9. Yendaw and Dayour; 2015	Review paper	GSFP participant perception of meal s	<ul style="list-style-type: none"> <li>The results revealed that a higher percentage of the respondents viewed meals prepared for pupils to be of moderately low quality and quantity</li> </ul>
10. Martens, T J 2008	129 children 4 districts in Central Region, Ghana (3 <sup>rd</sup> grade children aged 7 to 16 years)	Anthropometric measurement	<ul style="list-style-type: none"> <li>GSFP succeeded in increasing the dietary diversity of the diet of the school children in the selected school</li> </ul>
11. Manful et al, 2015	Cross section study and observation in six beneficiary schools and six non-beneficiary schools	Impact on Social Protection	<ul style="list-style-type: none"> <li>School Feeding Programme has achieved some gains for beneficiary schools but it has also resulted in inequality and injustice within the communities,</li> </ul>

Questions have been raised about the absence of nationally established nutritional guidelines/standards on meal composition, portion size and food safety for the GSFP (SNV 2007; Aliyar et al., 2012). Menus are said to be prepared with assistance from a nutritionist in some districts, but in most districts decisions pertaining to food procurement, menu planning and meal preparation follow the caterer model. In this model, nutrition centred decisions are solely based on the caterer/cooks knowledge and experience in child nutrition (Ohene-Afoakwa, 2009; Aliyar et al., 2012). The model leaves room for services discrepancies, and stalls comparable impact evaluation.

To date, over half a million school children depend on the GSFP meals as their main stable source of food for the day, however, there is insufficient rigorous evidence based evaluations of the nutritional and health impact of the GSFP meals (Nuako, 2007).

Currently concerns about the lack of nutritional impact has made it imperative that efforts be made to conduct studies that target and evaluate specific nutritional outcomes and biomarkers of children participating in the GSFP. To do this, there is a need to ascertain the nutritive value of meals being served at the school level, identify any possible short falls, design innovative ways to improve nutrient content and provide comparable nutritional surveillance data for future policy drafting. It is also critical to foster and empower the education of stakeholders at the district level to enhance its impact and ensure its sustainability.

## **2.5 Proposed strategy**

This research is geared towards evaluating the nutritional impact of the GSFP in the Lower Manya Krobo District of Eastern Region, Ghana by evaluating the nutritional status of the school children currently participating in the programme. The second phase of this research is geared at enhancing the current meals by optimising locally available produce to that meet the health needs of the pupils as well as promoting the incorporation of complementary health programmes such as deworming and growth monitoring into the GSFP activities in the district.

The study follows the Tailored Functional Food Recipes Concept (Amlogu et al., 2012; Kapoor et al., 2014) which is a novel concept that develops meals that are not limited to the elimination of hunger, but extends to the design and engineering of food that transcends disease prevention by improving availability of micronutrients, increasing biological functions and promoting sustainable health. The S-cool meal (SC<sub>m</sub>) is TFR concept that seeks to develop functional foods for school feeding programmes.

### ***Tailored Functional food Recipe concepts***

Tailored functional food recipes refer to food that is naturally occurring, accessible and affordable, perhaps consumed in unnatural concentrations as part of the usual diet and has demonstrated physiological and or biomedical benefits in reducing the risk of disease beyond basic nutritional functions (Amlogu et al., 2012)

The principles applied in this concept are based on the Global Strategic Framework for Food Security & Nutrition (2013) in that, the TFR concepts links knowledge of ethno-botany, consumer specific dietary preferences and advances in food technology to develop model meals that seek to attenuate a variety of public health concerns. The concept considers that for many populations healthy eating is based on the premise of the consumption of indigenous foods.

To promote sustainable nutrition solutions, a fair understanding of the local/indigenous food systems is integral to invoke real change in health

and nutrition outcomes (Ilyas 2015). Like the measures proposed by CFS Reform Document (2009), the TRF concept fundamentally attempts to promote and improve health by applying indigenous knowledge of local food systems (food preferences, food procurement & food distribution) and existing local low tech food processing (preparation, processing and preservation) techniques to optimize locally available agricultural produce. The aim to provide nutrition that is culturally acceptable, low cost yet appetizing (Amlogu et al., 2012; 2014).

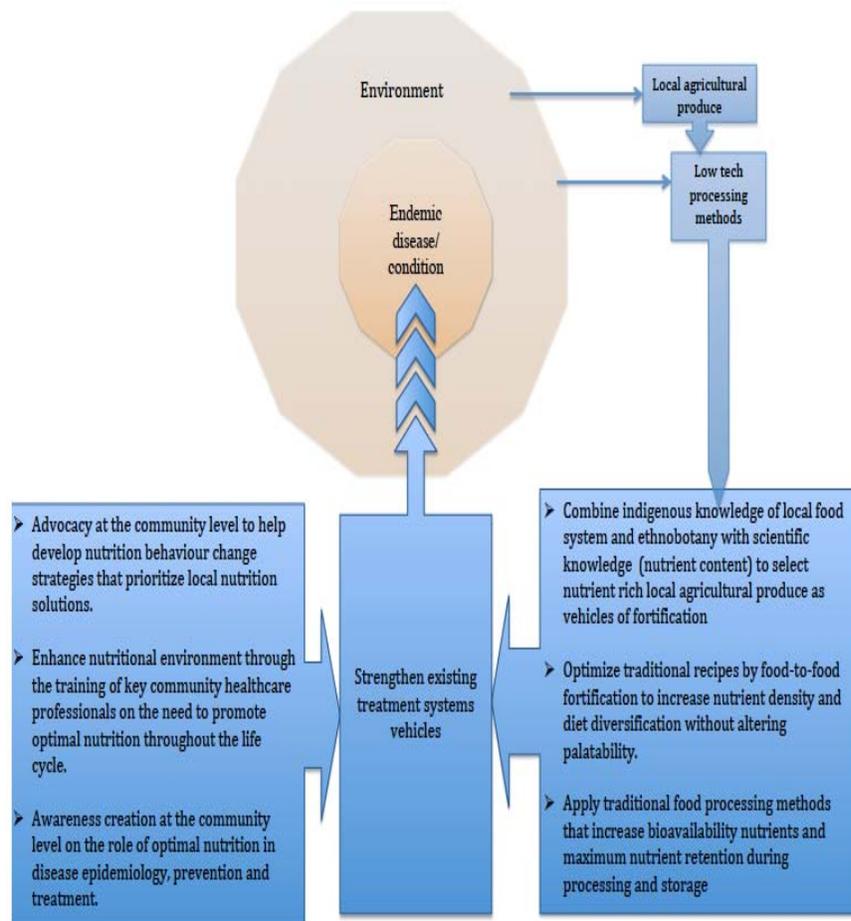


Figure 2.4: Conceptual framework of the TFR concept

### ***S-cool meal concept for GSFP***

The S-cool meal (SC<sub>m</sub>) is TFR concept that seeks to consolidate and strengthen the current effort of the GSFP by improving nutritional status of children through the provision of indigenous meals while improving food choices through nutrition education on indigenous diet diversification. In doing this, the concept seeks to build a framework that builds capacity of people at the community level upwards by equipping them with knowledge on to explore and tap food-based solution from their immediate environment.

The hope is that the findings in this study will establish evidence on the use locally available and accessible crops to improve health outcome, improve food security as well as enhancing food sovereignty. In practice, the concept of the SC<sub>m</sub> employs indigenous food processing methods to improve bioavailability of micronutrients of local agricultural produce without compromising palatability.

The SC<sub>m</sub> concept believes that methods based on only the clinic approach (supplementation) may accurately improve short term nutrition may not be a viable alternative for ensuring sustainable food security and nutrition. The aim is to ensure that methods used are environmentally safe, socially acceptable and replicable at low cost.

#### **2.4.1: SC<sub>m</sub> meal concept and conceptual framework.**

The framework of SC<sub>m</sub> is drawn from the growing wealth of evidence-based science that links diet to disease epidemiology (both chronic and infectious disease).

The ultimate strategy of the TFR is to develop and optimise tailored food recipes and meals that are not limited to the elimination of hunger (macronutrient) but extend to the design and engineering of food that transcends disease prevention by improving availability of micronutrients, increasing biological functions and promoting sustainable health. It capitalises on the principles of using food for that matter functional foods to decrease the disease incidence and improve disease outcomes in any given population as shown in Figure 2.6.

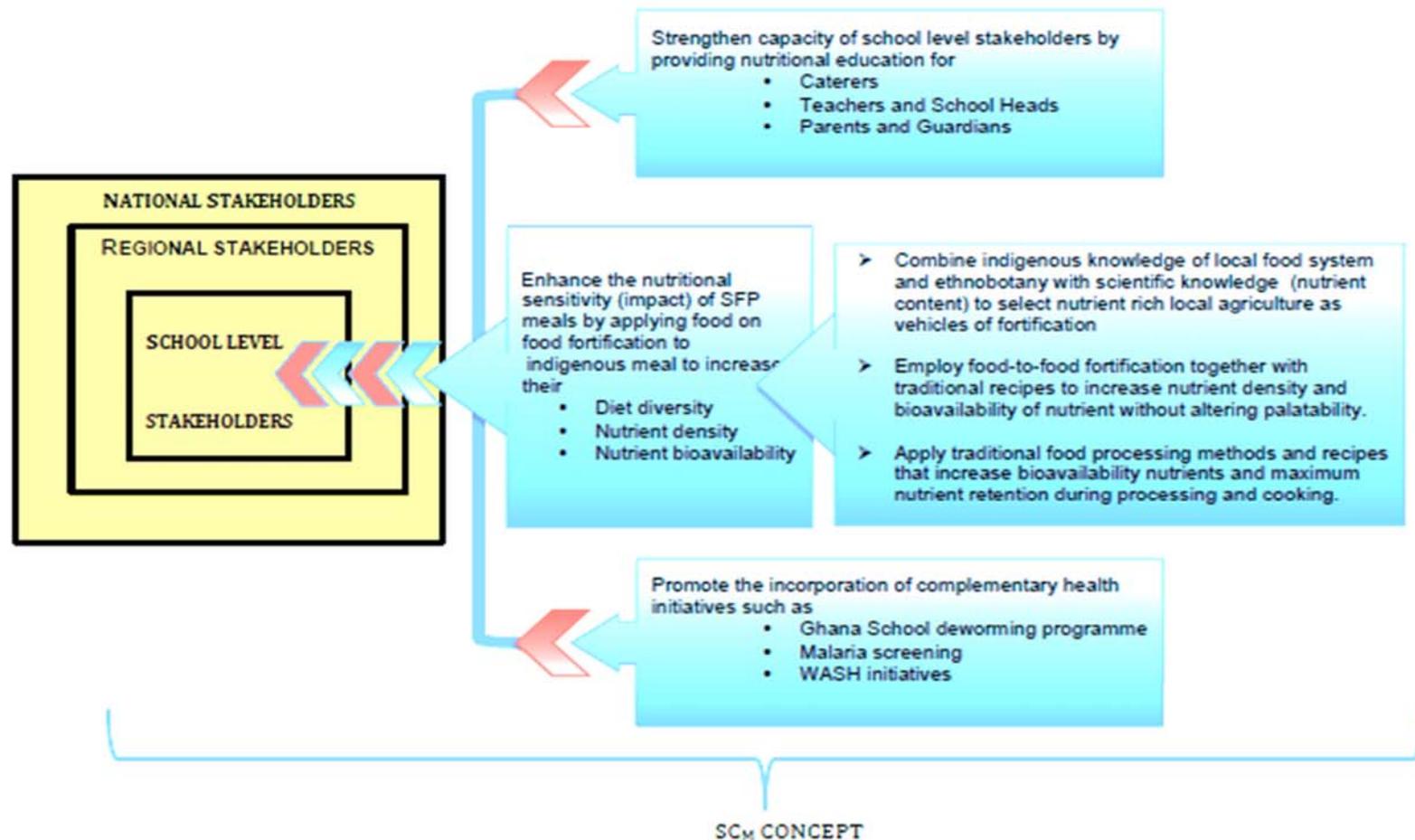


Figure 2.5: Conceptual framework of the SC<sub>m</sub> concept (developed by SC<sub>m</sub> team)

The concept relies greatly on a fair knowledge of local ethnobotany and food technology; the versatility of local agricultural produce and the ability to apply basic food-on-food fortification to manipulate food items to enhance their functionality as well as increasing bioavailability. The decision to use this strategy was based on programmatic opportunities in other studies mentioned in earlier sections, feasibility as well as the cost effectiveness compared to other strategies used in the past.

The assumption is that for each population, the dynamics of malnutrition as well as dietary patterns vary therefore inputs (meals and nutritional education) for intervention should be population /target specific (Ozor and Urama, 2013). This requires some knowledge on what is available in the immediate environment, and how can be used. In the present study, SC<sub>m</sub> prioritises the integration of both indigenous traditional knowledge and scientific knowledge in the planning and implementation of nutrition solution for any given population.

To do this, the concept adopts a three-step strategy; first, is to increase food diversity by applying indigenous food preparation techniques to increase the nutrient density of meals made from local agricultural produce. Second, is to build capacity by providing nutrition education to stakeholders at the school level and finally, promoting the incorporation of complementary health programmes by making a case for the importance of deworming and child physical measurement in promoting health.

#### **2.4.1.1: Enhance the nutrient density:**

The study seeks to develop model meals that will be designed based on sound scientific evidence (nutrient content) and engineered to provide optimal levels of nutrients. The formulations were based on the principle of food-on-food fortification.

The framework for selecting the raw materials was similar to those recommended by British National Nutritional Standards for school lunches in primary schools (See Appendix 4D). Formulations consist of combining locally available foods that complement each other in such a way that the

synergic effect of new pattern of nutrients created in the combination is similar to those recommended for children by WHO guidelines ( WHO/FAO,2006).

For instance, considering the fact that the physiological development experienced in childhood is characterised by high levels of cell division and replication, which easily deplete available protein and iron stores (SACN, 2010). The addition of fish will help increase the protein content whilst the integration of legumes likes soybeans and groundnuts will contribute of non-heme iron to meals (Davies, 2002). The vitamin C from the *Moringa oleifera* leaves will aid in absorption of no-heme iron. Also the utilization of starchy staples such as maize and rice provides good sources of the energy required for the increased physical activity levels in growing children (Lopatka et al., 2008).

The exact formulae and balance of micronutrient was adapted to the health needs the target population. The strategy is to optimise the traditional methods of food processing to ensure minimal nutrient loss during meal preparation. The use of indigenous (low-tech) food preparation techniques ensures easy technology transfer (FAO, 2010, Dube, 2002), reduced cost of production (FAO, 2010) as well as ensuring cultural acceptance.

Raw materials were processed using traditional Ghanaian household food-processing and preparation methods such as soaking, fermentation, germination/malting and solar drying. This is to ensure sustainability and to enable easy transfer of technology to the local cooks and caterers. For most methods, optimization involved reducing physical labour in processing, reducing processing time and preserving nutrient content. Soaking, fermentation and germination/malting of seeds and grains soften the coat of the seed and increase the physicochemical accessibility of micronutrients (Frolic, 2013). The microbial activity during these processes also increases the bioavailability of nutrients whilst decreasing the content of antinutrients, such as phytate (Tumwebaze, 2011; Saleh, 2013).

Some methods will be optimised to ensure maximum retention of nutrients. For instance, blanching of vegetables helps to inactivate degradative enzymes in order to conserve heat sensitive nutrients such as vitamin C and vitamin A. Ensuring maximum retention of vitamin C will facilitate absorption of non-heme iron from legumes and grains (Davies, 2002; Hotz, 2007). A combination of processes was employed to ensure a micronutrient adequacy and emphasis was placed on traditional Ghanaian recipes like aprapransa and mportormportor that ensure minimum processing and nutrient loss without compromising palatability.

#### **2.4.1.2: Build capacity by providing nutrition education to stakeholders at the school level.**

To ensure that wealth of knowledge amassed from the study makes an impact on the study, there was a need to ensure that nutrition education messages in schools translate into nutrition from the agricultural farms through the classrooms to lunch plate (farm-to-fork cycle). This approach was to link nutrition education in the classroom to nutrition practice in school environment (School Feeding Programme), home and in the community at large. The aim is to create a school nutrition environment, which is capable of designing and implement nutrition solutions long after the current project is over.

This study identifies that community involvement is a key part of the exit strategy of this study and a crucial requirement for its sustainability. The overall aim is to bolster local community participation in the existing national GSF programmes at the school level by targeting key change agents (caterers, teachers and parents). Targeting these agent will help to establish an effective school nutrition environment that is capable of filling the gaps in access to food and nutrition information and education.

#### **2.4.1.3 Promote timely complementary health interventions.**

This study recognises the role enteropathy, malaria and infectious disease in malnutrition and seeks to minimise their effect by encouraging

the incorporation of the existing GHS deworming and malaria programme into the GSFP in LMK.

Deworming at the beginning of the school term results in improved appetite, increased rate of absorption in the gut and remarkable growth spurts due to the maximum utilisation of nutrients (Stephenson et al., 1993; Nokes et al., 1992; Nokes and Bundy, 1994). In Kenya, dewormed school-age children gained one centimetre more in height in the four months following treatment than did children who received a placebo (Stephenson et al., 1993). Similarly, in Zanzibar treating with albendazole saved children a quarter of a litre of blood per child per year and improved cognitive function (Nokes et al., 1992; Nokes and Bundy, 1994). The study therefore seeks to provide scientific proof on the importance of deworming by studying at baseline the difference in nutrition status among school with deworming programme and those without.

This study also proposes a framework that links GSFP to continuous growth monitoring of children. In our view, the expected data will form part of the much-needed surveillance data required in the health sector for development of children centred policies. Collection of data on trends in the growth characteristics of children is vital for the purpose of monitoring and evaluation of the intervention impact.

#### **2.4.2 Theoretical Basis of SC<sub>m</sub>**

In 2004, the FAO AND WFP school garden concept note reaffirmed the mandate for carefully designed, comprehensive national nutrition programmes, which leave ample room for local adaptation and integration with the aim of ensuring the full engagement of local communities. However, till date, most donors and implementers still place emphasis on the delivery of maximum nutrition with very little attention to indigenous dietary preference and palate.

The failure to adequately factor-in indigenous dietary patterns and taste preference has been linked to high attrition rates during intervention and the lack of compliance to dietary recommendation post intervention (Colles 2013; GAIN 2007). Interventions that necessitate change in customary dietary practices experience very low sustainability rates and invariably significantly reduce the long-term public health impact.

It has therefore become imperative that, in the design of novel food concept for SFP, enormous consideration should be given to the role of indigenous agricultural produce and indigenous food processing methods and cooking practices as well as indigenous dietary patterns and preference. Tailored functional food/recipes (TFR) concept is one of such interventions and it offers prioritised meals that are prepared from local agricultural produce and formulated based on local food consumption patterns and dietary preference to meet peculiar nutritional needs of a given population (Amlogu et al., 2014).

#### **2.4.3 Study research questions**

This study looks at the development of SC<sub>m</sub> for the GSFP in Krobo Odumase in the Lower Manya Krobo District (LMKD) with the aim of enhancing its nutritional sensitivity by reducing anaemia and promoting physical (Appendix 1<sup>K</sup> to 1<sup>M</sup>). In this study, the critical questions that were addressed include:

1. What is the nutrition content of GSFP meals and what effect does it have on the nutritional status of children?
2. What agriculture produce available in the immediate environment can be used to enhance the impact of the current GSFP?
3. What traditional methods can be applied to ensure maximum micronutrients?
4. How adult indigenes perceive the sensory characteristics of the SC<sub>m</sub>; to what extent the variation in perceived sensory characteristics influences school children's response on hedonic rating scale as well as their future intention to consume.
5. Does the developed the SC<sub>m</sub> meals have any effect on the target

population in?

- a. Short term 6 months
- b. Long term 9 months

#### **2.4. 4 Aims**

To explore these questions the following aims and objectives were set. The overall aim of this study is to investigate the nutritional impact of GSFP in LMK District of Ghana on participating children and attempt to enhance effectiveness using local food crops and traditional recipes

#### **2.4. 5 Objectives**

1. To **determine the nutritional benefit of GSFP IN LMKD** by evaluating the nutritional status of participating and non-participating children over one academic term.
2. To evaluate the nutrition based factors that impact on its effectiveness by evaluating the nutritional content of meals using FAO WESTAC Africa food composition tables.
3. To develop/optimize food base framework to tackle the nutrient deficiencies by employing local agricultural produce in **food-to-food fortification (SC<sub>m</sub>)**.
4. To **evaluate the extent to which the SC<sub>m</sub>** affects the anthropometric and haemoglobin measurements of school children for two academic terms (pilot study) and subsequent three academic terms (scale up).

## CHAPTER 3 PARTICIPANTS, MATERIALS AND METHODS

### 3.1 Study design/approach

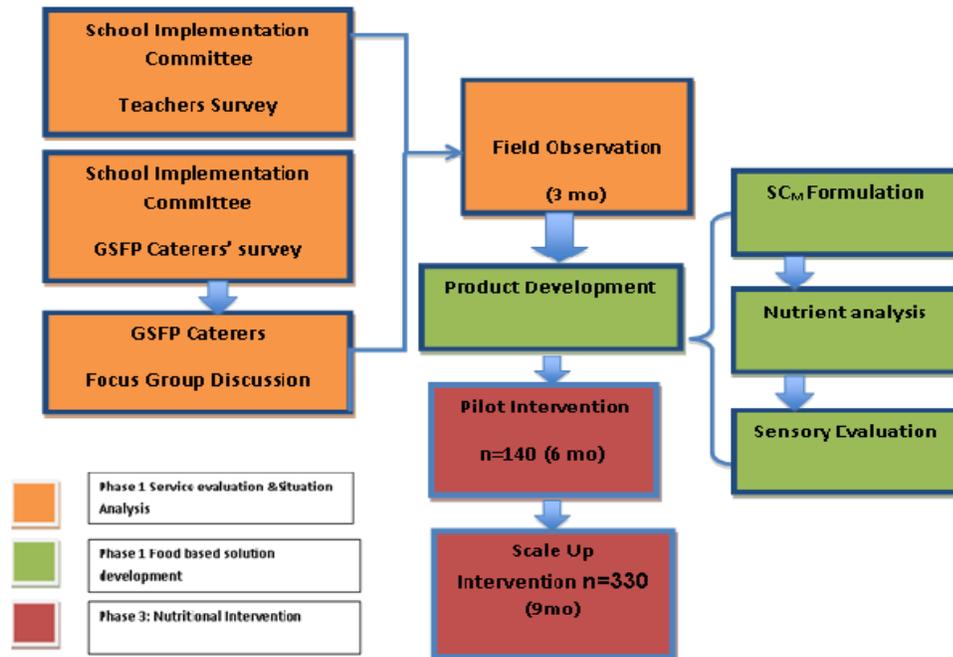


Figure 3.1: Flow chart showing study design through three phases

This study consisted of three main phases (Figure 3.1); a qualitative cross-sectional GSFP service evaluation phase which typically involved in-depth interviews of key informants from GSFP School level implementation committees, focus group discussions with GSFP caterers and with a field observation component which looked at on various key aspects of the GSFP programme implementation. The second phase was a product development that comprised of SC<sub>m</sub> meal formulation, nutrient analysis and a three stage sensory evaluation of SC<sub>m</sub> meals. The final phase was a two-stage SC<sub>m</sub> nutritional intervention (Pilot and Scale Up)

### **3.1. Justification of choice for study design and methods**

The study design and methods were chosen to suit the set objectives (Chapter 2) and obtaining a comprehensive picture of the nutritional status of pupils currently under the GSFP in the Lower Manya Krobo District of Eastern Region, Ghana.

First of all, this study sought to make plausible inferences about the efficiency and effectiveness GSFP in promoting good nutrition among children of school going age in LMKD. The mixed methods and triangulation techniques of data sourcing research facilitated and ensured the validation of data through cross verification of all observations from one phase to the other (Greene, 2007; Caracelli and Greene 1997). In 2000, Cohen and Manion explained that triangulation as an "attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint". This is evident in the triangulation of the data from the key informant survey and focus group discussion (caterer focus group discussion and school stakeholder survey) and the field observation in this study to provide a combination of channels to source data concerning the GSFP nutritional impact.

The collection of both qualitative and quantitative data, enhanced the evidence of any effects of the GSFP on nutritional status of participating children as well as improving the current knowledge on meals offered by the GSFP in the district. The belief is that the combination of evidence from the different design elements as recommended by Carvalho and White (1997) is useful in highlighting reasonable explanation (by deduction and inference) for observed effects (or the lack of effect) of the GSFP on nutritional status of children as well as provide insight as to the availability of local food based solutions to any current gaps in practice.

#### **3.1.1. Cross-sectional Surveys**

The Cross sectional surveys designed as part of the in service programme evaluation study. The surveys utilised open-ended styled questions to interview with GSFP school level stakeholders (teachers and caterers) to collect primary data on the current GSFP activities in

participating School. Key informant surveys helped in assessing the operational issues with the GSFP and served as an avenue for the exchange of ideas between the researcher and the key informants. The wealth of information is crucial in identifying key aspects of study that may not have been obvious in the theoretical analysis, and the rapport created with key informants can be beneficial if the research has a sustainability aspect. Key informant can essentially become behaviours change agents.

***Teacher and Heads of Schools In-depth survey:*** the survey utilised open-ended questions which allowed flexibility in the respondents' answers and prioritizes of the respondents' opinions and observations rather not that of the principal investigator. An analysis by Jamshed (2014) stated the open-end method of questioning was considered exceptionally useful in needs assessment. In the current study, it's provided individuals at school level implementation a chance to elaborate on the daily dynamics that may not be readily observed by an outsider.

**Caterer Semi-structured interviews:** Semi-structured survey technique of needs assessment allows the investigators to explore the views of others in an almost conversational manner by using predetermine open questions (Hancock et al., 2009). Laforest (2009) and Cohen (2006) as well as FAO (1990) all promote the use of semi structure interviews amongst indigenous populations as an effective tool for data sourcing. In this current study the method was employed to obtain data on the socioeconomic and professional characteristics GSFP caterers/cooks with special emphasis on their training and experience in childhood nutrition, their involvement in various aspects of the programme as well as their overall perception of the GSFP (highs and shortfalls in their daily GSFP activities). The conversational style of the interview was to allow caterers to feel relaxed in order to answer question truthfully without the threat of losing their job or being judged.

**Focus groups discussion:** Focus groups provide information about a range of ideas and feelings that individuals have about certain issues, as well as illuminating the differences in perspective between groups of individuals (Green et al. 2003; Krueger & Casey 2000). The use of Non-directive open-ended questioning allowed the focus group to explain, and share experience and provide extensive information about perceptions, feelings and attitudes of participating children are important to them, but may not necessarily be relevant stakeholders at the district and regional levels (Green and Thorogood, 2004). The focus group discussions in the current study were designed to provide a way to assess the current knowledge base and training requirements of the caterers and food service providers under the current GSFP. This was an avenue for the caterers to paint an exact picture of what goes on in their various schools on a daily basis as well as a giving the PI an in-depth view of the inherent programme needs (education and training needs) from the caterer/service providers' point of view.

### **3.1.2 Field observation:**

The current study acknowledges that stakeholder evaluation accounts alone may not adequately reflect actual GSFP activities in schools; hence a field observation component was added to give the Principal Investigator (PI) a snapshot of the daily activities of the GSFP at school level in real time.

**Onsite observation:** The field observation allowed the PI together with team to obtain reliable, up-to-date information on the nutritional value of foods currently available in the GSFP as well as pertaining to personnel, food procurement, menu planning, meal preparation, meal portioning, distribution and meal content (using weighed food records) as well as identifying any possible dietary nutrient gaps in the meals provided. The onsite observation also used to monitor the other nutrition and hygiene related activity in the participating schools. The Field observation was undertaken to obtain single, robust set of answers to evaluation question

values that is indicative of the potentially nutrition sensitivity/specificity of the GSFP at the school level.

**Preliminary study:** To increase plausibility of any observations and inferences made on the nutrient content of GSFP meals, anthropometric and haematological data of participating children at begin middle and end of the field observation. Preliminary data plays a critical role in establishing the relevance of proposed study or intervention as may be needed to providing up-to-date data specific to the proposed study (Leach et al., 2011; Obasi et al., 2006).

With the data gathered the study sort to make statements about adequacy GSFP implementation specifically the claims of improvement of child nutritional status and how well the current programme activities have met expected objectives of providing children with daily “**nutritious**” lunch. This study also aimed to demonstrate to a degree of confidence that observed outcomes at end of term are due to the GSFP. Kotler and Armstrong (2006) suggested that preliminary information helps to define the extent of problems, suggest possible hypotheses and solutions. The results from the preliminary studies were incorporated into the product formulation process. This phase was a strategic scoping exercise to ascertain limits of the study and help to develop a broad understanding of the structure of the programme and define the boundaries of the current study.

### **3.1.3 Product development:**

Traditionally, the idea of finding solutions to endemic health problems by focusing on nutrition is not a new concept, however the idea of health interventions that explore the application of knowledge of indigenous ethno-botany and indigenous foods together with indigenous biotechnology and food processing methods to develop food solution for the treatment of disease is indeed novel (FAO 2013: Cheikhyoussef, 2013: Fahey 2005: Fuglie 2003).

Usually product development methods that exclude indigenous food are known to have several shortcomings: they are unable predict acceptability, their impact assessments are short-term and subjective; assigning long-time cause and effect on health is difficult. International Food Policy Research Institute (2016) and FAO (2010:2013) advise that in order to provide long term sustainable nutrition solutions the efforts must be directed towards research that combines scientific know-how with knowledge indigenous nutrition, ethnobotany and biotechnology.

***Formulating products for health:*** This study capitalised on the concept of food-to-food fortification (Food synergy). Food to food fortification is based the principles of food diversification, which involves harnessing the full nourishment from foods by drawing on the strength of the each component/food items so that the nutrient profile of the resulting meal is well balanced to promote health (Jacobs and Tapsell 2007: Jacobs and Steffen, 2003: Messina et al., 2001).

The main advantage of this technique of formulation is that nutrients delivered by the various food items in a composite meal are natural and directly from the biological environment hence are likely much more bio-available compared to those formulated through technologic processing (Jacobs and Steffen, 2003). Similar studies like the Food Multi Mix (Zotor et al., 2008: Amuna et al., 2004) and Antewa meal (Amlogu et al., 2012) have all employed the concept of synergistic effects of combining various food items based on their nutritional strength.

The SC<sub>m</sub>, however couples the principles food synergy with that of WFPs home- grown nutrition strategies, which promote the use of indigenous food to decrease the disease incidence and improve disease outcomes (International Food Policy Research Institute, 2016). Findings from this study, seek to add to knowledge concerning the application indigenous food solutions in disease modulation and prevention.

***Food Processing:*** There is extensive knowledge concerning the impact of traditional low-tech food processing methods on nutrient adequacy of

indigenous foods (FAO, 2013; West et al., 2002; Gibson, 1994; Golden, 1991). Processing methods such as fermentation, roasting, blanching, soaking work by changing or manipulating the physicochemical properties of food products to enhance bioaccessibility of nutrient, reduce anti-nutrient factors, increase food digestibility and bioavailability (Redde and Love 1999; Erdman and Pneros-Schneier, 1994; Brown, 1991). The current study employs a combination of indigenous Ghana household food processes to ensure minimum nutrient loss, increased bioavailability and nutrient adequacy without compromising palatability.

**Sensory evaluation:** Nutrition interventions in low-income economies are designed for specific nutritional interests of the donor; unfortunately such products only focus on the nutritional adequacy with little to no attention the taste. More often than not, such interventions become unsustainable as they fail to reflect the indigenous dietary preference and patterns of target populations. Kuti et al., 2008 explains that unsustainable nutrition interventions are often due to noncompliance to intervention. To ensure that SCm meals are tailored to the target populations' palate, the study designed three levels of sensory evaluation (two acceptability tests and a preference test).

The acceptability test was divided into two tests (one with a trained panel and the other with an on field panel). The acceptability testing allows panellists scale (a degree of likeness) their sensory experience with a product on nine hedonic categories ranging from “dislike extremely” to “like extremely” with a neutral category in between (Jaeger and Cardello, 2009). The initial use trained (semi) sensory panel was to determine what sensory attributes were perceptible and to what the degree of acceptability for an indigenous population (Kemp et al., 2009). The one-week **sensory technique** training for the panel was to enable them to learn how to detect the difference between sensory attributes. This proved crucial in narrowing down and optimizing formulations for intervention.

Results of acceptability test enabled the investigators to make generalisation about the over acceptability of a test product based on the

degree of liking the product in general as well as allowing panellists to evaluate specific sensory attributes the test product (Food facts, 2010; Green et al., 1993). Interpretation and inferences can be made by correlations between specific attributes as well as how these correlations affect the over acceptability of the test product.

The paired preference test was conducted with a subset the target population to aid the Principal investigator in estimating the sustainability  $SC_M$  by comparing its preference score to that current GSFP meal. This test is essential because panellists may find a product acceptable on its own, but acceptability may not necessarily translate into preference when compared to another product.

Both Pieniak et al (2016) and Kuti et al., (2008) suggest that by providing each panellist two coded samples; the test product ( $SC_m$ ) and competitive sample (GSFP) presented randomly in AB or BA order, researchers can adequately gauge the sustainability of a product in a target population by comparing preference score of the test product in the presence of other competing products. Kuti et al., (2008) reports that an interpretation of panellists' response could provide detailed insight into whether a particular intervention food is sustainable.

In that, if significantly more panellists prefer sample A (the intervention test product) there is an indication that consumption of the intervention test product is likely to be adhered to post intervention. On the other hand, if significantly more panellists prefer sample GSFP (competitive product) implies that test product might not and might require total reformulation/reconstitution or optimization of certain attributes. However, when the preference responses are equally distributed between test and competitive samples, the relevance or novelty of the test product is called to play because such results indicate no significant difference between the two products.

#### **3.1.4. $SC_m$ meal intervention:**

The study attempted to deliver a reasonable explanation for the GSFP outcomes by conducting a 3-arm intervention styled intervention. This

ensured an unbiased account of the effect associations (or lack thereof) of a particular treatment or exposure to a particular outcome by testing both the GSFP and SCM intervention against a control. RCTs by design ensure a random selection of participants, systematic (regulated/controlled) distribution of participants into test groups in whilst ensuring even distribution of confounders across treatments (Levin 2007; French et al., 2002; Clandinin et al, 2000).

The design for RCT facilitates easy explanation for any phenomenon, observations and outcomes through statistical analysis and logical comparison, and helps to elucidate the actual cause and effect of an intervention on different outcome measures, as all factors other than the intervention are considered equal (Topp et al., 2004; Roberts and Torgerson 1999; Sundram et al., 1995 Truswell et al., 1992; Ng et al., 1991).

The pilot nutritional intervention (6 months n=180) was an initial investigation to determine the efficacy of the SCm meals in improving the nutritional status of the target population. This was done comparing the nutritional status of GSFP participating schools to two non-programme groups that were similar in all relevant characteristics except exposure to the GSFP, while taking into account possible confounders. To determine whether the observed effect of the SCm in a pilot intervention can be sustained over a longer period of time across a large number of participants a scale up intervention (9 months n=330) was undertaken. It was necessary to scale up to determine the effectiveness of the SCm meals. Effectiveness is a key indicator of sustainability of any intervention and helps to determine if the perceived effects are general or localised to a specific few.

### 3.2 Study Setting

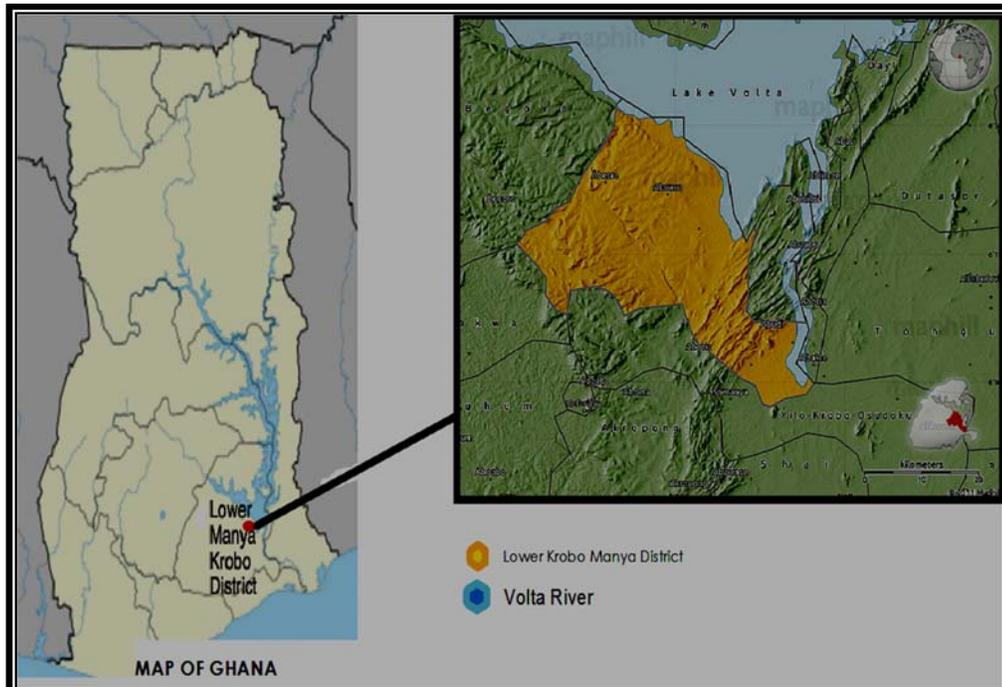


Figure 3.2: Map of Ghana showing insert of the Lower Manya Krobo District

The study was set in Lower Krobo Manya District (now municipality) in the Eastern Region of Ghana located on latitude  $6^{\circ} 05'N$  and longitude  $6^{\circ} 30'N$  and covers an area of 1,476 sq. km. It is bounded from north to south by the Volta Lake and to the Northwest by Upper Manya Krobo District, Northeast by Asuogyaman district, District and to the South are the Yilo and Dangme West District, respectively (GOG, 2016)

#### **Socio -Demographics**

According to the GSS (2014) there is a total of 87,649 people living in 22,150 households in the LMKD with an average household size of four. The composition of households is a male head (25.3%), a spouse (9.2%), children (35.5%), other relatives (19.8%) and step-siblings (5.2%). The population distribution indicates a youthful population structure with the largest proportion (35.1%) of its population being less than 15 years old. The average age dependency ratio was 70.2 implying that for every person in the working age population has at least one dependent. For

most households in LMKD, the child dependency ratio was much higher (59.7) than the old age dependency ratio (10.5).

On the average 11,197 households (53.2% of all households) engaged in agricultural activities in the municipality with a total of 20,250 hectares of farmland under cultivation (GSS, 2014: Government of Ghana, 2012). Among the agricultural households in the LMKD, those engaged in crop farming are 86.7%, 43.3 % in livestock rearing and 2.8 % in tree planting with about 3% of agricultural households are engaged in fish farming. A higher proportion of agricultural households 92.8% are engaged in mixed crop farming compared to urban agricultural households 84.1%.

### ***Health statistics***

There are two government hospitals and one mission hospital in the district (Atua Government, Akuse Government, St. Martin's hospitals). There are other private clinics, maternity homes, chemical sellers, traditional healers, traditional birth attendants and community-based volunteers providing complementary health services. The ratio of doctors to patient stands at 872 to 1 (GSS, 2014)

In the last two decades, the main public health concerns in LMKD are HIV/AIDS prevalence rate (18%) and its attendant problems (GDHS, 2008). However, with increased government and donor efforts in HIV prevention and management there has been a significant decrease in new reported cases in LMKD (Gyabaah, 2012: Ghana Human Development Report, 2004). In more recent years, the number of cases of chronic diseases has increased at an alarming rate. For instance, according to Ghana Demographic and Health Survey, 2014, OPD hypertension cases in the LMKD increase from 94,962 in 2013 to 109,969 in 2014 (over 10% increase in one year).

In the region, the Ghana Demographic and Health Survey (2014) estimates that 4.0 % of children have height-for-age (degree of stunting) Z scores of -3 SD, an additional 17.0 % have Z scores of -2SD for height-for-age whilst 3.2% of the child population have Z scores of -3SD for weight-

for-height (wasting). Also, 1.6% of these children are overweight with weight-for-age Z scores of +2 or more and a further 7.9 % of the population have weight-for age Z score of -2SD.

### ***Education***

Ghana statistical service for data 2013-2015 indicates that there are 85,990 children aged 3 years and older of school going age in LMKD. Out of this total, 24.8 % have never attended school, 33.5% have attended school in the past, whilst 41.7% are currently attending school. With respect to gender, 43.5% of boys aged 3 and above are currently in school whilst 39.9% of girls in the same age bracket are currently in school (GSS Population and Housing Census, 2010-2015). As at the start of this study (the 2013/2014 academic year) 1,622 new pupils were enrolled across the 90 primary schools (both private and public schools) in the LMKD. Among the public (government owned) schools, 16 were registered GSFP beneficiary schools with a total of 3,182 primary school children benefiting (MOFEP, 2010:2014).

### **Justification of study site selection.**

The abundance of indigenous agricultural produce and the existence of an established GSFP in the district (among one of the few districts in which piloted the GSFP in 2005 continuous to enjoy active GSFP) makes LMKD an ideal setting for this study. In addition, the District health secretariat in the Atua Government Hospital is renowned for its commitment to the area public health research and intervention in HIV and nutrition and runs an active school deworming exercise (Ritzenthaler, 2005). The close proximity of the Atua Government Hospital to the study site enabled easy collection and storage and analysis of all biological samples.

### **3.3 Target population and sample size**

The the population of interest consisted of school-aged pupils between 5-8 years and starting primary class one (P1) of government schools in the district.

Given the objectives of the interventions and evaluation, sample size calculation was based on prevalence of protein energy malnutrition with anaemia prevalence being the key outcome of interest. Sample size was determined using the Magnani (1997) and Bill Godden,( 2004) approach .  
Sample Size - Infinite Population (where the population is greater than 50,000)

$$SS = Z^2 \times (p) \times (1 - p) / C^2$$

- Z = Z-value (1.96 for a 95%confidence level)
- P = Prevalence percentage of population expressed as decimal; in the case of this study we are using 38%( anaemia prevalence in the study population). Anaemia prevalence was used as an indicator of iron status which is one of the outcomes of inter
- C = Confidence interval, expressed as decimal (0.05 = +/- 5 percentage points) Z-values (Cumulative normal probability table) represent the probability that a sample will fall within a certain distribution. The Z-values for confidence levels in this case is 1.96 (guided by the cumulative normal probability table).

Considering reports from similar studies by Aulo et al., 2014 and Abizari et al., 2013 and 2016, an average attrition 11% was assumed for the sample size of 330 was calculated based on a rate (GDHS 2014). (See Appendix 4A)

### ***Participants recruitment and inclusion criteria***

participants were recruited from schools in the LMK district. The study for intervention population was clustered into two groups; GSFP participating school and Non-GSFP participating schools. Each cluster was subdivided in a GSFP group (normal GSFP meal) and a GSFP group, SC<sub>M</sub> group (formulated meals) and the SC<sub>M</sub> control group). The two control groups were then merge to form the NO intervention group (NOI). The following inclusion factors were considered, for GSFP group

participants must be aged between 5-8years and starting primary class one (P1) of government schools in the district. At enrolment, participants must be in GSFP participating school and must be receiving GSFP meals during term time. For Non-GSFP participating schools (SCM and NOI), participants must not be partaking in any nutritional intervention at the time of enrolment. For the intervention phase, all participants with stunting/underweight/wasting Z-score  $\leq -3$  and or malaria ++ were be excluded and referred to a health facility

### **3.4 Research variables and outcome indicators**

The outcomes of interest of this study differed for each phase of the study as illustrated in Table 3.1.

For service evaluation the main indicators or interest were of

- a. Programme implementation
  - Available Infrastructure
    - Structures/ equipment for cooking, storage and distribution of meals.
    - Hygiene, water supply, sanitation and waste disposal aspect of UN's Water, Sanitation and Hygiene (WASH) for all Initiative
  - Guidelines and standards on
    - Meal Planning and raw material procurement
    - Meal menus /Portion Size
- b. Social influences on SFP
  - Caterers' outlook: caterer was aware of key components of child nutrition through knowledge of benefits
  - Parental involvement in SFP
  - Teachers' involvement in SFP roles in promoting healthy eating
  - School nutritional environment
- c. Dietary history (food frequency questionnaire and 24hr recall)
  - Total daily dietary: % attributable to school meals

- Nutrient Composition of school lunches: macro and micro nutrients
- Portion size: actual intake, % intake loss to waste
- Nutrient Adequacy: % DRI and Dietary Diversity

d. Haematological and anthropometric indices

- WHO Z –scores: BMI For Age, Height for Age, Stunting, Weight –for- Age
- Biochemical measurement: Malaria status screening, Worm infestation (% Ascaris, % Hookworm, % TT, % S Mansoni,), Haemoglobin concentration, % Anemia

Table 3.1 Summary of study's objective and outcomes

Phase	Stage		Objective	Factor	Outcomes	Inputs
Phase One	Service Evaluation A		Service evaluation (Situation analysis)	Programme implementation Indicators	<ul style="list-style-type: none"> <li>Nutritional Surveillance Data On School Level Food Service Guidelines on Procurement Preparation Facilities , Storage</li> </ul>	<ul style="list-style-type: none"> <li>School level Stakeholder Survey</li> <li>Field observation</li> </ul>
				Caterers' Outlook	Caterer Qualifications And Training On <ul style="list-style-type: none"> <li>Meal Planning</li> <li>Meal Schedules</li> <li>Portion Size</li> </ul>	<ul style="list-style-type: none"> <li>Focus Group Discussion</li> <li>Field observation</li> </ul>
				Nutritional Environment	<ul style="list-style-type: none"> <li>Healthy Eating Focused Nutrition Education/Messages In Class And Playground</li> <li>Involvement Of Parents In SFP</li> <li>Social Responsibility: School Adults And Peers As Role Models For Healthy Eating</li> </ul>	<ul style="list-style-type: none"> <li>School level Stakeholder Survey</li> <li>Field observation</li> </ul>
				Hygiene & Sanitation	<ul style="list-style-type: none"> <li>WASHH Initiatives On Water And Waste Disposal</li> <li>Deworming Exercises</li> <li>Vaccination /Supplementation Exercises</li> <li>Child Growth Monitoring Initiatives</li> </ul>	<ul style="list-style-type: none"> <li>Field observation</li> </ul>
				Food Intake Measures	<ul style="list-style-type: none"> <li>Nutrient Content Of Meals</li> <li>Total Dietary : Energy And Selected Micronutrient Intake</li> <li>Nutrient Adequacy</li> </ul>	<ul style="list-style-type: none"> <li>Food Frequency Questionnaire</li> <li>24hr recall</li> <li>Weighted Food Record</li> </ul>
				Preliminary study Nutritional status	<ul style="list-style-type: none"> <li>Nutritional Status: Z-Scores (Weight-For-Age, Height-For-Age Weight-For-Height</li> <li>Worming Infestation</li> <li>Haemoglobin Levels</li> </ul>	<ul style="list-style-type: none"> <li>Baseline Measurements</li> </ul>
Phase Two	Product Development		Nutritional	Food diversification	<ul style="list-style-type: none"> <li>Use Local Food Products In Formulating Model Meal That WHO Nutrient Content Quality And Safety Requirements</li> <li>Optimize Existing Indigenous Food Processing To Improve, Nutrient Density Food Quality And Safety</li> <li>Employ Sensory Techniques For Characterising Sensory Attributes And Evaluates Its Acceptability Preference</li> </ul>	<ul style="list-style-type: none"> <li>Food to food fortification</li> <li>HACCP Guidelines</li> </ul>
Phase Three	Intervention C		Nutritional	Nutritional status	<ul style="list-style-type: none"> <li>Nutritional Status: Z-Scores (Weight-For-Age, Height-For-Age Weight-For-Height</li> <li>Worming Infestation</li> <li>Haemoglobin Levels</li> </ul>	<ul style="list-style-type: none"> <li>Technical Training For Caters And Cooks, parents Teachers on nutrition</li> </ul>
	Post Intervention	Transfer technology	Value/Skill Transfer	Sustainability	<ul style="list-style-type: none"> <li>Nutritional Surveillance Data For District</li> </ul>	Help to direct policy planning and implementation
		Sensitization And Advocacy	Educational Capacity Building		<ul style="list-style-type: none"> <li>Recommendations on Menu Content, Portion Size and Food Safety Guidelines Based On Scientific Evidence of Study.</li> </ul>	Recommendations On district specific Menu Content, Portion Size And Food Safety Guidelines.

### **3.5 Ethical consideration**

The study involved primary data collection with ethical implications with respect to participants recruitment, sample collection and feeding intervention hence in the design of each phase of the project and outlay of work placed priority in minimizing

- The level of risk or exposure to potential risk
- If the risk is unavoidable within the study's objectives; the designs ensured that risk is justified by the importance and relevance of the research study;

Precautions that comply with basic principles of Ethical Practice were in place to deal adequately with the effect of participation.

#### **A. Informed consent.**

Consent was obtained at every stage to ensure that participants were fully aware of the level and nature of the risk before they agree, freely, to take part in any aspect the study. Each participant was informed and subsequently presented with information sheet that explained the purpose, design as well as what the risks were at the beginning of each activity. This include information on

- The storage of data will comply with the Data Protection Act and the University of Westminster's Data Protection Code.
- Voluntary nature of Participating
- Respect for individual autonomy and maintenance anonymity and confidentiality through the research and beyond.

Participants were allowed thoroughly ask question and address any grievance before they agreed to take part. Written consent forms and obtained (Appendix 1G to 1J) at each stage of recruitment and data collection.

#### **B. Risks and Discomforts**

- Invasion of personal space: the process for taking anthropometric measurements may constitute some stress to the participants. Consent was sort from both the participating class and the parents.
- Pain: Since the majority of the participants are children, the discomfort of the needle prick due to blood sample collection may psychologically affect some participants that have phobia for injections.
- The daily feeding of participants has no side effects due to the fact that the quantities nutrients to be consumed were within the limit for recommended intake; however daily consumption of SCM may constitute an additional stress as a result of adherence.
- The use of trained research team ensured compliance to health and safety procedures for sample and data collection.

### C. Legal Rights

The following documents were developed and submitted to appropriate authorities for approval before the commencement of the research:

Ethical clearance was obtained from the Westminster University, UK and the Kwame Nkrumah University of Science and Technology Ghana (Appendix 1<sup>B</sup> to 1<sup>E</sup>). Copies of the ethical approval together with introductory letters (Appendix 1<sup>F</sup>) were forwarded to the Ghana Education Service and all GSFP stakeholders at regional, district and school levels.

### D. Participants recruitment

Participants were approached and recruited with written approval from the District Health, the District Assembly, and the District Ghana Education Service Offices (Appendix 1<sup>C</sup> to 1<sup>D</sup>).

### 3.6 Field observation

Informal interaction and courtesy calls was made to the chiefs and kinsmen of the LMKD traditional area and traditional permission was obtained for commencement of studies. Meetings with regional and district level stakeholders consisted of telephone and face-to-face discussions with the acting district chief executive (Honourable Agbo) on the scope of the research and a formal presentation of the proposal document to district stakeholders such as District Education Officer, District Health Officer and Deputy Coordinating officer of the Lower Manya Krobo. During these meetings, letters of introduction were presented a formal permission was sought from all the above-mentioned individuals for commencement of the fieldwork (Appendix 1).

#### 3.6.1 Cross-section survey

##### *Head teachers and teachers' survey*



Figure 3.3<sup>abc</sup>: A selection of pictures from the key informant in-depth interviews

##### *Participant recruitment*

Participants were recruited from the 16 GSFP schools in the district. Subject recruitment was preceded by a face-to-face discussion with the Acting District Education Officer on the scope of the research and a formal presentation of the proposal. The District Education Officer provided

introductory letters to each school and letters were presented together with survey request letters requesting each head teacher to nominate a member of staff or themselves for a key informant interview.

### *Survey Procedure*

After formal invitation with the letter, participants were contacted via telephone using a list provided by District Education Officer to set a date for interviews in their respective schools. Upon arriving at the schools, a brief description of the scope of the research, the nature of the survey was explained to the participants and participants were asked to sign consent to volunteer to participate.

### ***Caterer survey and Focus group Discussion***



Figure 3.4 <sup>ab</sup> A selection of pictures from the focus group discussion

### *Participant recruitment*

Participants were recruited from the 16 GSFP schools in the district. participants were contacted via telephone and face-to-face using a food service providers list provided by the District Chief Executive for a meeting at the district assembly hall in Agormanya. The scope of the research and the

nature of the survey and focus group discussions were explained to the participants and participants were asked to volunteer to participate.

### *Survey and discussion*

Enumerator assisted interviews were conducted using an adoption Annor and Baiden (2011) evaluation questionnaire with inputs from CDC Food Service (2006) Questionnaire. Informed-consent procedures regarding anonymity and recording of audio were explained at the beginning of the focus group and consent forms were distributed accordingly for participants to volunteer to take part in the discussion (See Appendix).

The focus group was facilitated the PI using an open-ended interview protocol to guide discussion with the assistance of two volunteers from LMK district. An audio of the focus groups was recorded using a Sony PX440 Digital Voice Recorder addition written notes were taken.

### **3.6.2 GSFP schools field observation (on-site visits)**

The field observation was undertaken in the participating all GSFP schools using a checklist questionnaire (See Appendix 2d). This served as a tool to help the ascertain the conditions of the meals offered, to observe food service providers hygiene and cooking practice as well as observe the facilities and equipment used to facilitate the GSF programme.

Each GSFP school was observed by two volunteers for 4 consecutive weeks simultaneous to prevent caterers communicating with each other. In each school, one volunteer observed and noted the day-to-day activities of the service provider (caterer/cook) from farm-to-fork whilst the other volunteer observed and documented key aspects of the environment. The observation focused on elements of good practice as stipulated by the Indigenous Caterers Association of Ghana (ICAG) manual of operation. This included available the infrastructure and services available to guidelines/ policy/

protocols, meal planning, cooking practice food hygiene and safety members as well as water storage, fuel usage and environmental services by taking pictures

### **3.6.3 Preliminary studies**

A preliminary study was conducted to determine the effect of GSFP on the nutritional status of participating children over one academic term (3.5 calendar months)

#### *Participant Recruitment*

Sample size was calculated as one third of the number required for pilot invention (n=60). The district was stratified in the three major geographic towns (Odumase Township, Akuse and Kpong) and one township was picked at random. Participants (n= 60) were recruited from GSFP Schools in the selected township during the term starting April –July 2014. Information sheets and ethic consent forms were explained to parents and caregivers of the recruited participants.

Anthropometric and biochemical measurements were taken at the beginning of term, midterm and at end term. For the body weight, weight was taken with a Tanita scale whilst children wearing their school uniform with shoes removed. Each measurement was taken in duplicate and average weight recorded to the nearest 0.1 kg (Appendix 3).

Height was measured to the nearest 0.1 cm using a Leicester stadiometer. Trained field workers from the Asesewa Nutrition Centre took all the anthropometric measurements. Venous blood samples were taken by qualified phlebotomist from the *vena cephalica* of seated participants (Appendix). All the blood samples were drawn with minimal stasis and between 07h00 and 10h00 to avoid the effects of diurnal variation.

### 3.7 Product formulation and Development

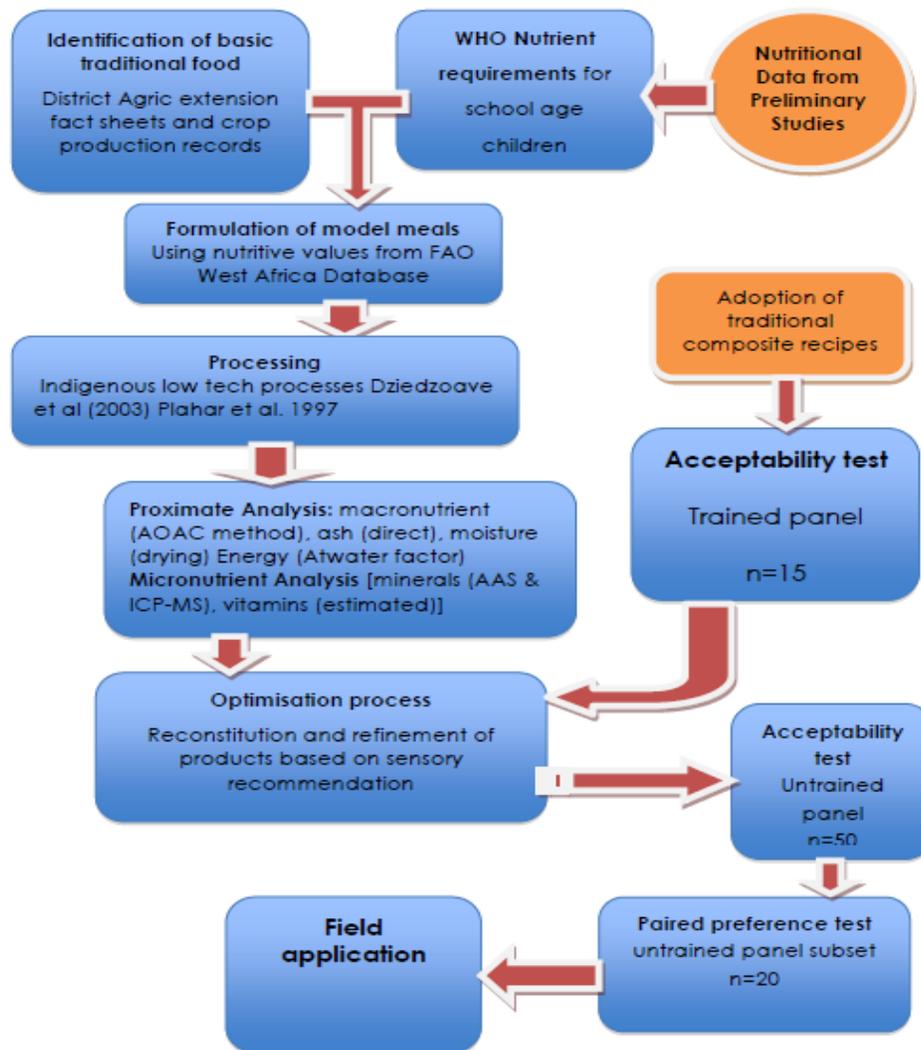


Figure 3.5: Flow diagram showing the processes involved in the SC<sub>m</sub> development

The guiding principle was to ensure food security within poor indigenous population by developing nutrient rich meals based on sound scientific evidence (nutrient content) by applying low-tech indigenous processing methods to enhance the nutrient profile of from low-cost, readily available indigenous crops to produce sustainable SC<sub>m</sub> meals that meet optimal levels of nutrients required by 5-8 years old school children in LMKD without compromising on palatability.

### 3.7.1: Raw material selection.

The Agricultural extension data (Appendix 4 Table 2) obtained from the District Assembly office was used to select meal components. A summary list of the food items utilised along with the rationale for selection is given in Table 3.2. Due to the lack of any plausible national and regional guidelines for school meals in the district and in the sub-region at large, raw materials were selected based on similar principles to the British National Nutritional Standards (Appendix 4 Table 1) for school lunches but modified to reflect the traditional dietary pattern of the LMKD population. The key rationale was to use ingredients based on their availability, affordability, versatility and sensory properties.

**Starchy staples:** The starchy staples formed the carbohydrate base of each SCm accounting for 40% to 50% of the formulation as the main source of energy. Both maize and potatoes were selected based on their affordability and the fact that they are cross-seasonal staples. In addition, both crops are versatile, in that, these can be manipulated into different forms (boiled, roasted, fried, mashed, pureed) for consumption and this is especially important when developing products for young children who are fussy eaters. There was a need to provide a variety of textures and taste to avoid sensory fatigue.

The Obatanpa variety maize used in this study is an indigenous quality protein variety of *Zea mays*. Its high energy (365 Kcals per 100g), protein (per 100g) and was fortified with lysine (Ahenkora et al., 1999; Bresanni, 1991). Lysine is crucial in protein synthesis for the growth of tissues as it enables absorption of calcium from the intestinal mucosa thus preventing excess loss calcium through urination (Panda, 2014). It helps in bone collagen link formation as well as the synthesis of elastin and carnitine, which are crucial for the growing bodies of school children (Panda, 2014; Civitelli et al., 1992). Other studies have reported that the nutritional advantage of using Obatanpa maize variety is that it improves levels of cysteine and methionine resulting in an improvement in the overall the amino acid profile of meals as

well as modulating tryptophan levels thereby increasing niacin levels (Ahenkora et al., 1999. Ahenkora et al., 1995; Serna-Sardivar et al., 1991; Bressani, 1991)

Sweet potatoes (*Ipomoea batatas*) are indigenous root tubers that have a high beta-carotene (6495 ug per 100 g) that gives the tubers their distinctive orange colour (Dansby and Bovell –Benjamin, 2003). Although the tubers are also rich in Vitamins C, Vitamin E, Vitamin K, Vitamin B, the focus of its application in nutritional intervention has been its high content of bio-available vitamin A (Hotz et al., 2012; Helen Keller International, 2012). For a large portion of people living Sub Saharan Africa, sweet potato provides the cheapest most readily available dietary source of beta-carotene (Gani and Micaville, 1999).

Several longitudinal studies in Uganda and Mozambique on the bioavailability and effectiveness of sweet potatoes as beta-carotene (pro-Vitamin A) source have reported increased intake of vitamin A levels with Mozambique reporting values 71-84% of total vitamin A whilst Uganda reported 44-60% bioavailability of total vitamin A from sweet potatoes (Low et al., 2010:2007). This makes sweet potatoes a vital tool against vitamin A deficiency among school children (Hotz et al., 2012; Helen Keller International, 2012; Low et al., 2007; Van Jaarsveld et al., 2005). The physiochemical structure (natural sweetness/ flavour and bright colour) also adds to the sensory appeal of intervention meals.

**Legumes (Soybeans and groundnut):** In many developing countries, legumes are largely being promoted as inexpensive alternatives to meat and fish. The high lysine content of legumes improves the nutritional quality of cereals by complementing their limiting amino acids (Coles , Wratten and Porter, 2016)

**Table 3. 2 Summary of rationale for the inclusion of some selected food items as source nutrients for S<sub>C</sub>m development**

Food Item		Common use in target population	Nutrient component of interest	Rationale For Selection
Starchy staples	<b>Maize Zea mays</b>	Banku Porridge (koko)	<ul style="list-style-type: none"> <li>• Energy</li> <li>• Fibre</li> <li>• Lysine</li> </ul>	<ul style="list-style-type: none"> <li>• Lysine is crucial in protein synthesis for the growth of tissues (Panda 2014Ahenkora et al 1999. Ahenkora et al., 1995)</li> <li>• Fiber from maize aids digestion by slowing the absorption of sugar and regulates insulin response</li> </ul>
	<b>Potatoes</b>	Chips (koliko)	<ul style="list-style-type: none"> <li>• Energy</li> <li>• Fibre</li> <li>• Vitamin A</li> </ul>	<ul style="list-style-type: none"> <li>• High beta-carotene Dansby and Bovell –Benjamin 2003)</li> <li>• Sweet taste adds to mouth feel and improves the overall sensory appeal</li> </ul>
Legumes pulses	<b>Soybean Glycine max</b>	Apranpransa Weanimix	<ul style="list-style-type: none"> <li>• Vitamins A, B, C, D, E,</li> <li>• Iron</li> <li>• Phosphorus,</li> <li>• Potassium,</li> <li>• Sodium A</li> <li>• Zinc</li> </ul>	<ul style="list-style-type: none"> <li>• Locally accessible and available across seasons,</li> <li>• Inexpensive sources of proteins and fibre</li> <li>• Rich source of micronutrients, especially vitamin b group</li> </ul>
	Groundnut Arachis hypogaea	Nkatie soup Ebefo ke akate	<ul style="list-style-type: none"> <li>• Energy</li> <li>• Calcium,</li> <li>• Magnesium</li> <li>• Phosphorus</li> </ul>	<ul style="list-style-type: none"> <li>• Energy</li> <li>• the breaking aromatic chains of the groundnut in roasting adds flavour and taste to meals Grimm et al., 1996: Newell et al., 1967)</li> </ul>
Leafy Vegetables <b>Moringa Oleifera</b>	Tea Abom	<ul style="list-style-type: none"> <li>• Iron,</li> <li>• Phosphorus,</li> <li>• Vitamin B. Complex,</li> <li>• Magnesium,</li> <li>• Calcium,</li> <li>• Vitamin C,</li> <li>• Zinc</li> <li>• Selenium</li> </ul>	<ul style="list-style-type: none"> <li>• Iron aids in growth of new body cells and differentiation of brain cells in children.</li> <li>• Calcium helps with bone and teeth development</li> <li>• Zinc is content with help brain development and function (Brown 2003)</li> <li>• Vitamin C helps release a higher percentage of iron from the non-heme, ascorbic acid is the single most important enhancer</li> </ul>	
Vegetable Oils • <b>Palm oil</b>	Apornu Abom	<ul style="list-style-type: none"> <li>• Calcium</li> <li>• Vitamin E</li> <li>• Provitamin A</li> <li>• n-3, n-6 MUFA and PUFA</li> </ul>	<ul style="list-style-type: none"> <li>• Rich source of carotenoids like beta carotene</li> <li>• Rich sources of anti-oxidant minerals.</li> <li>• Palm is an excellent source of energy</li> <li>• Delivery vehicle for fat soluble vitamins</li> </ul>	
Animal protein • <b>Fish (anchovies)</b>	One man thousand Shito	<ul style="list-style-type: none"> <li>• Protein</li> <li>• Omega 3</li> <li>• Calcium</li> </ul>	<ul style="list-style-type: none"> <li>• Cheap alternative protein source to red meat</li> <li>• Omega 3 and 6 aid in brain function and enhance cognitive abilities</li> <li>• Excellent source of minerals especially calcium potassium and phosphorus</li> </ul>	

Soybeans have recently become popular in the West African sub region as an important source of non-heme protein (35-40%) as well as being a rich source of fat soluble vitamins, iron, calcium and phosphorus (Abbey et al., 2001; Kure et al., 1998). The physiochemical properties (solubility, swelling power and water absorption capacity) of soybeans make it ideal for product developments. It can be worked into many forms (paste, dough or powder).

Groundnut (*Arachis hypogaea*) is a rich source of oil (up to 56%), protein (30%) and minerals like calcium, potassium, magnesium and phosphorus and vitamins It is also a rich source of fat soluble vitamins B, E and K (Master et al., 2013). Aside the array of nutrient, groundnut provides texture and aroma that increase the sensory appeal of foods. Upon heating the groundnut results in the release of amino acids and free sugars that hydrolyse to form fructose and glucose and aromatic compounds that give roasted groundnut its distinct flavour and taste (Grimm et al., 1996; Newell et al., 1967).

**Vegetable fat:** Palm oil is derived from the palm plant (*Elais guineensis*) and consists of an almost even amount of saturated (palmitic and stearic acid) and unsaturated fatty acids mainly oleic and linoleic acid. Palm is nutrient rich and contains healthy beneficial tocopherols /tocotrienols (600–1200 ppm), triacylglycerols, vitamin E, carotenoids (500–700ppm), phytosterols complexed with impurities, such as phospholipids, free fatty acids gums, and lipid oxidation products which are removed by refining (Mba et al., 2015; Clandinin et al., 2000; Sambanthamurthi et al., 2000).

The fatty acid content of palm oil has been the subject of several public health debates with many polarised on its use. The collective and individual effects on blood lipids and lipoproteins has been evaluated extensively in several humans and various animal studies (Boateng , 2016; French et al., 2002; Clandinin et al., 2000; Cook et al., 1997; Choudhury et al.,1995; Ng et al., 1991). The results and observation from several of these have often been conflicting, primarily due to the fact that most of the studies were designed to evaluate the effects of specific saturated fatty acids and their derivatives as

well as the used palm oil as a source of palmitic acid but the consumption palm oil per (Sundram et al., 1995; A.S. Truswell et al., 1993).

The consensus so far for the health sector, is that, although palmitic acid is the major saturated fatty acid in palm oil, it fails to impact plasma lipids when total fat intake is in line with the levels currently recommended by WHO (Mancini et al., 2015; Khosla, 2006). For a large number of people in the developing world, including the population currently under study, palm oil remains the most economic source of cooking oil hence its inclusion in this formulation.

**Leafy green vegetable:** An increase in green leafy vegetable consumption is critical to alleviate of the nutritional deficiencies incidence as they provide a large array of macronutrients, vitamins and mineral require for sustenance and disease prevention. The World Health Organization's (WHO) global initiative on fruits and vegetables consumption in many developing countries state that increased green leafy vegetable consumption is essential in the success any nutrition intervention (FAO/WHO, 2004). For Sub-Saharan African populations, the attention on vegetables as vital dietary components is significant, as leafy vegetables have long been known to be indispensable ingredients in traditional sauces that accompany carbohydrate staples

Several studies on African indigenous and traditional leafy vegetables like *Vernonia amygdalina* (bitter leaf), *Hibiscus sabdariffa* (hibiscus) *Amaranthus hybridus* (**red amaranth**), *Basella alba* (creeping spinach) *Moringa oleifera* (drum stick leaves) have been reported to have relatively available and affordable and sustainable source of protein, vitamins and minerals (Oduro et al., 2008; Islam et al ., 2002; Fuglie, 2001; Woolfe, 1992).

*Moringa oleifera* is a drought resistant crop, which grows across season and a rich source of protein and vitamins with nearly one third of the edible portion of its leaf supplies 27.1 grams of protein, 2.6mg of vitamin B1 (thiamine), 20.5mg of vitamin B2 (riboflavin) and 220mg of vitamin C (ascorbic acid) (Wayse et al., 2004 Nambiar *et al.*, 2003)

Consumption of Moringa has been linked with increase blood vitamin A and vitamin D levels, which translate into healthier gut integrity, improve absorption of nutrients and better mucosal immune function in the children (Quadro et al., 2000). Fuglie (2005) reported that a 8 grams serving of dried leaf powder will satisfy a child within ages 1-3 with 14% of the protein, 40% of the calcium, 23% of the iron and nearly all the vitamin A that the child needs. The Oduro et al (2008) recommended that effort be made to incorporate Moringa oleifera leaves into dietary staples the Ghanaian population.

### 3.7.2 Food processing methods



Figure 3.6<sup>abc</sup>: Selection of pictures from the product development phase

The strategy was to employ traditional methods of food processing (soaking, fermentation blanching, dry milling, pan roasting and solar drying) ensure minimum processing time and nutrient loss without compromising palatability.

All food items were purchased from the local farmers union in Odumase Krobo and its surrounding villages. Only cross-seasonal local varieties were purchased Obatampa maize (*Zea mays*), soybeans (*Glycine max*) and peanuts (*Arachis hypogaea*) and stored in Socioeconomic Unit of the Food Research Institute (FRI), Ghana.

All food items were cleaned and sorted using the standard FRI in-house protocol. Standard traditional Ghanaian methods as described by Plahar et al., 1997 (Figure 3.7) were used to obtain blanched potato flour, fermented and roasted maize flour (portions with and without groundnuts), roasted soya flour and blanched *Moringa Oleifera* leaf powder. The anchovies were sun-dried using the chamber method as described by Dziedzoave et al., (2003).

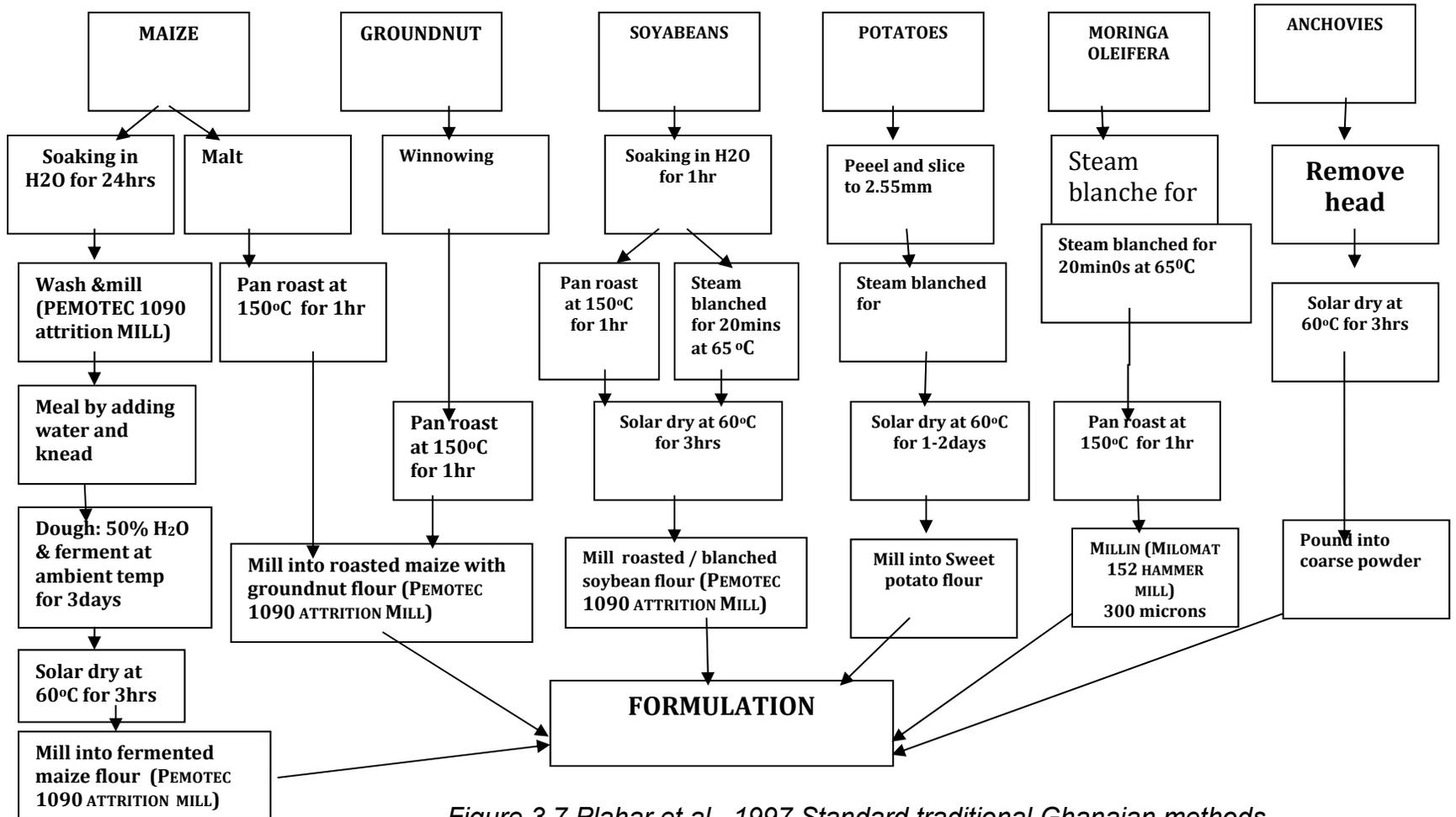


Figure 3.7 Plahar et al., 1997 Standard traditional Ghanaian methods

**Table 3.3 Summary of the processes used and rationale for selection**

PROCESS	RATIONALE (REFERENCE)
<b>Soaking</b>	<ul style="list-style-type: none"> <li>• To reduce the phytic acid content (Saleh, 2013; Tumwebaze, 2011)</li> </ul>
<b>Fermentation</b>	<ul style="list-style-type: none"> <li>• Induce phytate hydrolysis via the action of microbial phytase enzymes, which hydrolyze phytate to lower inositol phosphates (Hotz, 2007; Lopez et al., 1985)</li> </ul>
<b>Seed germination /Malting</b>	<ul style="list-style-type: none"> <li>• Reduce endogenous phytase activity in cereals, legumes, and oil seeds through de novo synthesis, activation of intrinsic phytase, (Mosha <i>et al</i>, 1987; Makeshi <i>et al</i>, 1981)</li> </ul>
<b>Roasting</b>	<ul style="list-style-type: none"> <li>• Release aromatic molecules that enhance the flavour and aroma</li> </ul>
<b>Blanching</b>	<ul style="list-style-type: none"> <li>• Stops enzymatic browning (Hotz, 2007; Davies, 2002)</li> </ul>
<b>Dry milling</b>	<ul style="list-style-type: none"> <li>• Ensures minimum water activity and extends shelf life</li> </ul>

### 3.7.2.1 Rationale for processing methods

The utilisation of indigenous (low-tech) food preparation techniques to maximize nutrient profile, ensure easy technology transfer (FAO, 2016, FAO, 2010), reduced cost of production (FAO, 2010) as well as ensuring cultural acceptance (Ozor and Urama, 2013)

**Fermentation:** The process of soaking increases the physicochemical accessibility of micronutrients minimizes the residual cyanide content of cereals, roots and tubers (Babalola, 2014; Frolic, 2013). The microbial activity during soaking, fermentation and germination also increase the content of compounds that improve bioavailability whilst decreasing the content of anti-nutrients, such as phytate and flatulence causing indigestible oligosaccharides into their more absorbable monosaccharide and disaccharide forms (Tamang, Watanabe and Holzapfel 2016; Tumwebaze 2011; Saleh, 2013, Sanches 2008; Nout 1994).

Fermentation enhances the nutritive value of food by increasing thiamine nicotinic acid, riboflavin, and perhaps protein content (Tamang, Watanabe and Holzapfel 2016; Nagai and Tamang, 2010) as a result of microbial activity. It has been observed that the digestibility, protein efficiency ratio, net protein utilization, and biological value were much higher in fermented cereals than in uncooked cereals (Lopez *et al*, 1985). Fermentation enhances the nutritive value of food by increasing thiamine, nicotinic acid, riboflavin, and perhaps protein content as a result of microbial activity. It has been observed that the digestibility, protein efficiency ratio, net protein utilization, and biological value were much higher in fermented cereals than in uncooked cereals. Also minerals are made more readily available and phosphorus is released from phytate during fermentation of maize.

Fermentation can also reduce the high bulk of the traditional weaning foods by reducing the viscosity of the cereal gruel. During cereal fermentation, microbial activity hydrolyses starch granules, resulting in reduced viscosity of the porridge. Also minerals are made more available

and phosphorus is released from phytate during fermentation of maize (*Zea mays*). Fermentation can also reduce the high bulk of the traditional foods by reducing the viscosity of the cereal gruel and the microbial activity hydrolyses starch granules, resulting in reduced viscosity of the porridge.

**Germination:** Germinated cereals are always advised in the process of preparing children's weaning foods because they help in breaking down complex carbohydrates and fibres making them easy to digest by a child. Germination reduces the viscosity of the food product. Ordinarily there are fibres, which are hard to be digested by a child because their gastric tract is still in the growing process.

Germination can improve the nutritional value of foods by reducing the water-binding capacity of cereal flour. This allows the cooking to have a free-flowing consistency even with a high proportion of flour (Mosha *et al*, 1987). Germination also converts insoluble proteins to soluble components and increases the levels of lysine as well as of vitamins B and C (Makeshi *et al*, 1981).

**Blanching** of vegetables helps to inactivate degradative enzymes in order to conserve heat sensitive nutrients such as vitamin C and vitamin A. Ensuring maximum retention of vitamin C will facilitate absorption of non-heme iron from the legumes and grains (Hotz, 2007; Davies 2002). In the case of the potatoes blanching was done to curtail the milliards reaction that normally potatoes are peeled.

**Dry milling:** Milling products in the dry state help to improve the nutritional value of foods by conservation; wet milling of cereal results in nutrient loss of water-soluble nutrient and allows contamination from dirty water. Dry milling ensures minimum water activity, which stalls microbial activity, thereby, increasing storage and shelf life of the products.

### 3.7.2.2 Food Processing Procedures

#### **Roasted Soya flour preparation:**

Soya was picked, cleaned thoroughly using a clean napkin. It was then roasted until slightly brown at 65°C. Beans were dehulled in a disc attrition mill, winnowed, and finally milled into smooth flour as shown in Figure 3.7a.



Figure 3.7<sup>a b</sup> clockwise: Roasted Soya flour and Blanched Soya flour.

#### **Blanched Soya flour preparation:**

Soya beans were soaked for 20 minutes, drained, and parboiled in water for 30 minutes and dried in solar dryer at 65°C to a final moisture content of about 8%. The dried beans were dehulled in a disc attrition mill, winnowed, and milled into smooth flour as shown in Figure 3.7a.

#### **Fermented maize flour preparation:**

Maize was *washed* and soaked for 72 hours. After 24 hours it was washed, drained and milled into dough, thereafter it was compressed with 50% water and allowed to ferment for 48 hours. After fermentation the dough was spread out in Solar dryer to dry at 65°C for 12 hours, it was then milled into fine fermented maize flour.

#### **Malted roasted maize flour preparation:**

Maize was washed and soaked for 48 hours; it was then drained and malted as shown in Figure 3.8b under controlled conditions, the temperature ranged between 29 to 30°C. Malting took place for 48 hours;

thereafter the malt was dried in the solar hot oven at 65°C. The dry malt was then pan roasted and mixed with 5% dehulled groundnuts milled uniformly into smooth flour using a disc attrition mill.



Figure 3.8<sup>ab</sup>: Roasted Maize and malted maize respectively

#### ***Moringa oleifera* powder preparation:**

The leaves were washed thoroughly under running tap. Then steam blanched for 5 minutes and dried in the solar dryer at 45°C for 1-2 days. After drying, leaves were ground into powder and stored in well-labelled Polypropylene films as shown in Figure 3.9ab.



Figure 3.9<sup>ab</sup>; *Moringa Oleifera* leaves processing from leaves to powder

#### ***Processed Potato Flour***

Sweet potato tubers were washed thoroughly under running water and peeled with a stainless steel knife. The peeled roots were rewashed

and cut into (2mm) thin potato slices. Slices were then blanched by placing in a stainless steel basin sieves over saucepans containing boiling water. The slices were removed after 3 min by lifting the sieve to allow any adhering water droplets to drain and spread thinly on drying trays. Slices were dried a locally fabricated solar dryer at 60°C for 10 hours. The dried sweet potato slices were then milled into flour and packaged in airtight bags.



*Figure 3.10a; Processed Potato Flour*

*Figure 3.10b; solar Dried Anchovies powders*

### ***Solar Dried Anchovies powder***

The head and appendages were removed to ensure that anchovies were free of sand and grit. Anchovies were then washed to reduce the saltiness and also the domoic acid then pattered with absorbent paper towel and Solar dry at 60°C for 3hours. Dried anchovies were then pounded using a mortar and pestle into flour and packaged in airtight bags.

### **3.7 .3 Formulation and optimisation**

In formulating for each composite SC<sub>m</sub>, the guiding principle was combining food items that complement each other in such a way that the synergic effect of new patterns of nutrients created in the combination is similar to those recommended for school children. Each formulation was engineered by combining locally available foods from each of the food groups. The products were developed based on the following criteria: availability of widely consumed foods, affordability, and sustainability and to meet at least of 40 % protein and 25% of DRVs for energy, iron, zinc and vitamin A for children 5 to 8 years. A combination of nutritive data from FAO West-African-Food-Composition-Table (2012) and McCance & Widdowson (2002) were used as reference nutrient content databases.

All ingredients were reduced to powder by attrition milling to easy storage and facilitate manipulation during the formulation and nutritional analysis processes.

#### **3.7.4: Proximate analysis**

Nutritional analysis of SC<sub>m</sub> was performed using AOAC 984.13 official methods and Atomic absorption spectrometry & ICP-MS (Appendix 2<sup>E</sup>). Moisture content, total ash, crude fat and crude protein were determined by oven method, hot furnace, Soxhlet and Kjeldahl methods respectively.

Carbohydrates were estimated by difference and energy was derived by calculation based on the Atwater conversion values for the macro-components (Appendix 2<sup>E</sup> Table 1). The iron (Fe) and zinc (Zn) contents of the food were determined using Atomic Absorption Spectrophotometer, Perkin-Elmer 2380. Calcium was determined using flame photometry. All values were expressed in mg/100g of sample. For all chemical analyses, samples were analysed in duplicates together with an in house standard.

### 3.7.5 Sensory Evaluation

Table 3.6: Summary of sensory evaluation stages with rationale

<b>Stage</b>		<b>Test Instrument And Scale</b>	<b>Panel</b>	<b>Rationale</b>
<b>Acceptability test</b>	Trained panel	9-point hedonic scale	Parents n=15	Product optimization
	<b>Untrained panel</b>	3-point hedonic scale	Pupils n=50	Testing Acceptability
Paired preference test		3-point preference scale	Pupils n =20	Testing market appeal

Sensory evaluation was done in two levels of acceptability testing and preference testing. By using multiple sensory measures, comparisons across samples could be made with some level of assessment of internal validity of the results. Acceptability testing was performed using trained (n=15) and untrained (n=50) panels Preference testing was using the “forced choice” technique (ISO 5495:2005), were the panellist (n=20) obligated to indicate which product they preferred to the other with respect to sensory attribute.

#### *Participant Recruitment*

An initial acceptance testing was conducted with 15 adult indigenes of LMK who had at least one child within the age bracket 5-8, non-smokers and were not allergic to any ingredients. Parents were recruited instead of the target school children because children in the target age bracket usually eat together with their parents. In addition, parents have the ability to be more objective in evaluating the characteristics of the formulations (Oram et al., 2001).

Panel members were recruited at random by invitation and offered training on how to detect differences in sensory attributes in FRI taste laboratory. In the subsequent field sensory test, (untrained) school children (n= 50) from two GSFP schools, were selected using a random numbering system from 1 to 5, pupils with the number 3 were asked to participate in the sensory evaluation. To further determine preference rating of the developed SC<sub>m</sub>, a paired preference test was developed

using a subset (n=20) from the untrained panel.

### 3.7.5.1 Sensory Evaluation Test Training



*Fig 3.11<sup>abcd</sup> (clockwise): Selection of pictures showing cross section sensory panel during training*

Prior to the evaluation, the adult panellists were trained over a period of one week by the FRI in-house training team at the Council for Scientific Research Sensory Lab one of the only ISO accredited labs in Ghana. This was to ensure that, panellists were well acquainted with the taste test procedure (Appendix 2<sup>F</sup>) and also to prevent panellist from indulging in practices that could create sensory bias during the evaluation process.

As part of the training, panellist tasted similar recipes and set up a list of descriptors that characterised similar meals. In doing this, panellists made a list of attributes that could be used to describe the sensory

characteristics fully and agreed through panel discussion on what terms were relevant, and arrived at definitions for each term.

Reference books (Civille and Lyon, 1996; Thybo and Martens, 1998) were used to guide panellists on formulating suitable definitions for each attribute. Colour, taste, aroma, mouth feel and aftertaste were agreed upon as the attributes of interest for the evaluation. A reference product was then provided to help the panel to understand each attribute adequately.

### **3.7.5.2 Adoption of recipes and meal preparation**

The traditional diets of the LMKD population is characterized by the inclusion of starchy staple such as yam, potato, cassava, plantain or cereals such as rice, corn and wheat, which is eaten vegetables usually made into stewed or soups with oil, beans, meat or fish.

The recipes were adopted from the FRI in-house manual of Ghanaian traditional recipes developed by Dei Tutu and Kwami (1993). The five formulas were divided into two groups, two formulations were prepared using the stew-based recipe (apranpransa) and the other three were prepared using soup based recipes (mportormportor).

The apranpransa based S-cool meals were prepared using vegetable oil as the base whilst the soup base S-meals recipe used water as the base (Appendix 2<sup>G</sup>). These recipes were adopted due to their versatility, in that, for both mportormportor and apranpransa recipes, constituent food items can be easily exchanged or substituted based on the metabolic needs of the target group without a causing a drastic change in the taste and nutrient content of the meal.

### 3.7.5.3 Sensory Evaluation procedure



Fig 3.12<sup>ab</sup>: A selection of pictures showing sensory panel in a testing laboratory

All sensory evaluation was conducted by mid-morning (10.30am-11.30am) to ensure that the panellists were neither hungry nor full during the evaluation period and to minimise any sensory fatigue related errors. All the samples were prepared and coded in an enclosed room away from the panel and presented in a sequential order with a serving of water and unsalted Jacobs's crackers as recommended by Beeren (2010).

*Trained panel:* members of the trained panel were asked to volunteer to take part in sensory analysis. Upon providing consent, the panellists were asked to evaluate the sensory attributes of measured samples (30g of each of the five S-cool formulations) using a 9-point hedonic questionnaire (Appendix 2<sup>H</sup>). Additional spaces were provided on the questionnaire for panellist to add comments if necessary.

*Untrained panel:* After ethical consent was sought from parents (written consent) and the pupil (verbal consent), each pupil given two meals (SC<sub>m</sub> and GSFP meal) to evaluate with the help of a research assistant. For the subsequent preference test (n=20) each panel member was presented with two aliquots of meals (one a SC<sub>m</sub> and the other an alternative meal) and asked to select which one is preferred using the forced choice method (ISO 5495:2005; Lawlss, 2010).

### 3.8 SC<sub>m</sub> meal intervention

#### 3.8.1 Training of volunteers, enumerators and S-cool Cooks.



Figure 3.13abc) A selection of pictures showing SC<sub>m</sub> team training.

Enumerators were recruited from the University of Ghana Nutrition Centre, Asesewa and Laboratory technicians and phloebometrist from the District Health Secretariat at the Atua hospital. The volunteers had extensive experience/knowledge of the study procedures but were provided a three day training to understand the scope of the study.

Training was provided on the use of all the questionnaires with emphasis on using household measures for portion sizing in food frequency. An illustrated recipe pamphlet developed by the FRI containing different recipes and traditional methods of cooking meals were given to the enumerator as a reference book to guide in the 24hr food record survey data collection. Mock interviews were conducted with enumerators

as participants and these monitored closely and guidance and correction on interviewing style was given when necessary. After the team gained confidence they were left on their own while the PI and the third supervisor sorted out logistics and also planned and carried out stakeholder interviews.

SCm Cooks were trained on how to prepare the SCm recipes and this included a Hazard Analysis and Critical Control Point training during handling, packaging and storing any food item. In addition, SCm caterers were trained on how to prevent contamination during cooking and distribution of meals.

### 3.8.2 Sampling and participants recruitment



Figure 3 14 <sup>abcd</sup>: Selection of pictures showing the subject recruitment process

For the SCm main intervention a sample size (n=330) was calculated using the Magnani (1997) sampling formula using prevalence of

malnutrition in the project area as main determinant at a confidence level of 95% (standard value of 1.96) assuming a margin of error at 5% (standard value of 0.05). For the pilot intervention, the sample size was obtained dividing the main intervention sample size in half with adjustments made for 9% attrition (an average of the attrition rates reported by Abizari et al., 2014 and Aulo et al., 2013).

### *Grouping*

The geographical area was stratified into three townships and one township was picked by random lottery draw to ensure comparability in the socio demographics and reduce variation in confounders as described by Leine Altman and Bland 1999; Begg 1996).

A list of all the government schools in the selected township was made, and clustered into school with GSFP and Non GSFP participating schools. From each GSFP, a corresponding non-GSFP school (at most 5 kilometres away) was selected and matched.

To narrow down the number of school in the study due to time limitations, schools with GSFP was subdivided into two groups (those with run the GSFP programs from more than three academics terms were considered. This because in school who just started the programme, were likely not to start feeding till mid-term which is considered too late in the programme to detect any programme effect (personal communication)

The result was four pairs of GSFP to non-GSFP schools (8 schools in total). The schools were randomized to three groups (based on the steps shown in Figure 3.3), On the first level, intervention population was clustered into two groups; GSFP participating school and Non-GSFP participating schools. Each cluster was subdivided in a GSFP group (normal GSFP meal) and a GSFP control group, SC<sub>M</sub> group (formulated meals) and the SC<sub>M</sub> control group). The two control groups were then merged to form the NO intervention group (NOI). The aim was to achieve a sample size of at least 60 per group. The pilot intervention was carried out with 180 participants over two academic terms. After which additional participants

were recruited for the Scale up intervention (n=330), which was carried out for three academic terms.

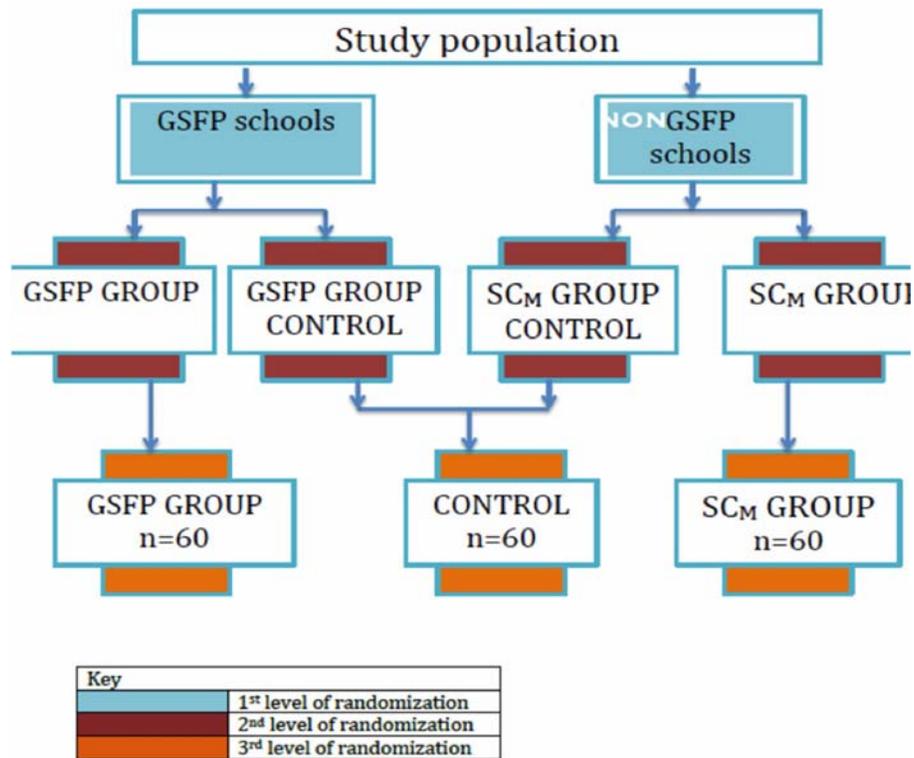


Figure 3.15 Flow chart showing sample randomization

#### *Inclusion criteria*

For the SC<sub>m</sub> intervention, participants must be aged between 5-8years and starting primary class one (P1) of government schools in the district. At enrolment, participants for the GSFP group (from schools with active GSFP daily meals for the last two terms academic terms) and must be receiving GSFP meals during term time. For Non GSFP schools participants must not be partaking in any nutritional intervention at the time of enrolment. For the intervention phase, participants with stunting/underweight/wasting Z-score ≤ -3 and or malaria ++ will be excluded and referred to Atua hospital.

### 3.8 .3 Feeding intervention

After screen for malaria and worm infestation, the study population was randomized into three groups, GSFP group (normal GSFP meal), SC<sub>m</sub> (formulated meals) and the control (No intervention group).

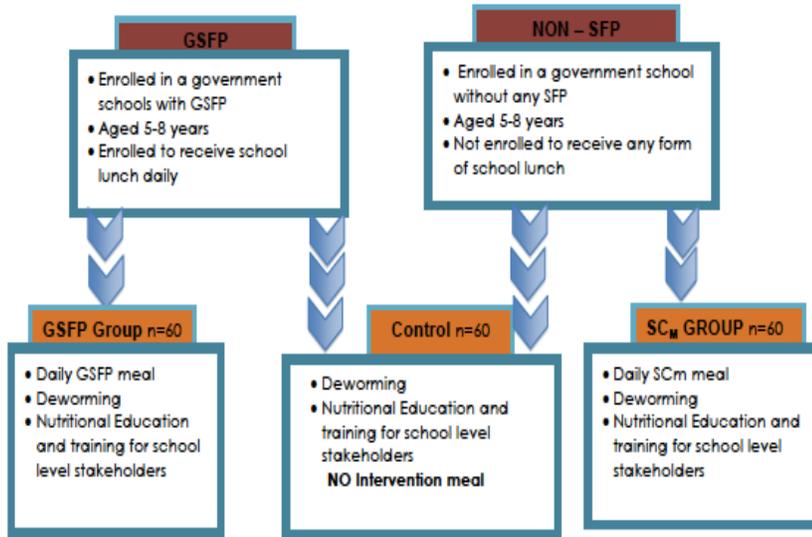


Figure 3.16<sup>a</sup> Flow Chart Showing Subject Distribution in pilot study

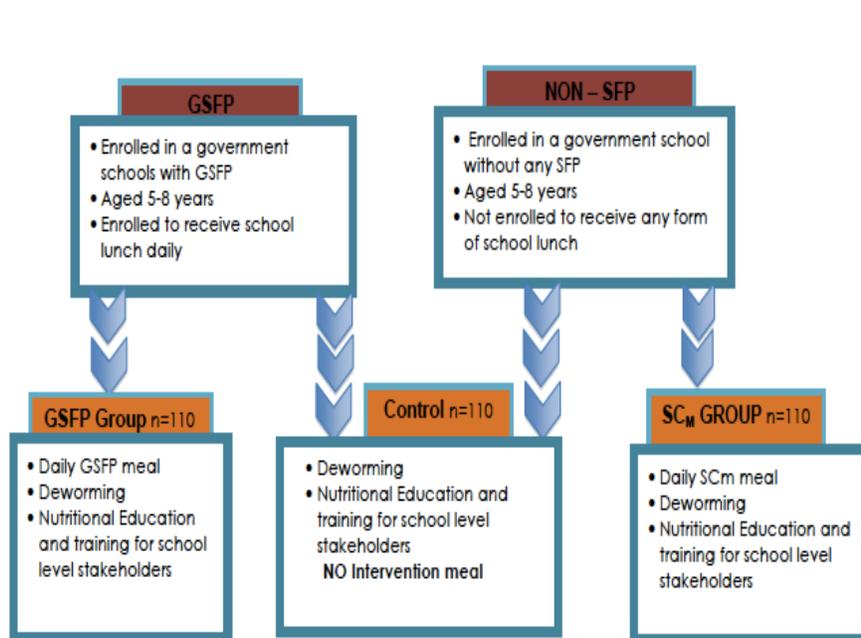


Figure 3.16<sup>b</sup> Flow Chart Showing Subject Distribution In Scale Up

### 3.8 .3 .1 Scale up processing for intervention

Processing of all the SC<sub>m</sub> intervention meals was done under supervision of the PI at the Food Research Institute Ghana which is part of the Ghana Centre for Scientific and Industrial Research: an ISO and SANAS certified facility. All SC<sub>m</sub> intervention caterers/cooks were provided additional training on food hygiene and equipped with a copy of the Ghana Health Service manual detailing food safety standards as reference in food handling.

SC<sub>m</sub> intervention schools received a supply of model meals raw materials weekly direct from the processing Unit of the Food Research Institute, Ghana and monthly supply condiments for meal preparation from the Agomanya Market. Meals were prepared on-site daily by trained cooks Monday-Friday.



*Fig3.17<sup>abcd</sup> Selection of pictures showing the cooks/ caterers cooking and distributing SC<sub>m</sub> meals*

### 3.8.3.2 Anthropometric and biochemical Measurements

For both pilot and scale up, across all three groups for the intervention feeding was pre, mid and post intervention anthropometric and haematological test were taken with additional measurements every third month.

Trained field workers from the Aseewa Nutrition Centre took all the anthropometric measurements (as seen the Figure 3.18 A and B). Identification documents such as birth certificates or weighing cards were used to determine age of participants. For participants who did not have verifiable documents age estimations were based on an event on the Krobo traditional calendar or significant events.

For the body weight, weight with was a Tanita scale whilst children wearing their school uniform with shoes removed. Each measurement was taken in duplicate and average weight recorded to the nearest 0.01 kg.



*Figure 3.18<sup>abcd</sup> Selection of pictures showing the volunteers taking Anthropometric and biochemical Measurements*

Height was measured to the nearest 0.01 cm using a Leicester stadiometer with shoes removed. An average of two measurements recorded. For the biochemical indicator; Haemoglobin, blood samples were taken by qualified phlebotomist from the *vena cephalica* from each child seated participants or standing. All the blood samples were drawn with minimal stasis and between 07h00 and 10h00 to avoid the effects of diurnal variation. Becton-Dickinson Diagnostics procedure was used for the determination of Hb concentration on the same day to avoid a denaturation.

### **3.8.3.3 Quality control and compliance**

A Hazard Analysis and Critical Control Points (HACCP) and COSSH plan was laboratory and fieldwork in order to identify areas of potential risks and possible steps to eliminate those risks.

The team visited the schools randomly each school day for the first month; thereafter, weekly visits were conducted to ensure that the distribution of food took place according to the guidelines provided, that the amounts ordered were delivered, that the food was of good quality and that all the foods were of the right quantity. For each intervention group, termly active record sheets were given to the class teachers to record any incidence of absenteeism or sickness (Appendix 1D).

### 3.9 Data Collection and collation.

**Table 3. Summary of survey instruments employed**

Stage	Survey Instrument	Target Group
Cross Sectional Study	Modified GSFP 2008 Evaluation Questionnaire)	School Level Stakeholders Teacher (N=16) Caterers (N=16)
Focus Group		Caterers N=16
Field Observation	GSFP 2008 Evaluation Questionnaire) Ndigenous Caterers Association Of Ghana (ICAG) 2010	Caterers N=16 School N=16
School Intake	Weighed Record	Pupils N(180)
Total Dietary Intake	Modified Nti 2008 24hr Recall Food Frequency Questionnaire	Pupils N (180)
Sensory Evaluation	Food-a-fact-of-life 2010 9 POINT HEDONIC QUESTIONNAIRE	Parents (N= 15) Pupils N(50)

#### **Cross sectional study**

**Teachers' survey:** The survey utilised a questionnaire (an adaptation from the GSFP 2008 evaluation questionnaire) and consisted both structured and unstructured questions which were administered the head teachers to ascertain their views on the current GSFP, the importance of nutrition education in primary and the benefits of the current school feeding programme. The interviews focused on the following key topics: the nutrition education capacity of the school, the nutrition related services available in their school, interaction between the teachers with GSFP

caterers and authorities; and their general opinion about the GSFP and what they think should be done to improve it.

**Focus group discussion**, Questions were developed with direction and input from the Indigenous Caterers Association of Ghana (ICAG) manual of operation and adopted to suit the Krobo language (See Appendix E). The questions were designed to cover a range of nutrition related topic and address specific questions on menu planning and portion control.

***Preliminary study/baseline survey***: Modified GSFP questionnaire (2008) included questions to determine household density, number of children in the family, age of children, gender of the children, length of breast feeding, household size, parents/caregivers' education and parents/caregivers' occupation, child's health, food, food procurement, food processing and preparation, and caring practices;

### **Dietary intake**

***School intake***: Weighed food records were taken on three non-consecutive days in 5 GSFP schools in Odumase. Data was collected on the same day as field observation days without prior knowledge of the caterer to ensure meals reflect what pupils receive on day-to-day bases. . A description of the composition of all school lunches per day per school was made by observation.

***Home Intake***: A food frequency questionnaire (FFQ) (Appendix B) as well as interactive 24-hour recall questionnaire (Appendix) to determine dietary intake and food consumption patterns at preliminary study stage and intervention phase.

***Food Frequency Questionnaire***: A modified version of Nti (2008) FFQ was used with inputs from the pre validated GDHS 2008 survey questionnaire

and MacIntyre questionnaire (1998:2000) FFQ. The FFQ contained various commonly eaten local foods divided into the 6 main food groups (Starchy staples roots and tuber, Grains/Cereals, Proteins, Oils, Fruits, Vegetables). The questionnaires were administered by trained enumerators and parents were asked to indicate the frequency of the child's consumption of the various food under each food groups (Appendix Two).

*Interactive 24-hour recall:* Recalls were done in the morning and a domesticated version of the Adamson et al 2003 24-hour recall (FAST) questionnaire which has been pre-validated to record young children's dietary intake was used to determine home intake. The recall was done in accordance to the Nelson et al (2007) procedure where parents/guardians (ideally the individuals who handled food preparation and feeding in the household) together with their child were asked to recall consumption starting with the most recent meal or snack working backwards to cover all foods, beverages, supplements and snacks eaten or drunk in the last 24 hours. Children filled in gaps of meals eaten away from parents. A list of meals (home cooked or bought) consumed was made with List of ingredients used. Enumerators probed for details on amounts of ingredients using household measures as estimates, type food processing/ cooking method used to prepare meals. Where meals were bought (street food, takeaway or fast foods), parents were asked to make estimates of the portions served or the price of the item.

### ***Product development***

***Acceptability testing questionnaire:*** The questionnaires were developed using a previously piloted (pre-validated) FRI in-house traditional food evaluation questionnaires and modified to contain the attributes of interest. For trained panel, a self-completion questionnaire with 9-point hedonic scale used (See appendix). According to Peryam and Pilgrim (1957)

hedonic scale, 9 represented the highest score (like extremely), 8 (like very much), 7 (like moderately), 6 (like slightly), 5 (neither like nor dislike), 4 (dislike slightly), 3 (dislike moderately), 2 (dislike very much) and 1 (dislike extremely). For the untrained panel, a simplified 3-point hedonic scale (3 =like, 2 = neither dislike nor like, 1 =dislike) was used to reduce error during rating, as described by Lawless and Heymann (2010).

**Preference test:** The standard paired preference procedure was followed as stipulate by Peryam and Pilgrim (1957) .The scoring was done using a 3-point scale where 2 represented preferred, 1 was NOT preferred and 0 was no preference. With the aid of sensory assistants the principle of **EITHER OR** was explained and applied.

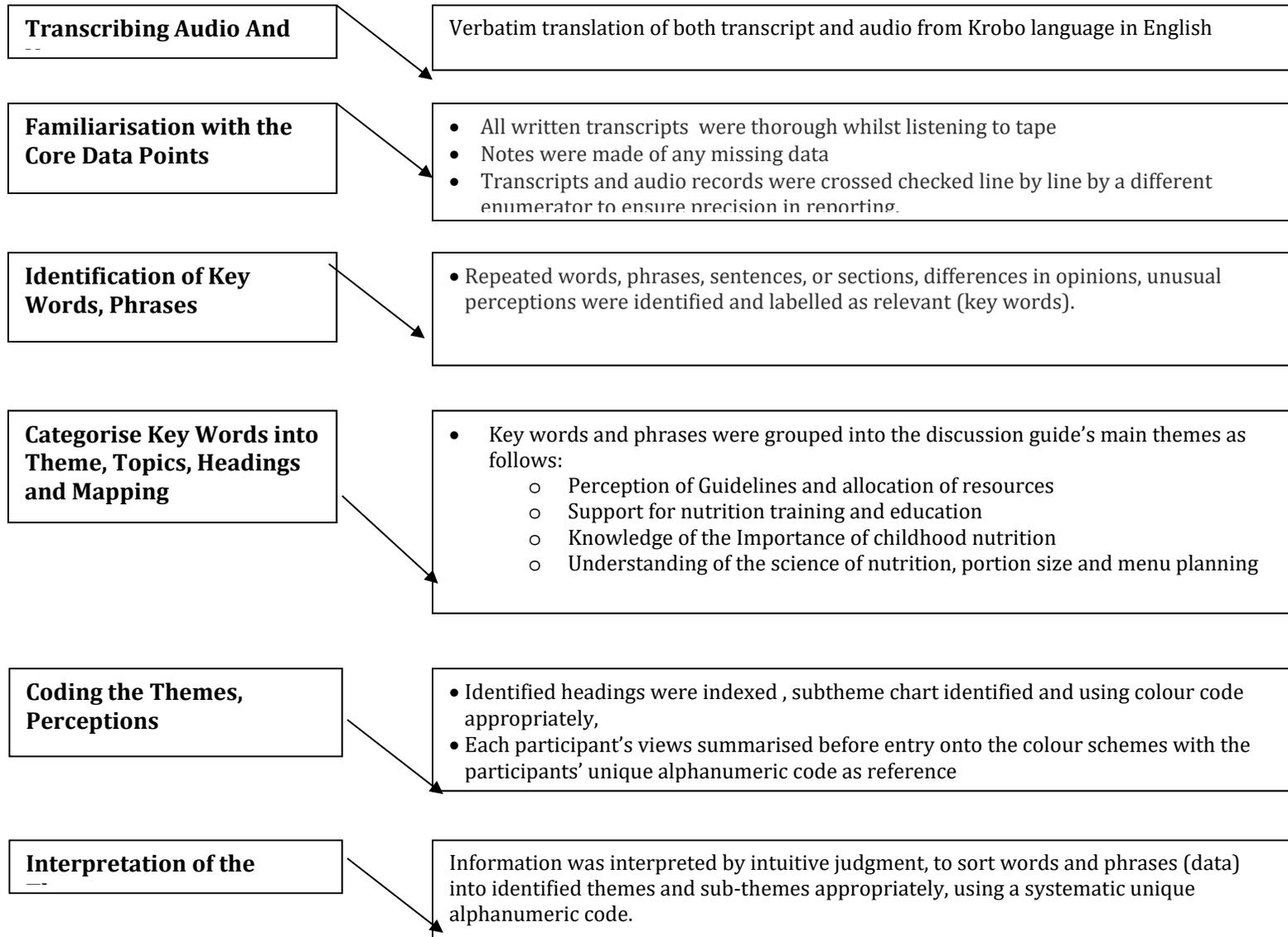
### **3.10 Data analysis**

All quantitative data (Socio-economic demographic data) were tabulated on an MS Excel software spread sheet for Mac 2011. Descriptive statistics (means and standard deviations) were derived for the different products for all attributes measured using MS Office Excel 2011 for Mac with Stat plus. All numerical data will be record to two decimal places.

Descriptive statistics was used to describe the population for each survey as well as baseline socio demographic data. Where appropriate Student's t, Wilcoxon-Mann Whitney and chi-squared tests were used for normally distributed anthropometric and biochemical measurements

Whilst non-normally distributed, and categorical data respectively. These analyses

Qualitative Data was analysed according to the Dixon-Woods, 2011; Ritchie & Spencer, 2002 approach and interpretation were drawn using the frame work as describe by Taylor-Powell, E., & Renner 2003. Figure 3 shows the entire data extraction concept used in analysing the focus and interview date



**Figure 3:18 Procedure for analysis focus group discussion results**

## **Dietary intake**

**School intakes:** Due to absence of plausible food content and menu data for GSFP schools in the district, nutritional value of meals was assessed using weighed meals food records (Appendix 2<sup>A</sup> Section B).

Weighed meals: Mean weights of the portions of the GSFP meals obtained from weighed food intake record were calculated converted into grams. Intake per pupil per meal was calculated using the menu planning software developed by Partnership for Childhood Development, which is based on FAO/WHO recommended nutrient intakes. For meals that were not available on the PCD software, the total of amount food cooked were reported in household measures were converted into raw weight (kg) using the MRC Food Quantities Manual (Langenhoevn, 1991) and the Noguchi Commonly Used Ghanaian household quantities conversion table (2013). Nutrient content calculation for the total meal prepared was made based on food composition dataset provided by FAO West-African-Food-Composition-Table 2012 and McCance & Widdowson (2002). The nutrients of interest were total energy intake (kilo-calories), protein (g), carbohydrates (g), fat (energy %), vitamin A, zinc and iron (mg). Nutrient adequacy derived from 4-day weighed records.

**Portion size:** Portion size of each was estimated using the MRC Food Quantities Manual (Langenhoevn, 1991) and the Noguchi Commonly Used Ghanaian household quantities conversion table (2013) and samples from for the weighed records were taken from pre coded plates and weighed using a Salter platform kitchen scale; precise to 0.1g with a load capacity of 10kg. In determining of portion consumed, the weight of the unconsumed portions in grams of the pre-coded plates was measured and substrated from the weight before consumption. Using the consumed portion in grams as part of the total meal, nutrient content of the child portion was calculated as a fraction of the total nutrient content of the portion served.

**Home intakes:** Home intake was assessed using 24hr recall and food frequency distribution methods, which have been found to be biologically

meaningful in determining actual dietary intake (). Data from 24-hour recall was converted into nutrient intake using FAO West Africa food composition table database (data not presented). Total daily intake was derived from summation of school intake and home intake taking into consideration snacks, supplements and herbal medicine that was taken. Data from the food frequency questionnaire were used to describe the food consumption patterns of the participants per week and inferences were made based on the main nutrients of interest.

**Proximate data:** The data was collected in duplicates and results were presented as mean with standard deviation. Percentage of each nutrient in 100g has been calculated as weight (g/ mg) per 100g in dry weight with corresponding percentage DRI. The recipes of mixed meals were recorded as standard recipes.

**Sensory data:** The results have been presented as mean scores with standard deviation. Panel check software was used to analyze all hedonic data. Results were generated in the form of attribute graphs with each attribute graph displaying individual panellist scoring variation. The attribute profiles developed from the software rates the panel scores for different SC<sub>m</sub> samples against panel consensus for a certain attribute (Fig 3.2 to 3.5). Each line represents one panel member (mean score) whereas the single bold black line represents the panel consensus. The tested samples are ranked along the horizontal axis according to the panel consensus from left to right with increasing intensity for that attribute. Pearson's two-tailed correlation was used to study trends and association between nutrient content and sensory attributes. Data was also subjected to analysis of variance at ( $p \leq 0.05$  and  $p \leq 0.01$ ), where necessary and followed up with posthoc testing (Kruskal-Wallis ranking test at  $p \leq 0.05$ ) to confirm trends.

**Acceptability test:** The arithmetic mean across attributes per panellist per meal was used to estimate the overall-acceptability of each S-cool meal. For each acceptability test,  $H_0 =$  (there is no significant difference in acceptability of meals despite difference in formulation)

$H_i =$  (there is a significant difference in acceptability of meals)

*Preference:* Only the top three performing meals from the trained panel acceptability were test on field. The data regarding the influence of reference test result were distributed over “Prefer A”, “No Preference” and “Prefer B” options for each attribute assessed and result displayed in percentage and illustrated using a pie chart as describe by

The hypothesis assume for this test  $H_0 =$  (preference for  $SC_m$  is  $\leq 40\%$  of the testing population)  $H_i =$  (preference for  $SC_m$  is not  $\leq 40\%$  of the testing population)

**Nutritional status and morbidity:** The Z-scores for height-for-age (HAZ), weight-for-age (WAZ) and BMI-for-age (BMIAZ) will be calculated using the WHO Anthro. The prevalence of stunting will be determined at height-for-age  $> -2SD$  and underweight at weight-for-age  $> -2SD$ .

In preliminary study, anthropometric and biochemical marker data for GSFP participating schools and non GSFP participating participants were analysed using chi square statistics and Pearsons to determine if there is an association between in nutritional (weight/height/HB) status improvement and participation in GSFP. Further, analysis of variance statistics was used to determine if there is any significant difference between nutritional status at start of term, midterm and end.

Individual multiple linear regression analysis was used to determine presence of correlation between intake of GSFP meals and changes in nutritional status during preliminary and repeated for the intake of model meals and changes in nutritional status across pilot and scale up intervention. To determine the factors influencing the Nutritional status and anaemia status a multivariate analysis was done. The nutritional status and anaemia status were used as dependent variables. A logistic regression was used to establish association between specific intake and socio demographic characteristics.

### 3.10 Sustainability plan

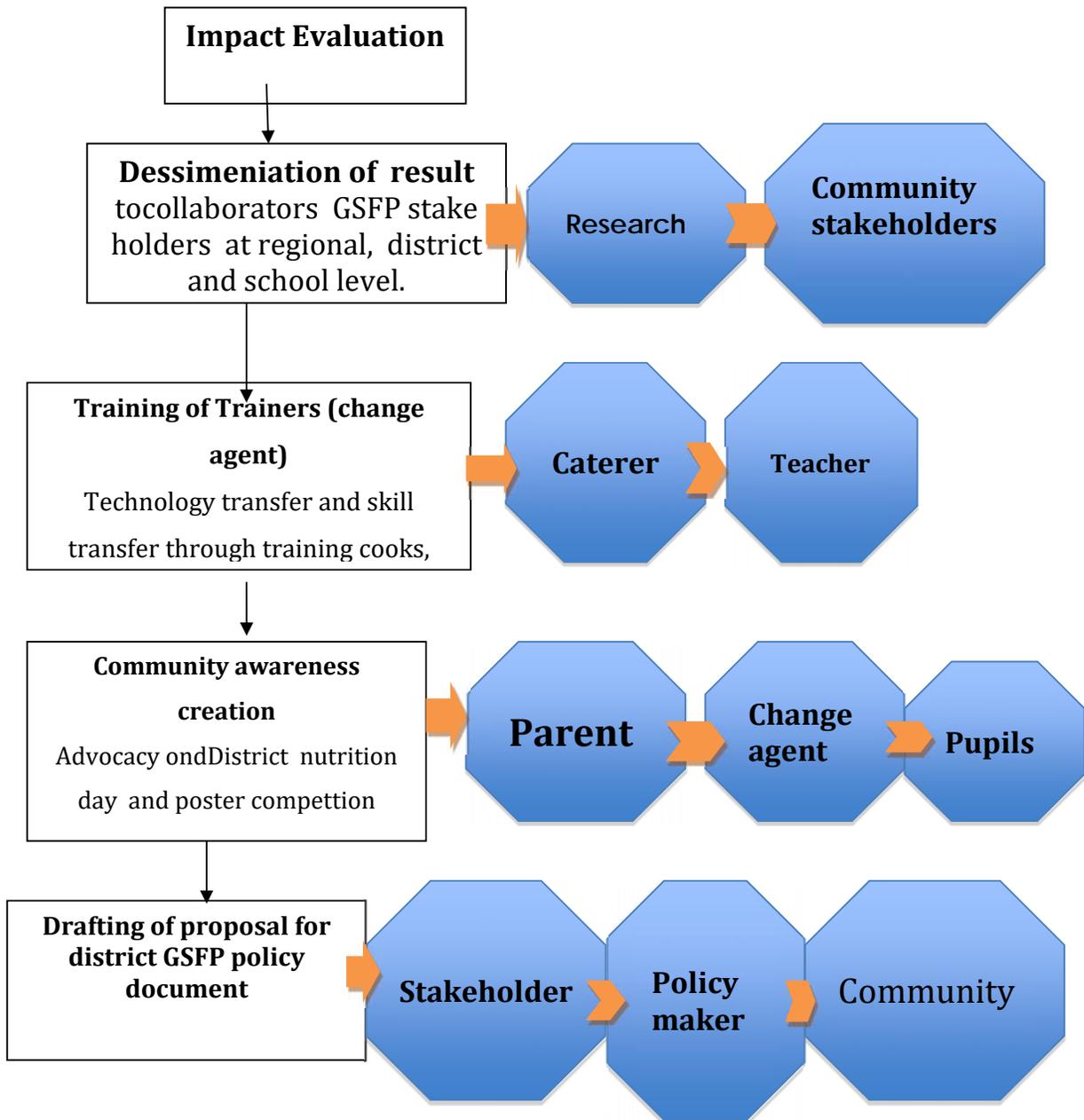


Fig 3.19: Framework for sustainability

### **Concept and approach**

The key factors appear to have affect the viability of most nutrition and other health studies in indigenous populations is the absence of a detailed an exit intervention strategy and/or a sustainability plan. This section looks as at an extensive approach developed by the SC<sub>m</sub> team to facilitate relationships and develop local change agent whilst interacting with local and regional policy makers on how to sustain the impact of the current study. Figure 3. shows the elaborate bottom to top approach that will be applied post intervention. The design is focus on promoting communication at community level to ensure long term success.

### **Impact assessment**

This was done to gauge and assess the impact of the current SC<sub>m</sub> intervention in the community by on the last day of term Follow up interviews were held with parent of children in of term using a 10 point questionnaire (Appendix) to ascertain they views on the SC<sub>m</sub> meals, intervention procedure, ascertain the view on its impact and their general perception on how the intervention was implemented. An initial cost analysis was performed to and calculation will be based on cost per child per term and per year and compared to that of the current GSPF.

### **Dissemination of result**

Considering the wealth of knowledge uncovered in this study, there is an indication of a big gap in knowledge concerning young child feeding at the district and if not address could significantly affect the long-term impact of the study. The study attempts to curtail this by providing capacity building and nutritional education on healthy indigenous food choices. The first point of education is the dissemination of the result of the intervention to local leaders, study collaborators; health works stakeholders at school and district level through conferences and local durbars. This will draw attention to the need for action and will mobilize support for community wide awareness creation.

## **Training of Trainers**

The aim of providing sustainable health through the use of indigenous nutritional solution will not be met if nutritional interventions are not accompanied with nutrition education and the capacity building at local and school level. It's the belief of the SCm team is that there is a need transfer of responsibility of nutrition information dissemination to local change agents to improve the chance of long-term sustainable impact. The activities proposed include training on WHO nutrient guidelines for caterers/cooks, nutrition education for teachers and mothers in the community on how to promote healthy eating / healthy food choices messages in the classroom and at home as well as how to monitor child growth.

To ensure that the impact made in this current study is amplified through the study area and beyond there is a need to equip and incentivise the chosen agents-of-change. To do this, the SC<sub>m</sub> team has obtained 1200-pound fund from the125 fund of University Of Westminster and its partners at. The funding will be used to provide training and resource pamphlets for caterers, parents and teacher on childhood nutrition, menu planning and how to reconcile nutrition messages from the classrooms to the dining rooms.

In addition, the SCm believed that aside providing resources, local change agents need to be linked with key players and agents in the health industry both local and national levels hence a workshop will be organised as part of the dissemination process. The experts will be from drawn from the various project partners in Ghana and United Kingdom. The aim is to create a platform for individuals from diverse fields in to disseminate their knowledge and research in the field of nutrition. The workshop will allow participants to learn about various nutrition-sensitive projects and possible identify areas for collaboration as well as disseminate best practice.

The hope is that at the end of the workshop is to develop a consortium or multispectral/multidisciplinary team to address future nutrition related challenges. This networking opportunity will help develop the local change agent teams and will contribute to their continuous capacity development

by providing them with first hand access to innovative nutrition research skills, best practices and technology.

### **Community awareness creation campaign in LMKD.**

To make the activities of the local change agent easily the SC<sub>m</sub> team seeks sensitize the community through the school Parent Teacher Association and the district assembly. The team hopes to utilise the rapport built with the stakeholders at the district level to organise a nutrition campaign. The main activity will be a school nutrition day, which will be organised in conjunction with Municipal Health Service to create awareness on malnutrition prevention in the district and the availability of local nutrition solutions. The aim is to shift the community's interest from rice based meals to more indigenous meals. In an attempt to involve the school pupils in awareness creation, a healthy eating poster making competition will be organised for school children.

### **Drafting of proposal for district GSFP policy document**

The result of this study is expected to contribute new knowledge as well as demonstrate areas that require alterations and this likely to help policy makers in modifying the GSFP approach to ensure maximum impact at district level. The plan is to engage key policy makers both at district and national level through drafting recommendations and proposals based on the current body of work. The bottom up is approach of engagement is crucial for take-up, and take-up is essential for ensuring long-term impact of the SC<sub>m</sub> intervention and the GSFP at large.

The belief is that the trickle-down effect of all the activities enumerated in this section will ensure that the nutritional gains made during this study will be sustained and the practical aspects of the training will help improve the food sovereignty situation in poor communities as more people will be able to know and plan healthier meals for their children using foods found in their immediate environment.

## **CHAPTER 4**

### **RESULTS AND DISCUSSION:**

#### **Introduction**

This chapter focuses on the results of the study and discussion of relevant trends observed in the three main phases of this study. The first, section describes the Service evaluation results which is divided in the cross sectional study and the field observation. This followed by the description and interpretation of the results for the product development phase and (pilot and scale up) final part describes the third phase: the implementation of the SCm intervention and follow up.

#### **Summary of methods**

A service evaluation was carried out using school level stakeholder cross sectional surveys followed by a two-month field observation which assessed nutrition related practices, nutrient adequacy of GSFP meals as well as sanitation and hygiene practices. The SCm meals were developed based on the nutritional inadequacies identified in the service evaluation using the FAO food composition and verified using the Imperial College/ formulated PCD meal planner. Nutritional content of SCm meals were analysed using AOAC (1999) methods of proximate analysis and formulation were optimised using three levels of sensory analysis. Two sessions of nutritional interventions were carried out with the SCm meals (pilot n=110, scale up n=330) over 6 months and 9 months, respectively.

#### 4.1. Service evaluation

##### 4.1.1 Cross-sectional survey

###### Heads of school and teachers survey

A total of 16 respondents were contacted for the survey, three individuals however did not give written consent hence were excluded. The survey involved 13 individuals consisting of 4 head teachers and nine teachers from primary schools in the LMKD.

**Table 4.1 Heads of school and teachers survey Participant Profiles**

<b>PARTICIPANTS</b>	<b>(MEAN ± SD)</b>	<b>MALE</b>	<b>FEMALE</b>
<b><i>Number of respondents</i></b>		7	6
<b><i>Teaching experience (years)</i></b>	8 ± 2.83	10	6
<b><i>Years in current position</i></b>	6±1.41	7	5
<b><i>Nutrition training</i></b>	1	0	1

Table 4.1 shows that age those interviewed ranged between 31-40 years old with the majority of respondent being male (7 males vs. 6 females). A similar trend was observed in terms of teaching experience with males having longer experience in teaching than the female respondents. This was understandable as the majority of the head teacher were males and had an average of 10 years under their belt. All respondents reported that they were either math or science teachers with one indicating that she had a nutrition related qualification. She further explained that she had prior secondary school qualification in home economics, which had a catering and nutrition component. All respondents expect the four head teachers taught an average of 243±28 pupils with an average of 52±10 students per class (1: 53 teacher to pupil ratio).

In response to questions about GSFP programme, only 6 respondents reported that feeding had commenced in their respective school as at the time of the interviews

**Table 4.2 Response to Nutrition environment questions**

Questions	Response	
	YES n (%)	NO n (%)
<i>Trained teacher with speciality in nutrition on school staff?</i>	3(22.07)	10 (76.92)
<i>Do you have a role in the school-feeding programme?</i>	5(38.46)	8(61.53)
<i>Are nutrition oriented pictures and educational material in your school?</i>	4 (30.77)	9(69.23)
<i>Are there discussions with your staff on the school-feeding programme?</i>	7(53.85)	6 (46.15)
<i>Are there discussions with parents on the school-feeding programme?</i>	9 (69.23)	4(30.76)
<i>Are there discussions with Caterers/cooks on the school-feeding programme?</i>	3(23.07)	10 (76.92)

On stating the most important impact the GSFP had had in their schools, 69.23 % (9) indicated that it had increase enrolment number and exponentially increased attendance hence the large teacher to pupil ratios. An additional 23.09% (3) mentioned that it had reduced the occurrence of child hunger levels among their pupils and one respondent mentioned that the GSFP had improved the nutritional status of pupils in her school.

In assessing the school nutrition environment and the role of the teaching staff, respondents were asked if they felt they had a role in the current GSFP programme in their schools. An initial 38.46% (5) indicated that they did have a role in school feeding programmes in their respective schools. They however added that it was simply a custodian role looking out for the welfare of their pupils, which is not necessarily an active part of the day-to-day running of the programme. The remaining respondents mentioned that they did not have a role and if they did, they were not aware of what it was because activities were out of their classroom jurisdiction.

All respondents reported that even though they did not actively play a role in the day-day activities of GSFP programmes in their respective schools, they had had meeting within the staff and with parents concerning GSFP meals as shown in Table 4.2. The complaints of staff most often boarded on timing conflicts between feeding and academic activities. Occasionally, there were discussions about meal quality, quantity/content and what to do to improve the GSFP experience in their respective schools. Only 22.07% (3) respondents indicated that the results of their staff discussion actually translated in action for the GSFP in their schools.

With respect to discussion with parents about the GSFP, 69.23% (9) mentioned they had had discussions with parents with the same majority indicating that the discussion pertained to addressing parent concern about the GSFP during Parent-Teacher-Association meetings. However for most respondents, the discussions did not impact on the activities of the GSFP in their respective schools. Some respondents mainly the head teachers indicated that there have been occasions where they had escalated parent's concerns to caterer about meal portion and meal quality.

All but one the head teachers reported that they had never had discussions with the GSFP caterer. When probed 3 headmasters indicated that caterers often give feedback on parental concerns and they sometimes invite the caterers to PTA meetings to address any problems parents might have. The head teachers mentioned that very often the caterers respond to concerns but act of their recommendations and they were of the opinion that their have been be systematically excluded from the GSFP programmes in their schools.

Focusing on the foods provided by the GSFP, respondents were asked to state what they thought was their pupil's favourite meals. In response, all the respondents mention rice based meals with white rice and stew, jollof, waakye (white rice and beans) the top three mentions. Respondents were probed to ascertain possible reasons for this trend. Eight respondents mentioned that the children had no choice because that was only meal the caterers offered. Rice meals usually required little effort

and ingredients to cook compared to other meals the children might prefer like banku.

**Table 4.3 Response to Children behaviour towards GSFP meals**

Item	Response n (%)			
	Dull / Inactive	Normal	Active/ playful/	Extremely active
<b><i>In class before meals</i></b>	7(53.85)	4(30.77)	2(15.38)	0 (0)
<b><i>In class after meals</i></b>	2(15.38)	1(7.69)	5(38.46)	5(38.46)
<b><i>On the playground after meals</i></b>	0 (0)	2(15.38)	7(53.85)	3(22.07)

To ascertain and gauge pupil's reaction to meals, respondents were asked to describe the countenance of the pupils before and after eating GSFP meals. In response, majority (53.85%) said that pupils act dull, lethargic and do not want to participate in class activities before meals whilst few were attentive (usually those who have had breakfast). Some respondents indicated that for most of their pupils, GSFP meals at lunch time are their first meal of the day hence a lot of pupil come to school hungry and remain hungry till the midday GFSP meals are provided.

The growing bodies of school children are in constant need of energy in the form of glucose for production of ATP for immediately or / and future use (Szablewski, 2011: Berger, Tymoczko and Stryer 2006: Bier et al: 1977). Prolonged fasting study (due to missed meal or delayed meal) like the one reported in this study may result in lowered blood glucose levels (hypoglycaemia) forces the body to make adjustments to cater for to depleted energy by switching to metabolic functions to conserve energy (Szablewski, 2011).

This subsequently triggers a sequence of indicators and symptoms like lethargy, dizziness, irritability and other dissociative behavioural patterns to prompt the body on the need for energy stores to be replenished (Kristjansson, 2009). For school children who constantly miss

meals or delay meals especially breakfast, there is a rise in negative coping mechanisms such as constant urge to snack, dullness, sleepiness, fidgeting or jerky movements, lack of attention or eventually confusion during class are much more prominent (Kristjansson, 2009). The prominence of negative behavioural coping mechanisms in hungry school children in this study population may be caused by a variety factors with complex interconnections which make it difficult to isolate an exact mechanism for causality.

In similar populations, Sprague and Arbeláez, 2011: Szablewski, 2011 together with Kristjansson, 2009 have reported constant prolonged hunger from delaying breakfast can result in brain dysfunction. The brain relies heavily on the body's glucose stores for substrates for energy (fuel) to function adequately, any fluctuations in blood glucose level resulting from delayed meals or fasting trigger coping response from the brain which may vary from hypoglycaemic symptoms such as slight heads or drowsiness or migraines to neurogenic and neuroglycopenic symptoms (brain dysfunction) such as sudden and significant changes in mood, attention span and even cognition (Sprague and Arbeláez 2011: Szablewski, 2011)

With respect to post mealtime behaviours, majority (76.92%) of respondents indicated the most of pupils were either active or extremely active. A couple of respondents went further to state that the children appear to show some sort of relief as if a burden has lifted from them hence they approach classroom activities with some level of renewed strength and enthusiasm. This goes to suggest some positive effect of the provision GSFP on short-term hunger among participating pupils similar to those observed in the Jackson (2012) study.

The Jackson (2012) study reported on adult perceptions about the GSFP in Adjeikrom in the eastern region of Ghana. The results indicated a general appreciation of the GSFP as intervention to reduce short hunger among pupils and several of 41 adults interviewed perceived that the elimination of hunger resulted in pupils behaving better in the class.

The Molinas and Regnault de la Mothe (2010) and Grantham-McGregor and Olney, 2006 studies both suggest that the provision of meals in schools may alleviate short-term hunger among children and subsequent result in improvement in classroom behaviour, performance, improve grades during tests and general aid in children's academic progression throughout education.

Although very few studies have attempted to elucidate the degree to which alleviation of short term hunger directly impacts on the improvement of grades in test (Jomaa et al., 2011), most suggest that a combination of alleviation short term hunger and increased intake of nutrient balanced meals together with adequate nutrition education is likely to result increased brain function and subsequently improvements in cognitive function and memory of school age children (Buhl, 2012; Morgan and Sonnino, (2008); World Food Program, (2004); Del Rosso, 1999).

There were also reports that the pupils who acted dull and lethargic after eating GSFP meals. Of those who reported lethargic behaviours after meals; the majority associated it with high energy content of meals especially white rice based meals. The perception amongst these respondents was that meals were energy dense and caused the pupils start to feel too fully and eventually some doze off during class. Considering that most of the meals provided in GSFP were white rice based, it is likely that the dull and lethargic behaviours report may have been due to temporary spikes in blood glucose level as result of the consumption of meals with fast-digesting carbohydrate content (usually high glycaemic index).

Reports by Sorensen and Johansen (2010); Norman Lavin (2009); Ceriello (2008) and other postprandial (reactive) hypoglycaemia studies in non-diabetic populations have shown similar trends in especially with white rice, rice pasta and Irish potato based meals. A cup of short grain White rice provides 45 grams of fast/short-acting carbohydrates which quick spike in blood glucose and provide readily available metabolic energy (Powell *et al.*, 2002). This further worsens when the rice is served with a high caloric sauce/stew with no additional fibre (cereal or

vegetables) content, In that, the spike blood glucose level as result of the intake of large quantity of fast acting carbohydrates sequentially results in the secretion of elevated or higher than normal insulin levels into the blood stream (Allessa et al., 2015; Willet *et al.*, 2002).

In cases where the prolong fasting is persistent, the pancreas continues to elevate blood insulin levels which in turn continues to mop up glucose in blood long after glucose digestion has been completed. This leads to subnormal levels of blood glucose (hypoglycaemia) accompanied by symptoms synonymous with hypoglycaemia such as dullness, drowsiness sleepiness/lethargy and lack of attention (Allessa et al., 2015: Borbély et al., 2013 Riddell and Perkins, 2009)

#### ***Teachers' perceptions about performance of the current GSFP.***

Based on the experience from the previous academic year, 53.85% (7) of respondents reported that the overall performance of the GSFP in terms of impact on health of the participating pupils as fair whilst (3) rated it as poor, 1 indicated that the performance of GSFP in his school was good and 2 others rated it as excellent. In terms of impact on hunger, 15.38% reported a good impact, 61.53% reported a fair impact, and 23.07% indicated a poor impact, 7.69% (1) indicate it was good with 1 reporting an excellent impact on hunger as shown in Figure 4.2.

Those who reported fair and poor impact indicated with their response that, in their respective school, providing meals at lunchtime (midday) was not ideal because for the poorest children (for whom the need is greater), they do not receive any nourishment till midday.

The perception of some teachers was that the poor timing and the low nutritional content of the GSFP defeat the purpose for which it was set up. Thus the programme as a whole fails exerts any significant impact on the health of the participating pupils. A similar trend was seen in the teachers survey response to questions about the impact of GSFP meals on nutrition, the majority of respondents (76.92%) indicated a fair impact

whilst 15.34% indicated that the GSFP had a poor impact on nutrition and a further 7.69% reported a good impact on nutrition.

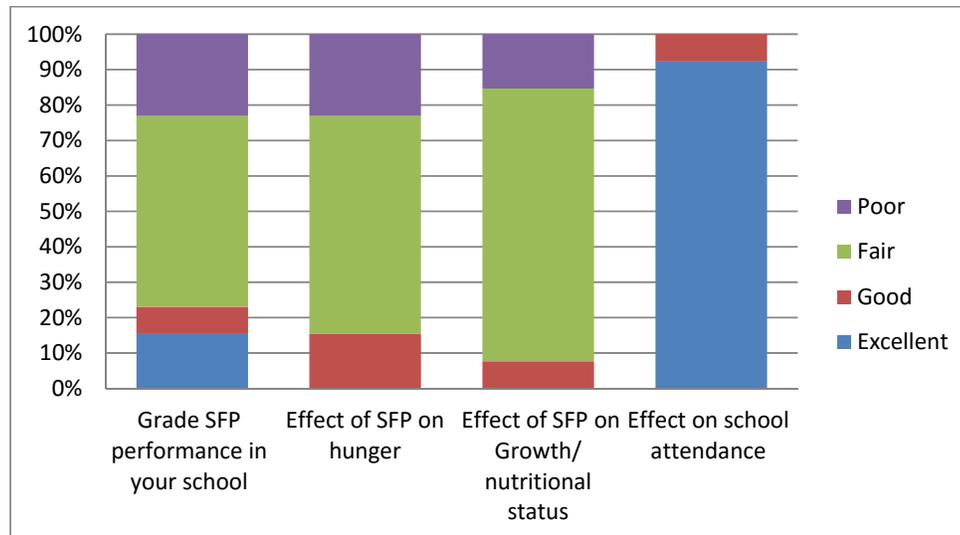


Figure 4.2 Teachers perceptions about the Current GSFP n=13

Insufficient portion sizes, low nutrient content and inconsistency in service provision were the main reason for the lack of impact on the nutritional status of the children. Those who rated the GSFP meals as good, they were of the opinion that for some of their student the GSFP meals remain their only stable/constant nourishment for the day during the school week.

With respect to attendance, 92% of respondents rated the GSFP as having an excellent impact on attendance whilst the remaining rated it as good. The underlining reason was that the GSFP meals served as an incentive for children to register for school. The promise of a meal at school provided some sort of safety net against going hungry. Similar results published by Boxx (2014): Oganga (2013) Omwami et al., (2011) and Yager (2002) all suggest that SFPs have some degree of influence on increasing enrolment and attendance in participating school.

Greenhalgh et al., (2007) however adds that the impact on attendance is relative to the economic status of the population because the provision SFP in population with high income have little to no significant effect on school attendance whilst the opposite is true in low income to poor income populations.

**Table 4.4 Perceptions about the Current GSFP**

Item	Response n (%)			
	Excellent	Good	Fair	Poor
<b>Grade SFP performance in your school</b>	2 (15.38)	1(7.69)	7(53.85)	3(23.07)
<b>Effect of SFP on hunger</b>	0(0)	2(15.38)	8(61.53)	3(23.07)
<b>Effect of SFP on Growth/ nutritional status</b>	0(0)	1(7.69)	10 (76.92)	2(15.38)
<b>Effect on school attendance</b>	12 (92.30)	1(7.69)	0(0)	0 (0)

On the question of challenges facing GSFP in their respective schools, the main challenge reported was the lack of funds. Some respondents indicated that the GSFP was intermediate and meals were not regular and there were periods during the term where meals were not served because caterers have no money for procurement.

The challenges mention were not different from those reported in previous studies (Abotsi 2013; Hauwere 2010; Danquah 2009: SIGN/SEND Ghana, 2009). Shaffer (2015) observed similar challenges when studying school breakfast implementation in a small school district in the Mid-Atlantic region of the United States and recommended an increase in the governmental commitment towards the provision food and resources to sustain SFPs.

The remaining respondents added that the GSFP lacked quality assurance and monitoring staff in that, no one was monitoring the caterers' work or output. In their perception, caterers tend to do whatever they like according to their discretion. The Gelli et al., (2016) and Atta and Manu (2015) studies both raised questions about the caterer model used by the GSFP and it impact on decision-making including healthy food choice. Buhl (2012), Aliya (2012) and SIGN/SEND Ghana, (2009)

recommended that for the caterer model to be effect there is a need to establish standards, guidelines and monitoring measures to ensure that the GSFP achieves it goal.

Other respondents added that although funding was not enough caterers could manage funds adequately if they prioritize buying local produce instead of retailed food items like rice. The Shaibu and Al-hassan 2014 study of the GSFP in the Tamale in the Northern region of Ghana, the results show that majority of caterers procured raw materials from the retail market with very few buying from local farmers.

In answering questions pertaining to how the GSFP in their schools could be improved, 6 of the 16 respondents reported the need for additional funding in order to improve the quality of meals, 4 mentioned the need to involve the teaching and academic staff in planning meals whilst a further 2 mentioned the need to train caterers on how to increase food quality and quantity. The last person explained that there was a need for the children to be taught what and why they receive school meals .He further suggested that certain participants that used to be in the syllabus like Life Skills need to be reintroduced into the classroom.

#### 4.12 Caterers survey

**Table 4.5 Caterer’s Characteristics**

<b>Participants</b>	<b>Mean</b>	<b>Male</b>		<b>Female</b>
<b>Mean Age</b>	43 SD±7.68	50		36
<b>Number of respondents</b>	14	1		13
<b>Number of support staff</b>	2.2 ±0.8			
<b>Key indicator</b>	<b>Less than 1</b>	<b>1-3</b>	<b>More than 3</b>	<b>None</b>
<b>Number of support staff</b>	2 (14.28%)	6 (42.86%)	3 (21.43%)	0 (0)
<b>Cooking experience (years)</b>	5 (35.71%)	6 (42.86%)	2 (15.38)	0 (0)
<b>Years in current position</b>	3 (14.28%)	7 (50.00%)	4 (28.57%)	0 (0)
<b>Time of last Nutrition training</b>	2 (14.28%)	8 (57.14%)	2 (14.28%)	2 (14.28%)

Fourteen out of the 16 GSFP caterers and cooks operating in the LMKD at the term starting March 2014, responded to the survey invitation. Of caterers surveyed, 90.9% were female and the mean age was  $43 \pm 7.68$  years. In terms of qualifications, 2 had had only primary school education, 5 indicated that they had at least secondary education (three had junior high school education, whilst 2 had attended secondary school), two had no formal education whilst 2 other respondents had higher national diplomas in catering. With respect to experience in catering for children, one caterer decided to abstain and not answer that question. Of those who responded, 11 indicated that they had less than 3 years' experience, whilst 2 had over 3 years' experience as shown in Table 4.5.

In all, 13 out of the 14 played a role in the daily cooking processes in their various schools with the help of other catering personnel. In response to questions about catering staff, 76.9% indicated that had between 1-3 people helping them to food preparation whilst the remaining 23.1% had more than 3 people helping in meal preparation and food service.

When asked about cooking environment and infrastructure, 10 caterers reported that they prepared meals onsite at their respective schools whilst one indicated that the cooking was done in her private kitchen at home. As per the type of kitchen infrastructure 63.63% (7) indicated that cooking is done in open-air structures, 27.27% (3) indicated that they cook in traditional shaded kitchen with firewood as the main fuel source whilst 9.09% cooked in modern kitchen with sinks.

The response to questions pertaining to time of last nutrition related training showed that 2 (caterer/cook) had had some nutrition training in the last year a further 8 had had some training in the last three years, an additional 2 indicated that their last training was over 3 years ago whilst 2 others had never had any training in nutrition at all. However when asked if they provide training for their personnel 81.18% indicated that they do whilst the rest indicated that they have never provided training for their personnel.

### **4.1.3 Focus group discussion**

A total of 13 respondents completed the consent forms and took part in the study. Focus group discussions were 0.45 to 1 hour in length and were digitally recorded and transcribed verbatim. Parts of the discussion that were formed in Krobo were translated, transcribed, and analysed in English as described by Morgan, (1997) and Krueger, (1998).

Perceptions of caterers and cooks were described and categorised under the following headings: the relevance of school feeding, well balanced meal: menu/ meal content planning, perceptions training and skill needs. The key research findings and have been described in the following section with some direct quotations provided given to elaborate some of the subthemes that emerged from the interviews.

#### **4.1.3.1 Nutrition in health**

Regarding the role of nutrition in health, the following three themes were identified.

##### ***Caterers' understanding of the science of nutrition***

Caterers expressed their understanding of the science of nutrition in terms of their knowledge of the food groups and provided local examples of food groups. The varied systems of classification were mentioned and some expressed their confusion of classification systems you. Some felt the three food function grouping (energy giving, body building and protective food groups) was easier that the 6 food categories grouping (Grains, Fruits. Vegetables, Dairy, Protein, Oils)

##### **Translating the science of nutrition into practice**

Caterers perceived that nutrition did not involve the knowledge of the science but extends to its application into practice. Several caterers mentioned the various interventions in the community that promote health and how those programme help to ensure growth and wellbeing.

- *“At the clinic, the nurse at antenatal clinic talks about how food is the best medicine” Caterer 10.*
- *“ There has been a lot adverts about how as we grow we need to eat more vegetables, I try to cook with a lot the vegetables we have around” Caterer 2*
- *“They say the more colourful the meal the healthier it is” Caterer 7*

*\*All comments are verbatim*

### ***The role of the school feeding programme nutrition in health***

The response to the questions about the role of school meals caterers/cooks perception could be categorised in to three subthemes.

#### ***Nourishment: according to their perception***

Caterers/ cooks regarded the school meals as a means of promoting health and nourishment. Although varied views were expressed on its effect of the health of children there was a general agreement that it provide beneficiary children with energy for the day. Some caterers mentioned the following

- *“For a lot of my pupils, the school meals are the only cooked food they eat because their parents are too busy with farm work or on the market” Caterer 3.*
- *“A lot of children are hungry when they come to school because there is no food at home” Caterer 12.*

***Social support:*** The general opinion was that school meals were established to help families by reducing the burden of providing meals daily. Caterers explained that the provision of meals in schools encouraged persons from poor backgrounds to send their children to school.

- *“Most the children in my area come to my school because of the food, they parents believe if they eat at school then there is one less person to feed or worry about” Caterer 3.*
- *“For most us especially myself, I know that the school population has shot up because of the provision of school meals” Caterer 8.*
- *“In my school, some of the children especially the poor once only come to school to eat, after the school meal, they run away home or to town to help their parents on the farm or market” Caterer 11.*

#### **4.1.3.2 Meal content and balanced diet**

This session of the discussion helped to examine the caterer’s knowledge of food groups. This enabled the SCm team to ascertain where the concept of balanced diet fit into the caterers’ quest to prepare and distribute school meals.

#### ***Concept well balanced diet:***

In all the caterers displayed a fair knowledge of the concept of well-balanced meals with respect to meal quality and quantity. Below are some of the views the caterers expressed:

- *“I think when they say well balanced diet it means eating every type of food in a small amounts like when you are eating rice with stew, add little fresh vegetables like dandelion and eat some orange after” Caterer 2.*
- *“I have also heard about dandelion, so I add it to my okro soup when cooking banku and okro” Caterer 13.*
- *“Balance diet is cooking with items from each of food group” Caterer 2*

With reference to the meals they cook at schools for their pupils, caterers expressed a feeling of inadequacy with respect to nutrient content of the meals they provided.

- *“In my school, I try to add beans to the stew for rice to make it a balanced diet because the stew is not rich” Caterer 3.*
- *“It’s not every day we can give balance diet, so what I do is if the previous days meal was not rich, I try to compensate by adding legumes to balance the inadequacies” Caterer 10.*
- *“I do my best to cook our local foods for the children; they are more balanced than the normal rice and stew” Caterer 6.*

However like the rest they expressed that the lack of nutrient adequacy was due to constraints beyond their control and that they were working with what is available.

- *If there was more money, I will add beans and green leafs to all the meals for my students, but the money is too small” Caterer 12.*
- *“Sometimes, the allocated money makes it impossible to give children enough food” Caterer 2.*

*“Most of the time, I cook with meat but the portions are not enough for even a glass so I give the meals with meals to the head teacher” Caterer 4.*

***Guidelines for ensuring balanced diet:***

There was no reference to any set of standards. The only nutritional standard was basically ensuring the wholesomeness of meals. Most caterers were of the view that fixed guidelines or food standards if available will make their work easier and much more effective.

- *If there was more money, I will add beans and green leafs to all the meals for my students, but the money is too small” Caterer 12.*
- *“Sometimes, the allocated money makes it impossible to give children enough food” Caterer 2.*
- *“Most of the time, I cook with meat but the portions are not enough for even a glass so I give the meals with meals to the head teacher” Caterer 4.*
- *“I cook rice most of time and there is not much you can add because the money will be finished after we buy the rice” Caterer 8.*
- *“I make sure that I save fresh food every day, I don’t save left overs”*
- *“As a rule, I prepare all the school meals in the school, so the teachers can see what goes into the meals, some of them can be paranoid about the quality of the food”.*
- *“I try as much as possible to make sure all the foods I cook are rich but I think it will be easier if I have help on exactly what to cook and how to cook” Caterer 11.*

#### **4.1.3.3 Menu planning and portion size control.**

This section was designed to develop a list of all the factors that affect each caterer’s choice with respect to meal/menu planning. The majority of caterer’s viewed the menus as ideal to work with if available. For most, the perception was that in SFPS where cash flow is limited and raw material supply is cash and carry based; menus will not serve their purpose. For most caterers, the perception was that planning and following menu was not effective because of resource constraints and the dependency on retail foods. Others believed that a fixed menu did not allow flexibility.

- *“It will be difficult to plan school meals in advance because sometimes we have money to stock on raw materials” Caterer 7.*
- *“Cooking with menus gives the children expectation that we cannot always honour so I will rather cook what is available” Caterer 4.*

The majority of caterers were in favour of menu but did not think setting fixed menu would help. At least 8 of caterers thought that setting standards a/guidelines for cooking and menu planning would make their work more effective or easier to implement

In the absence of menu, caterers were asked about the chain of decision making in deciding what to cook and when to cook it. The response indicated that for most caterers decision was solely based on the money available and the contracting caterer made the final decisions on food type.

- *“Me, I like the idea of the menu, if they are there parents and community members can actually see what you give to their children” Caterer 2.*
- *“Menus are good but they have to be changed time to time because they the meals become boring, every week repetition of the same foods” Caterer 13.*

#### **4.1.3.4 Meal distribution**

Perceptions here were similar to those on menu guidelines with considerable more caterers stating that their services were likely to be much more uniform and effective if there were district and national on meal allocation and distribution.

- *“I feed the young children first because they are the ones who cannot cope well with hunger; after that I give the boys before the girls they are more activity than the girls so they need more food” Caterer 11.*
- *“Like my sister, I give the boys more, they girls are usually very fussy eaters and waste a lot of the food, and they prefer toffees and sweets to actual food” Caterer 9.*
- There was also mention of the factor that most caterers know their pupils because they are from the same town, hence they are able to identify the most vulnerable pupils.
- *“In my school, there are a couple pupils are I know who have lost both parents to HIV (all in one year), I do my best that to make sure they get more than average because that might be the only thing they have for the day”. Caterer 1*
- *Some these pupils look so hungry during feeding time, you can't help but give them a little more, others won't even stand in the queue to be serve and you know very well that they have eat so there is no way they will finish their meal, I know allot of them just wasting the food whilst others want more”. Caterer 2*
- *I come from a poor area so I hate it when people waste food and some of the children just don't like eating so with those children I give them smaller portions. Caterer 6*

In the absence of official guidelines, the general consensus was to guide portion size based on their experience as well as their experience as mothers in their community. Caterers stated that their portions were decided on in an almost hierarchical scale, with the first consideration being age, followed by gender. In terms of whether the current informal guidelines they employ were effective in ensuring health, there was no consensus over the impact of the lack formal guidelines on meal portion size.

- *“If the food I cook is nutritious whatever amount I give my pupils they will still grow”. Caterer 3*
- *“There is a difference between knowing what to cook and knowing how to share food, someone can tell you how to cook food to make it nutritious but it will be difficult to tell you how to share because they don’t know the kind of children you have, some can eat only small, others eat plenty. I know how all the child we serve in my school eat so i give them according to my experience with them, no one can give you guidelines on that” Caterer 1.*
- *On the other hand, a few caterers mentioned that the presence formal guidelines and rules for portion size were necessary to prevent discrimination, favouritism and social injustice. In their opinion, the lack of guideline allows certain caterers or cook favour other pupils over the others so a set portion size for the different ages will make food allocation and distribution.*
- *“I think guidelines are necessary, because I don’t think it’s fair that some people will receive more than the other, we must treat all the children equal”. Caterer 5*
- *“I think that to prevent favouritism because we come from the same area, there should be a rule about how must each child should receive. Some people give their relatives of friend children more food” Caterer 8*

The perception of some caterers was that there was no ideal way to guide the portion size because eating patterns differ from place to place as well as portion size. They continue to say that what was need is a formal menu and meal content guide which will serve as a standard to ensure that no matter what portion size they serve the pupils will receive some amount of nourishment

- *“Nowadays even, the waakye seller uses those small bowls to measure their food, so it will be easy for us” Caterer 1.*
- *“If they introduce measures it has to be one that will be easy to use because the time for eating is short, I can’t be wasting time and measuring/ gauging every ones plate” Caterer 8.*
- The response to the questions on portion size brought out a lot of the caterers perception on training needs and their desire to organise their activities at a school level.
- *“I feel all the things we have talked about to do has to do will doing things properly, I this we need help from the government to organise our cooking better” Caterer 13.*
- *“The problem is that we are doing all we can with what we have, if the money was better and we learn how to balance the meals, properly, there will be no problem, because this school feeding is helping our community” Caterer 2.*
- *We need training on a lot of things, especially the ones you mentioned here, dividing the food and preparing it, I personally have difficulty dividing equally” Caterer 11.*
- *I think that because most of us are mother we have no problem cooking, but the problem is knowing how to manage the small money we get to ensure that the meals are rich, so we need help Caterer 7.*
- *“Government has to increase the money then if they add the guidelines we can make the foods nice and rich” Caterer 1*

Towards the end, a couple of caterers reflected on the role of guidelines and standards in service delivery and a number of caterers suggested the need to develop future guidance on food procurement, menu planning and portion sizes. They recommended that in the implementation standards

and guidelines that are based on local/house hold measures based. The perception of the caterers was that this type of menu and portion size guides/ standards will be easier to implement since most household measures are already being use in the commercial food industry and are effective in making sure all individual receive almost equal portions.

#### **4.1.3.5 Interpretations and Implication of discussion**

Findings from this section study revealed that caterers had a fair knowledge of nutrition, which did not span beyond the fundamentals of nutrition groups without any specialty knowledge on child nutrition. However there was a general desire to improve their knowledge and an awareness of the need for training in nutrition topics and concepts that integrate traditional food systems with the science of nutrition.

There was also a general appreciation for the need for standardisation of menu guidelines and portion size control. Suggestions were made that standards should developed using already existing Ghana household measure to ensure ease of implementation. Indications from the discussion also showed a dependency on rice based meals as the main meal in GSFP similar to the results shown by Shaibu, and Al-Hassan (2014). This iterates the need for GSFP to effectively incorporate locally /indigenous available, accessible and affordable foods crops into the menus in school as suggested by Hauwere (2010) and Buhl (2012).

In general, caterers' perception of their inability to always provide nutrient adequate or balanced meals was attributable to the monetary constraint not resource-constraint. The prescription was that the difficulties being experienced in the current GSFP in the district was solely due to inadequate fund and that he money allocated per child needed to increase. Most caterers explained that if the allocated money is increased the meals would get richer. In the discussion sample, there seem to be confusion between meals looking rich and meals being balanced.

The perception was that once meals were rich they were automatically well balanced. This may be attributed to deficit in training and nutritional knowledge among the caterers. A similar trend was reported in Barima (2011), who stated that the lack of impact of the Ghana School Feeding Programmes lack of impact was as a result of contracts being awarded to unqualified cooks who had little or no training in the field.

#### **4.1.4 Field observation**

The data presented here was taken from the field observation done between April 2014 to Jun 2014 from personal observation done by SCm volunteers and as well as conversations with GSFP cooks and caterers.

##### *Characteristics of main cook*

The records presented here are those of the person in charge of the cooking on the day of observation and were not necessarily that of the head of the food service provider. None of the cook visited onsite had had any prior educational background in nutrition or a related field, 37.50% indicated that they had some nutrition education in the last 1-3 years, 31.25% had had some training more than 3 years ago, 25% had had no training and the remaining had some training in less than a year.

Of those who had had training, 56.25% indicated that their training was provided by the district assembly whilst 31.25% mentioned that their trainings were provided by NGOs with the remaining 12.5% explained that their training was by personal arrangement.

##### *Personnel Infrastructure and facilities*

Out of all entire respondent, 87.5% cooked (partially and fully) meals for the day on site with an average of two additional helpers. As per the type of kitchen infrastructure, 68.75% indicated that traditional open air structures usually a canopy structure with an earthen welled tripod stove, 18.75% cooked under traditional shaded kitchens which use charcoal as

the main fuel source whilst the rest cooked in modern kitchen without sinks.

### ***Procurement***

In all, the cooks indicated that they didn't have any formal procurement guidelines for purchasing the agricultural produce required for cooking however 14 out of the 16 cooks indicated that they had their own guidelines which was typically based on the time of the year and what was in season and affordable. Out of the total GSFP cooks, 68.75% purchased food stuffs from the main markets (Asesewa market and Agormanya) from retailers who provide food stuff on credit basis whilst the remaining cooks bought from farmers and producers directly without any agents or middle men.

In terms of frequency of procurement 56.25% purchased raw materials as and when needed, 25% stocked up for a hold academic term, 12.5% stocked up on produce monthly and the remaining 6.28% purchased foodstuffs weekly. For commodities like rice, the district assembly had a "prearranged agreement" to provide cooks with stock each term. There was no way of ascertaining whether this was free or provide on credit as both parties decline to comment about it.

#### 4.1.4.1 Cooking environment hygiene and WASHH initiatives

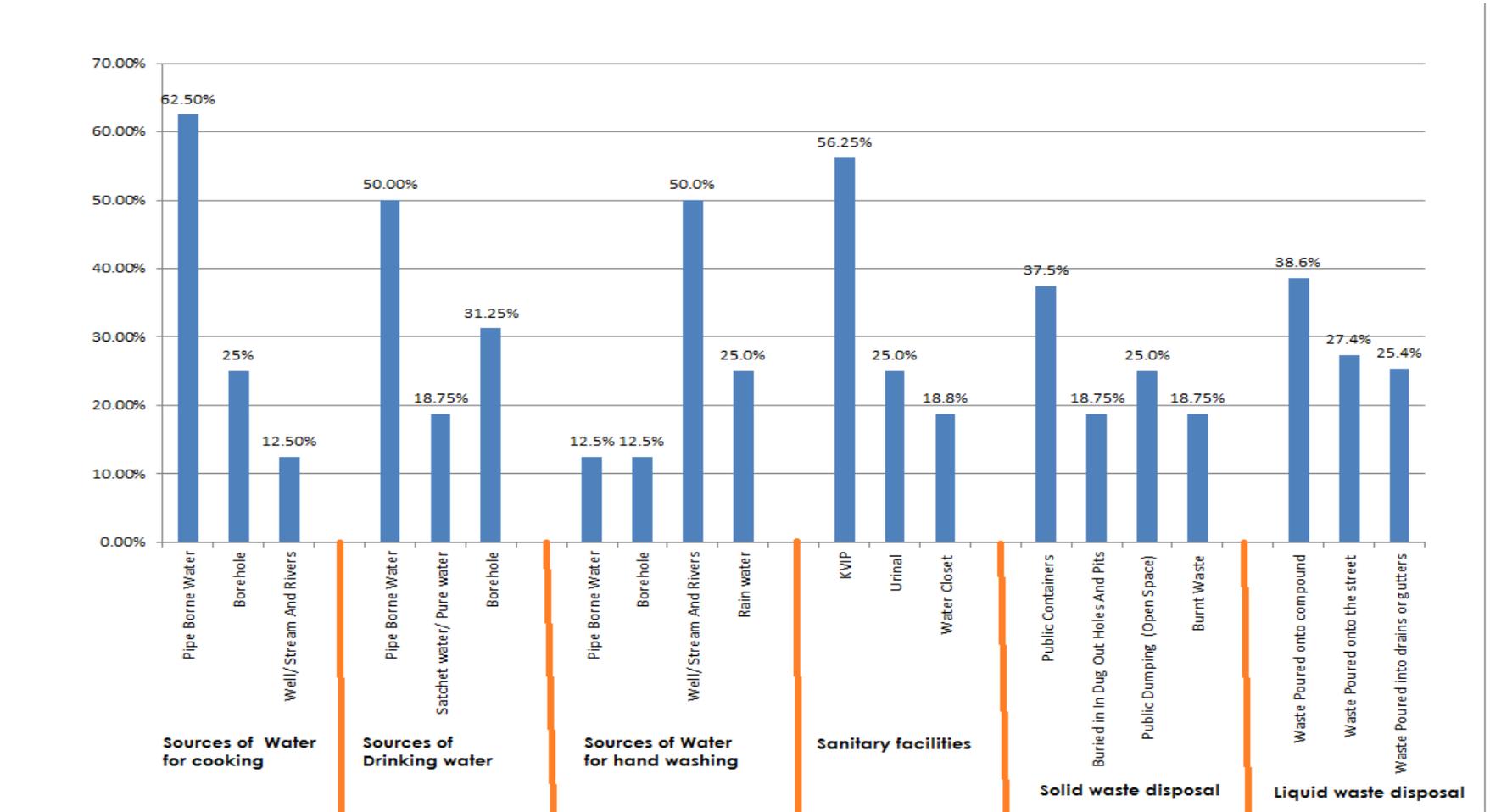
**Table 4.7 Elements Of Good Practice Cooking Environment**

Key indicators	Observation	
	Yes	No
<b>Cater washing hands before cooking</b>	62.5%	37.5%
<b>Are child asked to wash hands before meals</b>	75%	25%
<b>Are they supervised during hand washing</b>	43.72%	56.25%
<b>Sanitary facilities available</b>	87.5%	12.5%

For most of the schools observed (62.5%) the source of water for cooking was pipe borne water, others used borehole (25%) and the remaining caterers (12.5%) used water from stream and rivers. Water from streams were boiled and stored in kegs as shown in Figure 4.7A&B.

Figure 4.6 to 4.7 shows a cross section of the types of sanitary facilities present in GSFP schools in the district. The main types of sanitary facilities were KVIP (55.1%), urinal (38%) and water closet (7%). For most GSFP schools the main way of disposing solid waste was dumping in public containers (37.40%), followed by public dumping (open space) (25.60%) t a few of the schools (23.30%) burnt waste in dug out holes and pits.

In the disposal of waste liquid from the GFSP activities, the commonest option of disposal of liquid waste was to throw onto the compound (38.6%), whilst throw liquid waste onto the street (27.4) and over a quarter (25.4%) threw liquid waste into the large drains or gutters near the schools. All school stocked separate water for cooking and that for washing up. There was no record of used water being stored. Washing up dish were either than immediately after cooking



**Figure 4.4 Bar graph showing results of WASH, environmental and sanitation facilities and process**



**Figure 4.5<sup>a-e</sup>** Selection of pictures showing mealtime procedures from washing of hands (clockwise) to eating time in GSFP schools

### Water Source



**Figure 4.6<sup>a-d</sup>** Array of pictures showing the different sources of water for cooking and drinking in GSFP schools

### Sanitation



**Figure 4.7<sup>a-c</sup>** Selection of pictures showing the different sanitary facilities in GSFP schools in LMKD

#### 4.1.4.2 Meal planning and content

**Table 4.6 Elements Of Good Practice Meal Content Guideline**

Key Indicator	Response	
	Yes	No
<b>Displayed Menu</b>	1	15
<b>Portion size guidelines</b>	0(0)	16
<b>Menus are prepared by nutritionist</b>	0(0)	16

During the observation period, one school had displayed a menu (Figure 4.8). However upon probing further, the cook at that school indicated that she did not follow the menu and it was put up there by a science teacher who wanted to give guidelines. All other schools did not have displayed menu and were observe as not having any form of planning procedure for daily meals. In short, the cooks decide what to cook based on what was available before service.



*Figure 4.8 Menu displayed in a GSFP onsite kitchen storeroom*

In terms of chain of decision making when it comes to meal planning, SCm team observed that 85% of decisions on what to cook was made by the contracted caterer whilst the remainder of the time the decision considering meals and meal plans were left entirely to the cook who actually cooks the meals.

#### 4.1.4.3 Meal preparation and distribution

Focusing on the content of school meals with peculiar interest in protein portions, 87.5 % of schools did not serve or cook meat or eggs at all during the week. Among 1.25% who served meat, the meat portions are actually served to children because the meat not enough but added to meals as flavour enhancers. During the observation period, all schools served fish at least thrice a week with 36% serving fish more than thrice. The fish of choice was predominantly tuna flakes and mackerel flakes.

In meal preparation, all respondent were observed using food additives with salt being a constant for all meals, 82% used stock cubes and flavour powders, 12% used natural herbs and species, 4% used meat stock and 2% used a mixture of stock cubes and natural herbs.

In determining portion size, it was observed that cooks (who usually do the portioning and distribution) do not use any formal guidelines provided by GSFP. The cooks added that they had not been provided any guidelines and hence rely on their own discretion to allocate portions.



Figure 4.9<sup>ad</sup> Selection of pictures of the meal distribution

#### 4.1.4.4. Intake at school



Figure 4.10ab Selection pictures of GSFP meal preparation and consumption

Across the GSFP schools studied (Akro, Zim, Asite, Kodjonya), there were no guidelines for food procurement, composition, processing and preparation. With the absence of displayed menu, menus and meal content were usually determined based on what raw the caterer/cook has available on a day-to-day basis. In these school, the average budget per child range between ₵ 0.45 to 0.6 cedi≈£0.10 similar to figures reported by SNV (2008).

Table 4.8: Food provided by GSFP over 15 field visits

DAY	Field observation		
	WEEK ONE	WEEK TWO	WEEK THREE
<b>MONDAY</b>	Rice and tomato stew with tuna	Jollof rice	Rice and tomato stew with tuna
<b>TUESDAY</b>	Banku with pepper sauce and tuna	Rice and tomato stew with tuna	Gari and soup
<b>WEDNESDAY</b>	Waakye with tomatoes stew	Banku with okro stew	Banku with pepper sauce and tuna
<b>THURSDAY</b>	Jollof rice	Gari and beans with palm oil	Waakye with tomatoes stew
<b>FRIDAY</b>	Rice and tomato stew with tuna	Jollof rice	Rice and tomato stew with tuna

In GSFP schools, GSFP meals were served before 12pm. Meals were predominantly rice-based meals (11 out of 15 observations) as shown in Table 4.8. The rice was usually served in various forms: as rice and stew, which consisted of, boiled rice with a serving of tomato stew (tomato puree, onions, pepper, seasoning and tuna or mackerel flakes) or jollof (rice cooked in tomato sauce) or waakye (rice cooked with beans with dry millet leaves). Other foods offered during the observation period were banku (cassava and maize dumplings) or gari (tapioca) usually served with a portion of tomato stew, soup or sauce. For most meals, the main protein sources were flaked smoked mackerel or tuna and occasionally beans.

A similar observation was made by Martens (2007) and Danquah (2008), the latter reported that rice which was not indigenous to Ghana was the predominantly preferred starchy staple and its price significantly affected the quantities of protein used in the preparation of the sauce. In the Danquah (2008) study, 1.7kg of tinned mackerel was used in preparing a meal for over 500 pupils in one school. Palm oil was the oil of choice in all schools surveyed in the current study. This may have been due to its abundance in the district and its relatively cheap price.

**Table 4.9: Nutrient adequacy of GSFP (% DRV)**

Nutrient	DRV*	WFP **	Mean	%DRV	Pvalue
Energy kcal	1445	433.5	362.34	25.07%	0.0082
Carbohydrate g	130	39	168.70	129.10%	0.026
Protein g	19	5.7	4.63	21.05%	0.096
Fats g	35	11	14.56	41.60%	0.065
Calcium mg	550	165	140	25.45%	0.782
Iron mg	8.7	2.61	3.06	35.17%	0.340
Zinc mg	5	1.5	0.87	17%	0.00

\* Dietary Reference Values (DRVs) comprise a series of estimates of the amount of energy and nutrients needed by children 5-8years

\*\*WFP recommend school lunch average requirement usually 30% of DRV

The average portion size was for rice based meals was  $350\pm 95\text{g}$  (3 flat household ladles with 100mls of stew) whilst non-rice based was  $250\pm 64\text{g}$ . None of the schools studied provided fresh fruits or vegetables during the course of the survey (April 2014-1 July 2014).

Caterers self-reported that meals were balanced however mean nutrient intakes from the weighed GSFP meals were inadequate when compared to required DRV for children aged 5-8 years.

The average GSFP meal provided less than 30% DRI of micronutrients and mineral but over double the DRI for fats and carbohydrates as shown in Table 4.9. Martens (2007) reported that when studying the nutrition content of GSFP meals in 4 districts in the central region of Ghana, the GSFP meals provided adequate energy but inadequate micronutrients considering that; most children depend on school meals as one of the three main daily meals. The study together with other studies (Oduro-ofori and Adwoa-Yeboah, 2014; Aliyar 2012) recommended meals should meet at least  $\frac{1}{3}$  of the nutritional requirements for children.

### ***Plate Wastage***

During the field observation, the team realized that a number of children were not finishing their meals during lunch; hence this adhoc section was added in order to identify the extent of food wastage during the GSFP meals and to how this impacts on the amount of food actually eaten and also identify the reason for the wastage. Plate wastage cannot be ignored in dietary assessment due to significant impact it can have on actual food/nutrition intake.

To do this, two GSFP schools were selected at random through lottery ballot and wastage was monitored for three non-consecutive days. In the selected schools, GSFP meals were served during the 30-minute lunch break, which usually started at 12:00 pm for most school.



Figure 4.11a-c clockwise: Selection of pictures showing waste of food.

- a) Children seating for lunch time meals
- b) Children leaving table to play
- c) Food remaining (food wastage)

The GSFP meal cycles were similar throughout the study period with most offering similar rice based meals on different days. To ensure comparability the percentage of wasted food was calculated using methods used by Bergman et al (2004). Wastage was expressed as weight of food remaining in pre-coded plates after lunch over weight of portion served.

Before each lunch meal, every fifth bowl was marked and the weights of portioned meal were measured in triplicate using the Salter 5kg capacity scale, and an average weight of each portion was calculated and recorded. Children were asked to leave their bowls on the table after lunch, marked bowls were identified and their content measured using the same procedure described earlier.

For the study's target group (KG1 class) there was an average of  $72 \pm 4$  meal portions dished per day per mealtime per school. The average portion size for rice-based meals was  $350 \pm 95$ g (3 flat household ladles with 100mls of stew) whilst non-rice based was  $250 \pm 64$ g.

On the average  $78 \pm 13\%$  ( $273$ g- $318.5$ g) of the served portion was actually consumed by pupils in the GSFP with the rest constituting plate waste. The actually portion consumed falls within the range of portions size published in other GSFP related studies such as the Danquah (2012) study which reported a portion size of  $315 \pm 24$ g, whilst the Owusu et al (2016) reported  $243 \pm 50$ g. The range was how more than the 208g

reported by Parish and Gelli (2015) and significantly less than the 470g reported by Martens (2008).

Considering that mealtimes also served a dual function of being lunch time and break time (recess), several children cited that they would rather finish their meals quickly so they can have some play time. Prioritizing play over eating results in the plate wastage due to unfinished meals like the one portrayed in Figure 4.11a to c. In the USA, the National School Lunch Program, (2003) reported about 12% of calories lost daily and annually estimated direct economic loss of \$600 million in revenue due to plate waste as a direct result of socializing and playing during meal times.

There is also the possibility that food wastage in this current population can be attributed the timing of meals at midday. School children who do not eat breakfast at home find themselves hungry before lunch time and indulge in coping mechanisms such as snacking and drinking a lot of water before lunch, thus they are less hungrier by lunchtime and end up eating less food. Recommendations made by Moosburner, (1985); Ruppenthal & Smith, (1980); Hogue, (1977) suggest that separating of times allocated for playing and eating. In this current study, the observation suggest the need for meals to be served at a time (preferable earlier than midday) that serves the dual purpose preventing short term hungry as well as ensure minimum plate waste.



*Figure 4.12 Primary school children in GSFP School buying from food vendors before lunch*

#### 4.1.4.5 Nutritional Impact of GSFP

Table 4. 10 Nutritional Status Classifications At Baseline Across Gender

	Total	Boys n=37	Girls n=34
Normal Weight	36	20	16
Underweight	21	8	13
Overweight	14	9	5
Stunting	34	21	13
Both Overweight & Stunted	10	6	4
Both Under Weight & Stunted	12	3	9

In all 80 pupils were recruited from four schools for the preliminary study with the aim of obtaining a true picture of the nutrition status of the children start of term time, midterm and end of term. After follow up for three months (one academic term), data from 6 participants were excluded due to missing data (participants were not available during some of the measurement exercise) and data from those who had all three record for all the three measurements were used. One participant however withdrew from the study for personal reasons. The average age of the school children recruited was  $6.8 \pm 0.75$  years. The recruited school children were made up of 47.8% (34) girls and 52.1% (37) being boys.

Anthropometric indices measured at baseline indicated that 49.3% (35) of the recruited GSFP participating school children were either underweight or overweight with the remaining 36 (50.7%) being normal weight. A total of 34 (47.89%) out of the 71 were stunted for their age out of which 12 were both stunted and underweight and 10 were overweight and stunted.

Boys more likely to be overweight than girls (9 vs. 5), similarly stunting was higher in boys compared to girls (21 vs. 13) whereas a lot more girls were underweight than boys (8 vs. 13) as shown in Table 4.11. Figures 4.13 and 4.14 chart the progress in nutritional status of the observation population (controlling for gender and age) from start of term through midterm to end of term.

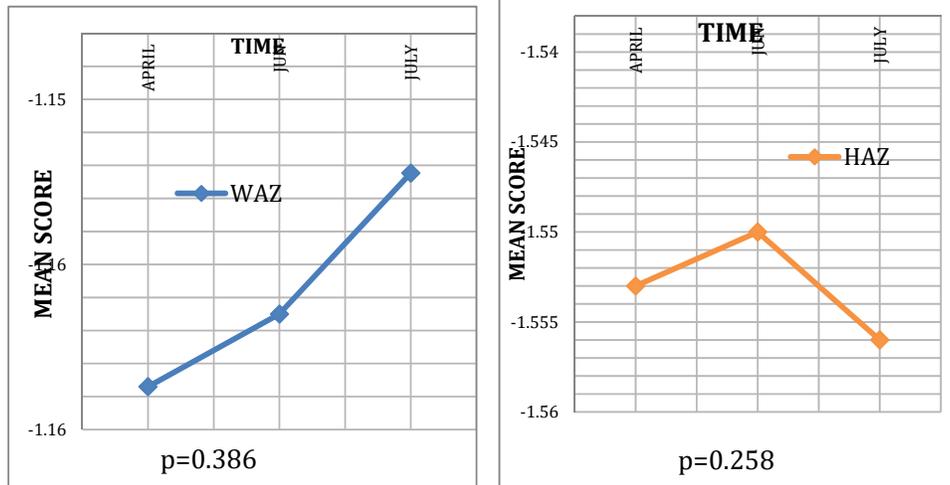


Figure 4.13ab clockwise: Line graph of mean WAZ and HAZ measurement at baseline through to end of term.

There is an indication of slight positive clinical improvement the weight-for-age from start  $-1.162 \pm 0.8964$  (-1.36 to 0.97) with a further plateauing from midterm  $-1.16 \pm 0.9243$  (-1.37 to 0.95) to end of term  $-1.15 \pm 0.7834$  (-1.33 to 0.99). However changes in body weight were not statistically significant value ( $p=0.386$ ). There was improvements were made in BMI-for-age from baseline  $-0.80 \pm 0.782$  (-0.98 to -0.64) to midterm  $-0.79 \pm 1.16$  (-1.03 to -0.53) to end of term  $-0.77 \pm 1.20$  (-1.05 to -0.5) with no statistically significant different at  $p=0.465$ .

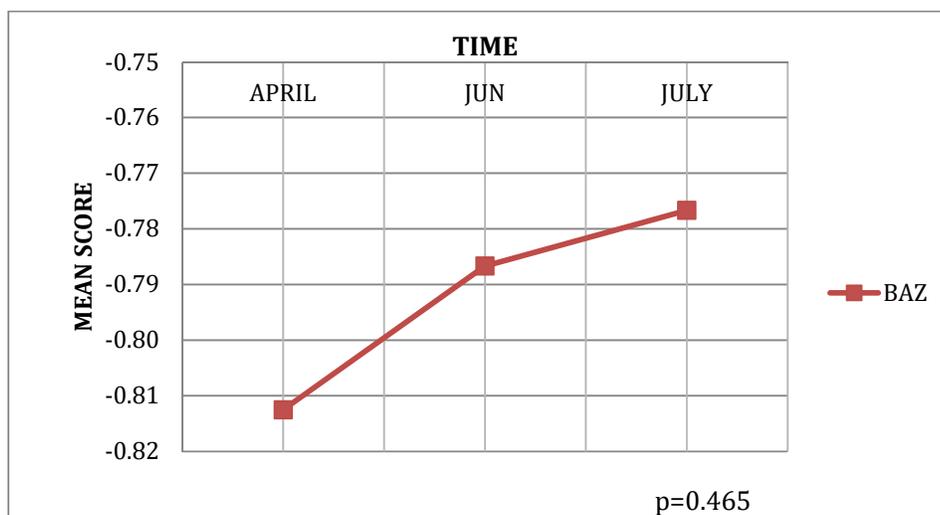


Figure 4.14 Line graph of mean BAZ measurement at baseline through to end of term.

This is likely to be as result in the increase in weight without a corresponding change in height across age. Variations in height for age measurement of the participants seem to portray that stunning was increasing with age at midterm  $1.55 \pm 1.029$  (-1.78 to 1.02) to end term HAZ of  $1.56 \pm 0.529$  (-1.67 to 0.44) at ( $p=0.258$ ). Considering that the mean age at baseline was  $6.8 \pm 0.75$  years, it is likely that the dip in HAZ after midterm (June) may have been as a result of the fact at least half of the population had increased in age without necessarily increasing in height within that same frame of time.

The lack of corresponding change in height with respect to change in age might have resulted in the decrease in HAZ. The results of this section of the field observation tend to suggest the consumption of GSFP meals did not have any significant impact on the anthropometric parameters as reported in previous studies by Danquah et al., (2012), Owusu et al., (2016) and Agbozo et al., (2017). The results of these studies did not find any associations with GSFP intake with nutritional status of participants.

It is however prudent to add that the previous studies in addition to this current field observation provide just a snapshot of impact over a limited period of time hence may not adequately reflect or represent actually impact over an extended period. The observation made in this session helped to establish the state of the GSFP in the LMKD and identify possible confounders that may be limiting or affecting the impact or lack thereof.

## **4.2 S- Cool Meal Product Development**

### **Introduction**

The main aim in this phase was to identify nutrient inadequacies of the current GSFP meals provided in the LMKD, identify affordable and accessible local agriculture produces that can readily provide the limiting nutrients. Selected food items were combined (based on their individual nutritional strengths and their synergistic potential) to form cereal-legume-fish blends by applying the principles of material/energy balance, food-on-food fortification and food diversity and using indigenous low-tech processing methods (Chapter 3) (SCm). The meals were then cooked based on traditional Krobo recipes to ensure maximum nutrient retention (40% DRV of protein) without compromising the sensory appeal of the final products.

#### **4.2.1 Criteria for raw material selection**

The main criteria used in raw material selection was nutrient density, availability in the local area, accessibility, affordability and the versatility of the raw material (ability to be processed into different forms) using low tech indigenous food processing techniques at minimal cost.

Secondary data from LMKD agriculture extension together the household consumption patterns identified from the field observation were used to list available food items. Maize, rice, cassava, plantain, yam, potatoes were identified as the main staples in LMKD.

A combination of market prices from the LMKD market and secondary market price data available from the Ghana Ministry of Food and Agriculture were used to select the lowest costing cross-seasonally varieties of the staples to ensure accessible across season to the poorest populations (where the need is greatest).

Each of the meals staple was paired with one or more protein source, one or more zinc and vitamin A and C rich food source as described in Table 4.10.

TABLE 4.12: Criteria for raw material selection

Agricultural produce	Rational for selection
Carbohydrate staples <ul style="list-style-type: none"> <li>• <b>Maize</b></li> <li>• <b>Potatoes</b></li> </ul>	<ul style="list-style-type: none"> <li>• Availability: these staples are commonly consumed across different</li> <li>• Low-cost of preparation.</li> <li>• Versatility: these food crops can be processed and consumed in various forms</li> </ul>
Legumes and pulses <ul style="list-style-type: none"> <li>• <b>Groundnuts</b></li> <li>• <b>Soybeans</b></li> </ul>	<ul style="list-style-type: none"> <li>• Inexpensive sources of proteins and fibre;</li> <li>• Locally accessible and available across seasons,</li> <li>• Rich source of micronutrients especially vitamin b group</li> </ul>
Leafy Vegetables And Vegetable Oils <ul style="list-style-type: none"> <li>• <b><i>Moringa oleifera</i></b></li> <li>• <b>Palm oil</b></li> </ul>	<ul style="list-style-type: none"> <li>• Traditional leafy vegetables Rich source of carotenoids like beta carotene</li> <li>• Vegetable oils like as rich sources of n-3, n-6 MUFA and PUFA, anti-oxidant minerals.</li> <li>• Palm is an excellent source of energy and serves as an important delivery vehicle for fat soluble vitamins</li> </ul>
Animal protein <ul style="list-style-type: none"> <li>• <b>Fish (anchovies)</b></li> </ul>	<ul style="list-style-type: none"> <li>• Cheap alternative protein source to red meat</li> <li>• Excellent source of minerals especially calcium potassium and phosphorus</li> <li>• Rich source of omega three</li> </ul>



Figure 4.16 A to E (left-to-right) Formulated SC<sub>m</sub> FSM101, FSM579, FSM789, FSM123 & FSM456

#### **4.2.1.2 Cost Calculation and Analysis**

To ensure that the SCm are both affordable and accessible, cost estimation for product was calculated for the formulation groups. In order to ascertain whether additional financial commitments have to be made if the model meals are to be adapted and implemented by the LMKD.

Bodies of work such as the Lancet series 2008 and 2013 on maternal and infant nutrition and Holla (2013), both emphasize that, for any form food based intervention to be effective, meal cost estimations are key requirements for planning, implementation and scaling up. Estimations give an insight into the sustainability of an intervention. New intervention that cost more than existing food cost are likely to fail due to non-compliance and lack of political commitment especially in resource poor environments.

For this cost estimation, the focus was to use an approach similar to the WHO One Health Tool ingredients-based approach of intervention costing (Bhutta et al., 2008:2013) which relies on population specific cost of ingredients to determine financial resources needed for planning, implementing as well as sustaining and nutrition interventions. In doing this, the study utilised cost values of all ingredients that were tailored towards district and town market prices.

This was ensured that prices of commodities were captured adequately to reflect the local context, variations and modalities. Using national commodity prices and estimates fail to adequately represent and account for regional and district nuances and over lapping similarities. Disregard for population specific context may lead to gaps in estimation which may be particularly pronounced for farming communities like LMKD where indigenous crops are readily available and relatively cheaper (Boehler and Lord, 2016).

In light of this, a combination of commodity prices from the Agomanya and Asesewa markets were used to determine the cost values presented in Tables 4.14 and 4.15. Additional data commodities prices list from Farm gate (the official publication of The Ghana Post-Harvest

Committee District Price List) for the period between April 2014 to June 2014. The main aim of farm gate prices to protect the Ghanaian farmer by guaranteeing a secured income by taking in account cost the estimation based cost on production with a 10% adjustment for profit margin.

**Table 4.12. Cost of Potatoes based SCm**

<b>Ingredients per 25kg</b>	<b>Amount Needed In Kg</b>	<b>Cost Per Kg in Cedis</b>	<b>Daily Cost in cedis</b>
Potatoes 45%	11.25	4.5	50.63
Anchovies 25%	5.75	1.8	10.35
Peanuts 30%	7.5	1.28	9.60
Processing	-	-	12.00
Fuel	-	-	10.00
Water	-	-	5.00
Condiment	-	-	15.00
Total for 250 children			112.58
Per Child Portion 150g Wet Weight			0.45

The optimal price for each commodity was derived from an average of the local market cost and cost from the Ghana Post-Harvest Committee District Price List (GOG, 2014). For values that were too wide apart, a median was quoted. This was done to prevent underestimation and to ensure that values are comparable to that of the GSFP food commodities, which are predominantly sourced, from market retailers and not directly from farmers. Additionally cost of processing and preparation was obtained from GSFP caterers during field observation phase of the state. Adjustments were made to take care of recipe variations.

The results in Tables 4.12 and 4.12b show the average daily expenditure per child for any SCm meal. Cost of SCM varied based on the cost of the main carbohydrate staple and protein used with potatoes based meals costing more than the maize based meals. This observation falls within the known literature, which states that maize based meals

seem to be cheaper than other cash crops staples sources such as rice, yam and plantain and potatoes.

**Table 4.12b: Cost of Maize based SCm**

Ingredients for 25kg	Amount Needed In Kg	Cost Per Kg In Cedis	Daily Cost in cedis
Maize 45%	11.25	0.8	9
<i>Moringa oleifera</i> 15%	3.75	5	18.75
Palm Nut Oil 10%	2.5	3.2	8
Soya Beans 30%	7.5	2.2	16.5
Processing			12
Fuel			12
Water			10
Condiments			15
Total for 250 children			101.25
Per Child Portion 150g Wet Weight			0.405

The yearly feeding cost per child was extrapolated from the daily estimate over an average of 200 feeding days per academic year/calendar. Although the estimate here provide a guideline as to the average cost of SCm, it is important to know that the cost can considerable be decreased if food commodities are purchased directly from the farmers.

This results provides comparable financial framework for the implementation of the SCm meals and further emphasizes the need to move towards intervention that prioritizes local farm produce as the many source of school meals. The current GSFP is currently resource constraint and rice (which is the mail meal provided) prices in Ghana are based on dollar rates, the estimate provided here make a case for the need to find alternate sources of food stuff that are not only affordable and accessible but provide the necessary nutrition

#### 4.2.2 Formulations of SC<sub>m</sub>

The objective in formulating SC<sub>m</sub> meals was to provide the target population with consumable quantities of food that it is capable of supplying all required nutrients in adequate quantities cost effectively. Formulations were done using the nutrient balance technique and adjustments made to match the dietary pattern of the LMK which mainly meal are divided into a starchy staple accompanied with protein gruel.

In choosing the various food combinations, the priority was given to combinations/formulation that could contribute the key GSFP meals had difficulty meeting requirements for, namely protein, vitamin A, calcium, and iron at the least cost. This was done by identifying the constraints of the GSFP meals, specifying the nutrient requirements of the pupils in the target population and finally finding the combinations of foods available in the local area to overcome the identified nutritional constraints at the minimal cost.

In this current study, each for 100g ration of SC<sub>m</sub> meal (Figure 4.16 A to E) was designed to combine the strength of each ingredient to meet the nutrient specifications (gender adjusted) for school pupils aged 5-8 years. The amount of each ingredient in the ration was determined based on its nutrient strengths and its synergy with other ingredient.

In all five formulations were obtained; FSM101, FSM123, FSM456, FSM579, FSM789. Three of the SC<sub>m</sub> were soup-based and other two were stew-based meals as shown in Figure 4.16 A to E. The SC<sub>m</sub> composite flours had average moisture content of 5.04%, which indicates the possibility of long storage life.

Moisture content of the meals ranged from high of 5.9g to low of 4.3g with FSM789 having the highest moisture content owing to the fact that contained fermented maize flour. The tradition fermentation process involves soaking of maize softens the seeds, encourages microbial breakdown of complex starches (Agbor-Egbe and Mbome, 2006).

### **Mixing ratios**

The endpoint for mixing ratio was to obtain composite meals made from 40-50% carbohydrate base and an average total energy of 490 (1/3 of energy DVI for 5-8 years) and at least 40% DVI for protein. The formulations were thoroughly mixed in a 'Y' cone mixer to give evenly distributed flour. Each composite meal was assigned an alphanumeric code name (for patent purpose) as shown in Table 3.5.

**Table 4.12c Composition Of Formulated Sc<sub>m</sub>**

Formulation	Maize	Potatoes	Moringa	Soya Beans	Anchovies	Groundnut	Palm Oil
FSM123	-	+	+	+	-	-	+
FSM789	-	+	-	+	+	-	-
FSM101	+	-	-	+	+	-	+
FSM456	+	-	+	+	+	-	+
FSM579		+	+		+	+	-

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*\*Means food item is found in the meal and - means vice versa*

### 4.2.3 Proximate analysis

Table 4.12 charts the result of the proximate analysis and micronutrient analysis for the 5 developed SC<sub>m</sub> meals. The protein profile ranged between 16.32g (FSM123) and 27.52g (FSM101) per 100g. Fats content was between 19.4g (FSM579) and 4.1 (FSM789) whilst carbohydrates range from 54.3g (FSM101) to 68.07g (FSM123) as shown in Table 4.12. Formulation FSM101 had the highest protein content of 27.52g and FSM123 contained the least with protein (16.32g per 100gs).

The high protein content of FSM101 is likely to be due to fact that, it contains *Moringa oleifera*, soybean and anchovies. All these food items have been used in similar studies have been used in different capacities in environments where higher biological proteins are costly or limited (Plahar *et al.*, 1997; Oduro *et al.*, 2008; Glover-Amengor and Vowotor, 2010). In the study by Plahar *et al.*, (1997) the addition of 10g of soybeans to traditional meals the improved the protein content and influenced the amino acids balance. Similarly, Price (2007) reported the addition of *Moringa Oleifera* leaves increases protein pro-vitamin A and calcium content of meals.

On the average, each SC<sub>m</sub> provides 28.3% DRV of fat, the 78.9% that protein DRI, 44.9% DRI of carbohydrates (including fibre), over a third of DRI for iron per 100g of dry weight of composite flour. For every 100g of composite SC<sub>m</sub> has the capacity to provide up to one third of the EAR for energy. FSM579 had highest fat level of 19.4g per 100g whilst FSM789 had the least with a fat content of 4.1g per 100g.

Incorporating groundnut and palm oil greatly enhanced fat profile of the SC<sub>m</sub> meals. The average fat content of the SC<sub>m</sub> (28.29% DRI) is in line with the current recommendation of 30% of energy from dietary fat for children aged >2years for adequate growth.

**Table 4.12. Nutrient content of S-Cool meals compared with the percentage of the RNI for school children aged 5-8 years**

ode	Moisture	Ash/g	Fat/g	Protein/g	Carbohydrate/g	Energy/Kcal	Calcium/mg	Iron/g	Zinc/g
<b>FSM123</b>	4.7	3.61	7.3	16.32	68.07	403.3	284.69	7.17	1.59
<b>FSM789</b>	5.9	6.02	4.1	23.21	60.77	372.8	960	5.12	0.58
<b>FSM101</b>	5.2	4.28	8.7	27.52	54.3	405.6	523.33	7.17	0.97
<b>FSM456</b>	4.3	4.27	10	21.84	59.59	415.7	502.81	11.17	0.6
<b>FSM579</b>	5.1	3.62	19.4	22.7	49.18	462.1	305.99	6.47	0.97
<b>MEAN</b>	5.04	4.36	9.9	22.32	58.38	417.9	515.36	7.42	1.12
<b>RNI<sup>a</sup></b>	-	-	35	19	130	1445	550	8.7	5

*a\* RNI: Recommended nutritional intakes is the amount of each nutrient need to meet 95% of the population's nutrient requirement*

**Table 4.13: Mean scores in acceptability testing using a trained panel n=13**

Meal	Colour	Taste	Consistency	Mouth f.	Aroma	Aftertaste	O.A*
<b>FSM101</b>	8.00±0.71 <sup>a</sup>	7.69±1.10 <sup>a</sup>	7.38±1.12 <sup>a</sup>	7.31±1.49 <sup>a</sup>	8.15±0.69 <sup>a</sup>	7.69±1.10 <sup>a</sup>	7.70±0.73 <sup>a</sup>
<b>FSM123</b>	7.92±0.95 <sup>a</sup>	7.38±0.65 <sup>a</sup>	7.85±0.69 <sup>a</sup>	7.62±0.77 <sup>a</sup>	7.38±0.87 <sup>a</sup>	7.31±0.63 <sup>a</sup>	7.58±0.56 <sup>a</sup>
<b>FSM456</b>	6.77±1.74 <sup>b</sup>	7.23±1.17 <sup>a</sup>	6.85±1.46 <sup>b</sup>	7.31±1.32 <sup>a</sup>	6.85±1.72 <sup>a</sup>	7.23±1.69 <sup>a</sup>	7.06±1.33 <sup>a</sup>
<b>FSM579</b>	7.5±0.90 <sup>a</sup>	7.85±0.90 <sup>a</sup>	7.46±1.05 <sup>a</sup>	7.85±0.99 <sup>a</sup>	7.77±1.09 <sup>a</sup>	7.69±0.86 <sup>a</sup>	7.74±0.81 <sup>a</sup>
<b>FSM789</b>	6.54±0.78 <sup>b</sup>	5.15±1.82 <sup>b</sup>	6.08±1.50 <sup>b</sup>	5.54±1.45 <sup>b</sup>	4.85±1.95 <sup>b</sup>	4.92±1.80 <sup>b</sup>	5.51±1.26 <sup>b</sup>
<b>p value</b>	0.001	0.000	0.004	0.000	0.000	0.000	0.000

\*O.A : overall acceptance of the a meal sample .

*Means in row with different superscript (a, b) represent significant difference (p < 0.05). Means in same column followed by the same letter are not significantly different at (p < 0.05) (*

Lower fat intakes in children may be associated with inadequate vitamin and mineral uptakes and increased risk of poor growth however higher fat intake may lead to higher body fat (GDHS, 2008). Therefore there is need for the SC<sub>m</sub> meals to provide just enough to sustain growth without inducing excess body fat storage.

Minerals like calcium, iron and zinc play a vital role in energy metabolism (Sandstead, 1994; Institute of Medicine, 2001), gene regulation, cell growth and differentiation (Heyneman, 1996; Institute of Medicine, 2001), oxygen binding and transport, neurotransmitter synthesis, and protein synthesis (Prasad, 1995; Heyneman 1996; Solomons, 1998). All these processes play an essential role in physical and cognitive development characterise the rapid growth spurt experienced by school children in the 5-8 year bracket. Calcium content of SC<sub>m</sub> meals ranged from 284 mg to 960 mg while iron and zinc contents range between 11.17g to 5.12g and 0.97g to 1.59g, respectively.

Although FSM123 contented the least calcium among the formulated meals, it is able to provide at least two thirds of the DRV for children aged 5-8 years. For target age group, the average SC<sub>m</sub> provides over 50% of DRI (8.7mg) for the iron and up to 20% DRV for zinc.

Based on the aforementioned results, it is expected that the SC<sub>m</sub> meals are likely to exert positive nutritional impact on the study population and help to enhance the nutritional sensitivity of the GSF programme. As evidenced in the similar studies (Stuijvenberg, 1999; GAIN, 2007; PATH, 2009) that reported that better growth ratios were realised when similar food-on-food fortification techniques were used to develop model meals for school feeding programmes.

### 4.2.3 Sensory Evaluation

The sensory acceptability of food is based on an array of complex interactions between food and sensory receptor systems located all over the human body. The attributes of interest in this study were colour, taste, aroma, consistency, mouth feel, and aftertaste.

#### 4.2.3.1 Acceptability testing

School feeding interventions like many other nutrition interventions in low-income economies are usually designed for specific nutritional interests and more often than not do not adequately consider palatability. Acceptability tests for food products usually indicate actual desirability and helps to gauge sustainability of intervention foods.

##### 4.2.3.1.1 Untrained panel sensory evaluation

###### *Characteristics of panel*

The 15-member trained panel was made up 8 women and 7 men with an average of 33.5 SD± 13.44 with varying socioeconomic backgrounds. On the day of evaluation two panellists were disqualified because they were unwell with flu. Additional panellists were not recruited to re place them.

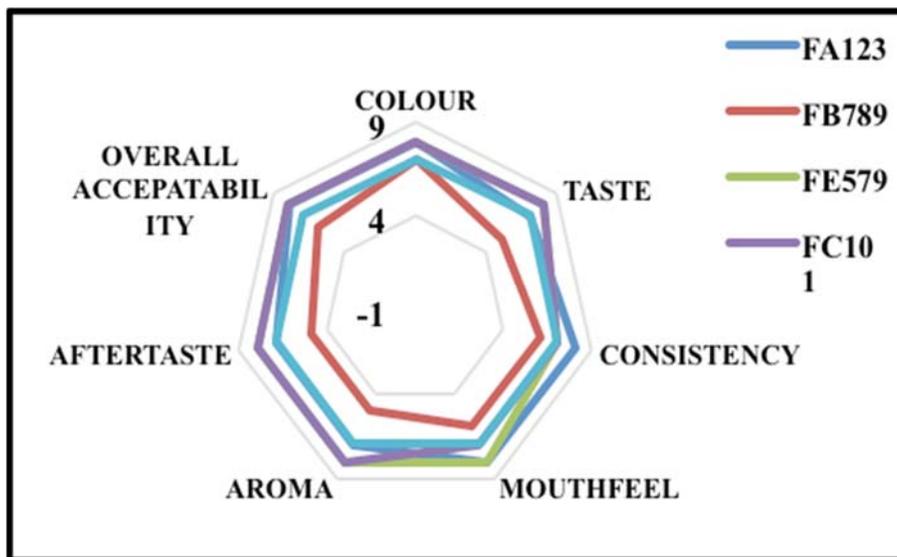


Figure 4.17: Results of trained panel acceptability test.

Figure 4.17, summaries the attributes scores from the trained panel acceptability test, with scores away from centre being higher on the hedonic scale. Each SC<sub>m</sub> obtained a mean score above mid-point (5) on the hedonic scale across all attributes evaluated. Score for colour ranged between 8.0±0.68 and 6.54±0.75, those for taste ranged from 7.85±0.90 to 5.15±1.75.

Consistency mean scores were within the range 7.85 ±0.69 to 6.08±1.44 and mean mouth feel scores ranged from 5.54±1.45 to 7.85±0.99 whilst scores for aroma and aftertaste were 4.85±1.95 to 8.15±0.69 and 4.92±1.80 to 7.69±1.10, respectively.

### Colour

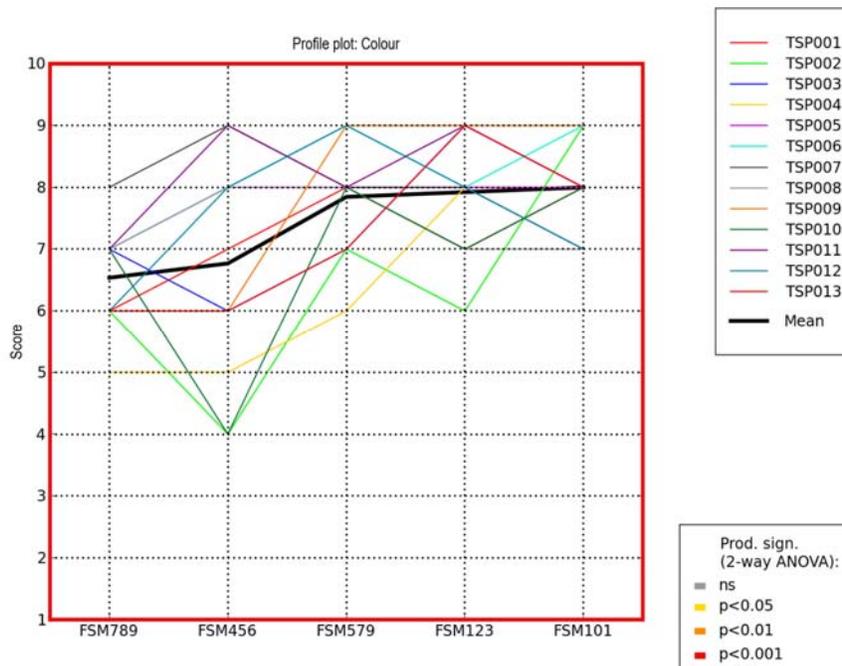


Figure 4.18: Colour profile displaying individual ratings in trained panel acceptability test.

Colour perception is the main visual parameter that forms the basis of initial sensory perception of food. Each aspect colour (hue, depth, shade, bright and Chroma) contributes to an initial prediction of food quality and informs the assessor about level of desirability even before food is actually masticated (Joshi and Patel, 1997; Hoda et al.,2002).

From the colour attribute profile (Figure 4.18), FC101 obtained the highest mean score of  $8.00 \pm 0.68$ , followed by FSM123, FSM579 and FSM456 with mean scores  $7.92 \pm 0.95$ ,  $7.85 \pm 0.90$  and  $6.77 \pm 1.74$  respectively.

While FSM789, a soup-based meal scored the least with mean of  $6.54 \pm 0.75$ . The high mean scores obtained FSM101 can be attributed to the array of orange–red colour pigment (pro-Vitamin A) from the palm oil and the deep-green (*Lutein and zeaxanthin*) pigments of the *Moringa oleifera* leaves. The combination of the pigments in a FSM101 is likely to have contributed to a medley of colours (Figure 4.16a) that were aesthetically appealing to the panellists. Deductions from these results are supported by the results of previous efforts by Spencer (2015), which suggests that the blend of complementary colours is a key determinant of acceptability ratings for mixed meals.

#### *Aroma and taste*

Aroma and taste were assessed to evaluate the influence of the SC<sub>m</sub> on the olfactory and trigeminal sensors and to study how these senses in turn influence panellists' acceptance.

For the soup-based meals, FSM579 obtained a mean score of  $7.85 \pm 0.90$  and  $7.85 \pm 0.99$  for taste and aroma respectively; FSM123 also scored  $7.38 \pm 0.65$  and  $7.38 \pm 0.87$  for taste and FSM789 had a mean score of  $5.15 \pm 1.75$  for taste and  $4.85 \pm 1.87$  for aroma respectively.

For the stew-based meals, FC101 obtained a mean score of  $8.15 \pm 0.66$  for aroma and a score of  $7.69 \pm 1.07$  for taste while aroma whilst FB789 had a score of  $6.85 \pm 1.72$  and  $7.23 \pm 1.17$  for aroma and taste respectively. The relatively low mean scores obtained by FSM789 as shown in Fig 3.4a can be attributed to several reasons.

The huge disparity in the individual rating might be as result of leniency (carry-over) error from panellist rating. In that, from the graph, some panellists scored the sample about 7 and other scored it as low as 2, which might suggests that intrinsically FSM789 may not be undesirable on

its own but appear to be rated low because of carried on taste perception from other samples

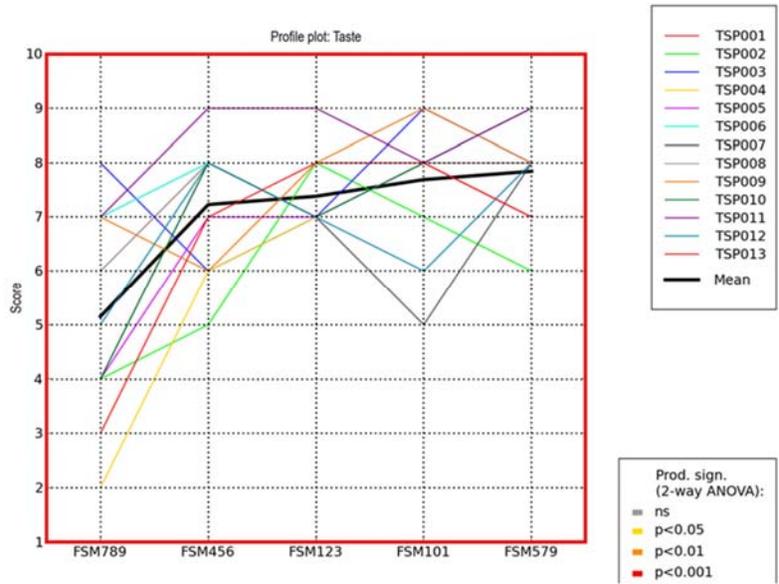


Figure 4:18a: Taste profile displaying individual ratings in trained panel acceptability test.

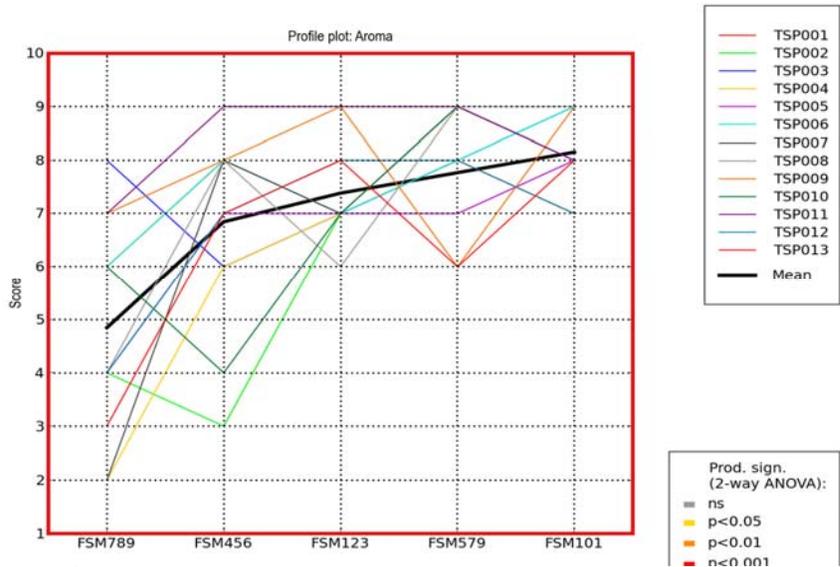


Figure 4:18 b: Aroma profile displaying individual ratings in trained panel acceptability test.

Another reason worth noting is that, considering the nutrient content of FSM789, the low taste score can readily be attributed to high levels of calcium in that formulation. Previous studies (Tordoff and Sandell, 2009; Ross, 2011) have suggested that meals that have high calcium content especially those with elevated concentration insoluble forms calcium

(calcium carbonates and phosphates) usually exert a chalky/gritty mouth feel and may promote bland or bitter notes. For such meals, consumers are likely to report taste characteristics as astringent, lemony, soapy or bitter (Tordoff and Sandell, 2009). These observations were confirmed with a strong negative correlation between calcium content and overall acceptability ( $r = -0.92$ ).

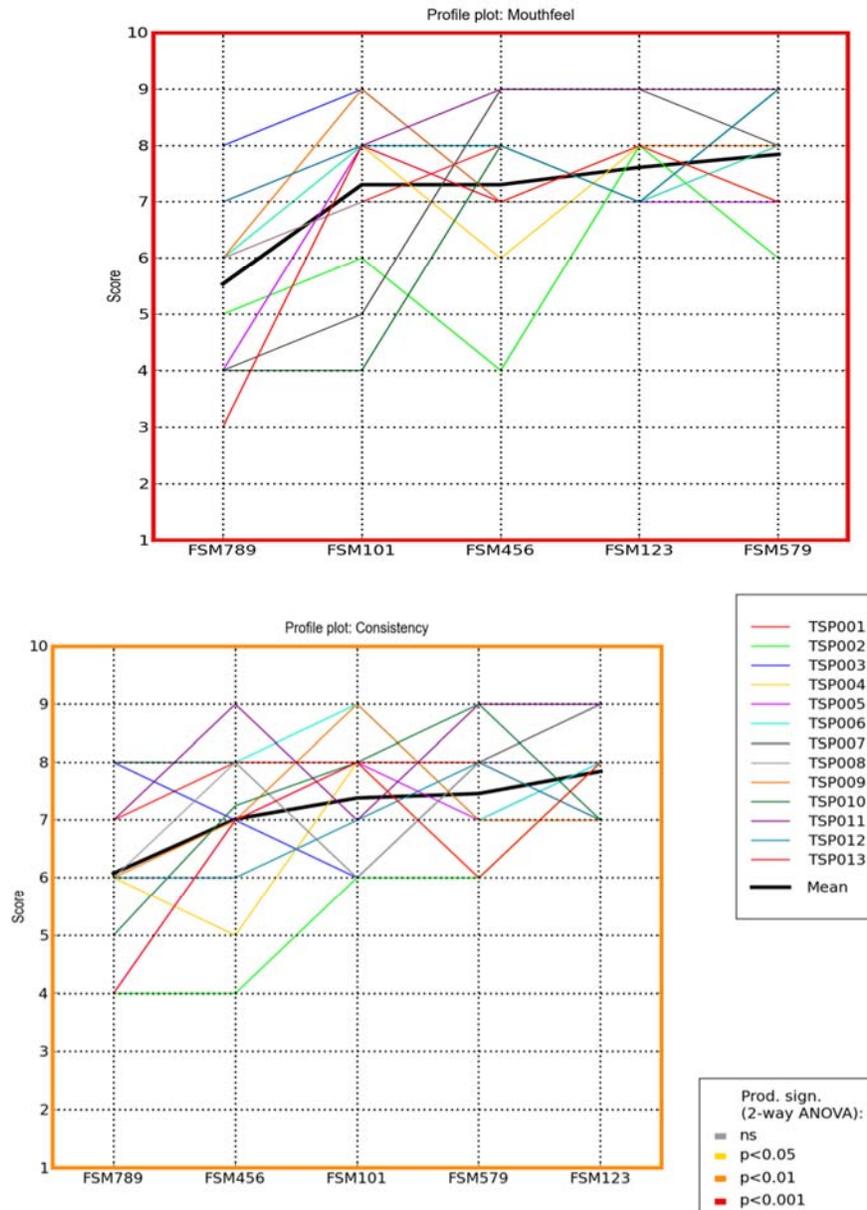
Similarly, in examining the high taste and aroma rating obtained by FSM579, the following could be conclusions drawn. First, the high taste score could be attributed to its relatively high fat content. Previous taste studies (Mela, 1988; Schiffman et al., 1998; Folkenberg and Martens, 2003) have all suggested that there is a direct association like between fat content and perception of palatability. It has been suggested that the classic perception of palatability arises from the dynamic interaction between fat content, food texture. In that, fats content impacts on some vital textural (viscosity, elasticity, and orientation) properties of food texture that enhance the feel-good factor (salivation) associated with the pleasurable eating experience.

Correlation test with taste scores showed a positive correlation of  $r = 0.68$ . Secondly, FSM579 contains roasted groundnut, which has been reported to have pleasant aroma (Hira and Chopra, 1995; Dapi, 2007). The traditional pan roasting process induces the release and breakdown of volatile aromatic compounds like methanethiol, 2,3-pentanedione, 3-(methylthio) propanol and 2-and 3 methylbutanal. Once emitted, these odorants linger on in the meals to give a much more pleasant olfactory experience (Zellner et al., 2008).

#### *Consistency and mouth-feel*

In assessing the rheology, consistency and mouth feel were the main attributes in assessing the textural attribute. Consistency of the meals was assessed prior to mastication using the spooning procedure as described by Desai (2012). FSM123 a soup-based meal scored the highest mean of  $7.85 \pm 0.65$ . FSM579, which is another soup-based meal, scored a mean of

7.46±1.05. FSM101 and FSM456 both stew based meals scored 7.38 ±1.08 and 7.0±1.41 respectively while FSM789 scored the least mean with a mean 6.08±1.44 as shown in (Figure 4.19<sup>B</sup>).



Figure

4.19<sup>ab</sup>: Mouth-feel and consistency profile displaying individual ratings in trained panel acceptability test.

The higher rating obtained by the soup-based meals is likely due to the fact that the soup recipes were water based and spooning was much easier during assessment.

A similar trend was observed for the mean scores for mouth feel (Figure 4.19 a) expect for FSM789, which scored the least ( $5.54 \pm 1.39$ ). In assessing mouth feel, panellists were asked to rate their acceptance of the texture of the meals during mastication. FSM101 and FSM456 (both stew-based meals) obtained mean score of  $7.31 \pm 1.43$  and  $7.31 \pm 1.32$  whilst soup based meals (FSM123 and FSM579,) received higher mean scores for mouth-feel of  $7.62 \pm 0.77$  for FSM123 and  $7.85 \pm 0.99$  for FSM579. These findings here are in tandem with the previous discussed impact of fat content in textural perception and acceptance.

Collectively the soup-based meals obtained higher mean scores for rheological attributes. The structural combination of the moist soupy gruel and the texture of the sweet potato chunks (Figure 4.16<sup>abc</sup>) are likely to have contributed to pleasurable rheological effect during mastication. Similar observations made in studies by Singh, (2008), Neyraud et al., (2005) and Neyraud et al., (2003). In these studies, overall acceptability was greatly dependent on mouth-feel and the presence of complimentary mixed textures showed positive correlation with greater flavour release.

Combining different textures in the mportormportor recipe (Appendix 4) did not only intensify the pleasurable experience during mastication but also enhanced the structural complexity of the meal. In that, food components especially fat usually takes varying forms (temperature dependent) at different sections of the oral cavity, these variations in texture/structure can greatly influence mouth-feel and heighten eating pleasure (Engelen and Van der Bilt, 2008).

In mixed recipes like the mportormportor and apranpransa recipes, rheological pleasure is partial as a result of a variety of intrinsically different flavours and textures hitting the mouth at different sections to produce an almost synchronised effect, which greatly enhances mouth feel.

## After taste

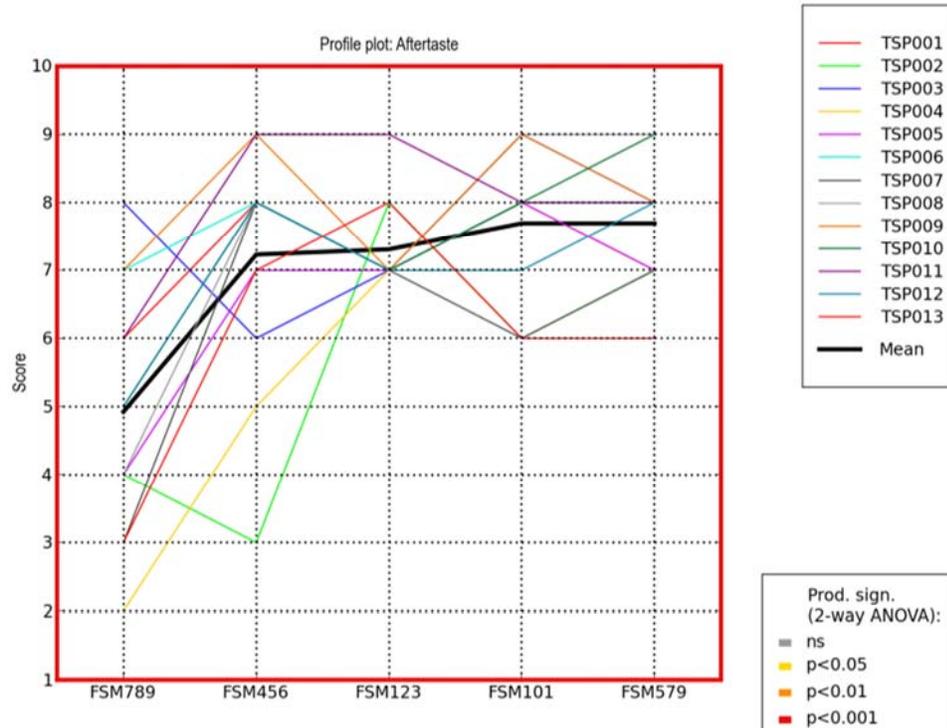


Figure 4.20: Aftertaste attributes profile displaying individual ratings in trained panel acceptability test.

In profiling aftertaste, this study sort to ascertain the desirability of the meals in terms of acceptance of the meals post mastication and swallowing. Aftertaste is primarily modulated by intero-ceptive awareness centre of the brain (via the insula) and is essential for the formation of distinct and highly resolved feelings about future appetite for the food being tasted (Craigs 2013).

Implying that, aftertaste influences the food memory of individuals and aftertaste scores can serve as predictive tools as to whether or not an individual accepts an intervention meal and the likelihood of consumption post intervention phase. The mean scores aftertaste for the SC<sub>m</sub> meals ranged from a high of 7.69±1.07 for FSM101 and 7.69±0.85 for FSM579 to a low 4.92±1.80 for FSM789. As more indigenous societies are faced with an increasing range of intervention programmes supplying a varying array of products, the role of sensory memory becomes more important in determining acceptance and sustainability.

For this distinctive purpose, aftertaste might play an essential role in promoting adhesion to intervention meals and is likely to play a vital role ensuring sustainability. Considering aforementioned and the attribute profile shown in Fig 3.5, it can be inferred that FSM789 although high in calcium and protein which are vital for children, FSM789 will not be a suitable intervention meal for the current population under study.

#### *Overall Acceptability*

The findings indicate that all the SC<sub>m</sub> evaluated obtained mean over acceptability (OA) scores of midpoint and above as shown in Figure 3.21. This may be due to the fact that the meals were developed using traditional recipes indigenous to the study area hence panellists were familiar with basic concept. Overall, there was significant difference in overall acceptability of meals at  $p= 0.000$ .

On the hedonic scale, FSM789 had a mean score of  $5.51 \pm 1.26 \approx 6$  on the hedonic scale implying that overall it was like slightly. FSM456 was accepted moderately with mean score of  $7.06 \pm 1.34 \approx 7$  (on the hedonic scale). FSM123 had a mean score of  $7.58 \pm 0.56$ , FSM101 had a mean score of  $7.70 \pm 0.73$  and FSM579 had mean of  $7.74 \pm 0.81$ , all approximating to 8 on the hedonic scale, which implies these samples were liked very much.

Inferring from results, meal FSM579 was the most accepted whilst FSM789 was the least accepted. This was confirmed with the post-hoc (Kruskal-Wallis) ranking at  $p \leq 0.05$ ; where formulation FSM579 had a rank score of 42.58 as against 12.23 for FSM789.

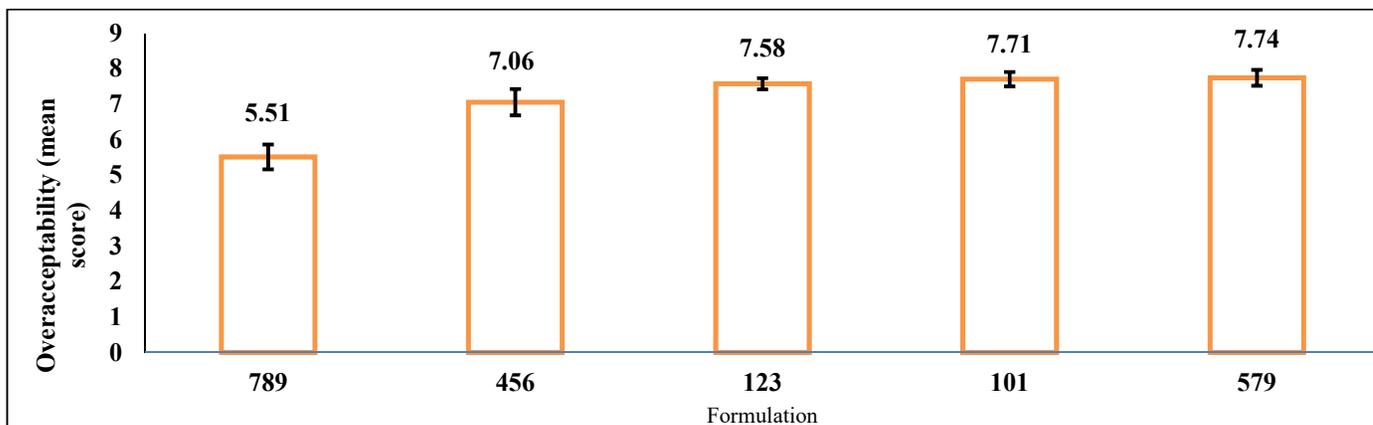


Figure 4.21 : Mean overall acceptability scores of trained panel

Table 4.13 Pearson correlations coefficients across attributes in trained panel acceptability test

Attribute	Colour	Taste	Consistency	Mouth feel	Aroma	Aftertaste	Overall
Colour		.566**	.637**	.481**	.624**	.505**	0.715**
Taste	.566**		.660**	.789**	.819**	.892**	0.931**
Consistency	.637**	.660**		.662**	.621**	.631**	0.802**
Mouth-feel	.481**	.789**	.662**		.673**	.756**	0.854**
Aroma	.624**	.819**	.621**	.673**		.856**	0.903**
Aftertaste	.505**	.892**	.631**	.756**	.856**		0.921**
Overall	.715**	.931**	.802**	.854**	.903**	.921**	

\*\*Pearson's Correlation with significance testing at the  $p \leq 0.01$  level (2-tailed)

#### 4.2.3.1.2 Relevant Trends and correlations

The factors that influence overall panellist acceptance were explored using a two-tailed Pearson's correlation as shown in Table 4.13 Positive correlations (significant at  $p \leq 0.01$ ) were found with comparisons colour, taste, consistency, mouth feel, aroma, and aftertaste.

Taste however had the highest correlation coefficient ( $r = +0.93$ ) with over acceptability, which suggests that for this study, taste was the main sensory attribute that influenced a panellist acceptance of the SC<sub>m</sub> meals the most. Mouth feel and aftertaste also correlation in the area of  $r = +0.9$  which also indicates very strong correlation with overall acceptance of the meals.

Colour had the least correlation with O.A ( $r = 0.72$ ) indicating relatively weaker correlation with overall acceptability, which is contrast with results of similar studies (DuBose et al., 1980; Clydesdale, 1993; Spence et al., 2010). In these reports, overall acceptance was affected by colour intensity. For most of the foods studied in Clydesdale (1993) and Spence et al., (2010), higher colour intensity gave rise to higher overall evaluation responses by panellists.

The current results were however in tandem with studies by Zellner (2013), Nayane, 2012 Bayarri et al., (2001) as well as Lavin and Lawless, (1998). The results of Zellner (2013) and Nayane (2012) studies indicated that for certain mixed meals; there was a reduction in overall flavour acceptability with every increased colour blend. In this current study however, it evident that although colour might have informed initial perception of taste based on appearance but the appearance-based taste perception didn't always accurately match the actual taste.

Although colour has been reported as the principal product-intrinsic attribute that informs acceptability of meals, in mixed meals, the disparity between the colour and taste exerts a risk error (Expectation error) in evaluating overall acceptance rating. This type of error is likely to have occurred in ratings for meals (FSM579 & FSM789) with colour-taste disparities in this study.

A clear depiction is seen in the rating of FSM579. FSM579 was the most accepted meal overall however it received one of the least mean scores for colour out of the five SC<sub>m</sub> meals. The distortion between the appearance-based taste perception before mastication and the actual taste of meal during and after mastication is likely to be the contributing factor to the difference in scores. As a result large number of the trained panel based their acceptability ratings heavily on taste. These observations are further confirmed with panellist comments such as the following:

• **FSM 789**

*“The colour resembles our local mportormportor but it tastes funny”.*

*“The colour is very nice but it has a sandy/gritty taste”.*

*“I don’t like the aftertaste at all, it looked nice but it doesn’t taste nice”.*

• **FSM 579**

*“Looking at the colour, I thought it will not taste nice but I found the taste surprisingly interesting”.*

*“To me, it tasted like far better than it looks”*

*“I have never seen mportormportor with a groundnut, but I like how the taste so much”*

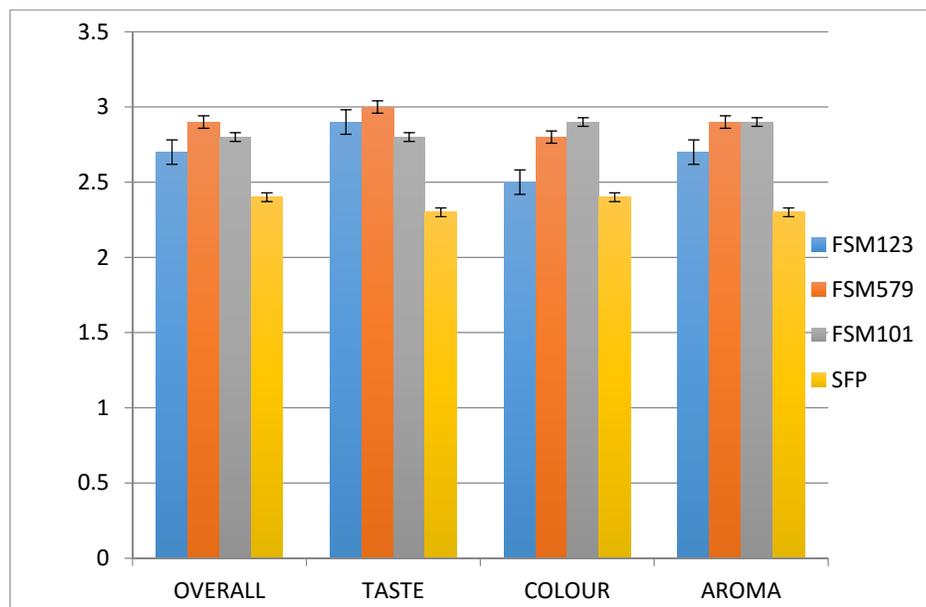
These comments indicate that although colour did not influence the acceptance of the SC<sub>m</sub>, it invoked feelings of disappointment and/or surprise about overall acceptability in relation to colour-taste agreement. Other significant trends observed were a positive correlation between aroma and taste ( $r=0.82$ ). This result is in line with several other studies (Delwiche, 2004; Adam Drewnowski and Roig 2010) that stipulate that the sensations of taste and smell interact in such a way that for most foods a high aroma score is likely to be directly proportional to a high taste score which depicts the dependency on the ortho-nasal olfaction mechanism for taste perception.

#### 4.2.3.2: Acceptability test with untrained panel.

##### *Panel Characteristics*

For the untrained panel, 27 girls and 23 boys from primary KG<sup>1</sup> and KG<sup>2</sup> pupils were recruited from two GSFP schools in LMKD. Three out of the recruited pupils, failed to obtain parental consent from their parents and an additional pupil declined to take part in the evaluation, hence four panellists were disqualified from that evaluation process.

To obtain a true picture of the acceptability among the intervention target group (school aged children), it was necessary to study acceptability of the SC<sub>m</sub> on the field. The use of untrained panel helped to study whether training caused perceptible variations in sensory evaluation and also to see if there are any perception differences in acceptability scores between adults and children.



*Figure 4.22: Mean overall acceptability scores of untrained panel*

FSM123 had an overall rating of 2.7, mean taste score of 2.9 and mean colour score of 2.5.meal. FSM579 obtained overall mean of 2.9, 3.0 for taste and 2.8 for colour. FSM101 also had overall acceptability score of 2.8, mean taste score of 2.8 and mean colour score of 2.9. The SFP

meals obtained the least overall score of 2.4, taste score of 2.3 and colour score 2.4.

Average scores for aroma were 2.9 for FSM123, 2.9 for FSM579, 2.7 for FSM101 and 2.3 for SFP. The relative low rating for the SFP meals may have been as result of leniency error, where the assessor underscores or over rate a meal usually because he /she is too familiar with meal (eats it daily) or out of sensory fatigue.

From in Figure 4.22, the trend in  $SC_m$  acceptability with untrained panel was similar to that of the trained panel. FSM579 obtained the highest mean score for taste, colour and aroma followed by FSM101 then FSM123 and SFP respectively. Unlike trained panel results, colour played a pivotal in the decision to accept the meals.

There were positive correlation between all attributes assessed and O.A with Colour having the highest correlation ( $r=0.94$  at  $p=0.0014$ ). The results presented in Table 1 in Appendix 3 are in agreement with similar efforts by Scaglioni (2011) and Ventura and Worobey (2013). In these studies, colour was the key determinant of acceptance or reject meals for children.

The comparison of the trained and untrained panel result indicates a trend of similarity in the influence taste in the acceptability of meals. The high correlation between O.A and taste ( $r=0.83$ ) agrees with similar studies (Lehrner et al.,1999; Guinard,2001) that suggest of taste thresholds in children ( $5\pm 7$  years) are similar to taste perception in adults.

There was weak correlation between O.A and aroma ( $r=+0.10$ ) in children (untrained panel) compared to the adult panel( $r=+0.90$ ) is not unexpected. In that, although school age children tend not to differ much with respect thresholds for olfactory sensing, the degree of sensitivity is low as children are less likely to correctly identify an odour and adequate link it to specific food memory (Moskowitz 1994, Lehrner et al., 1999; Lehrner and Walla 2002). This makes it difficult for child to interpret the aroma perception with respect to O.A as seen in this study.

#### 4.2.3.1.3 Preference test with untrained panel.

By directly assessing preference in children predominantly aged 5-8years, this study hoped to attain an important insight into the mechanisms responsible for food acceptance and rejection if intervention food are line-up with similar meals that are currently being served by GSFP

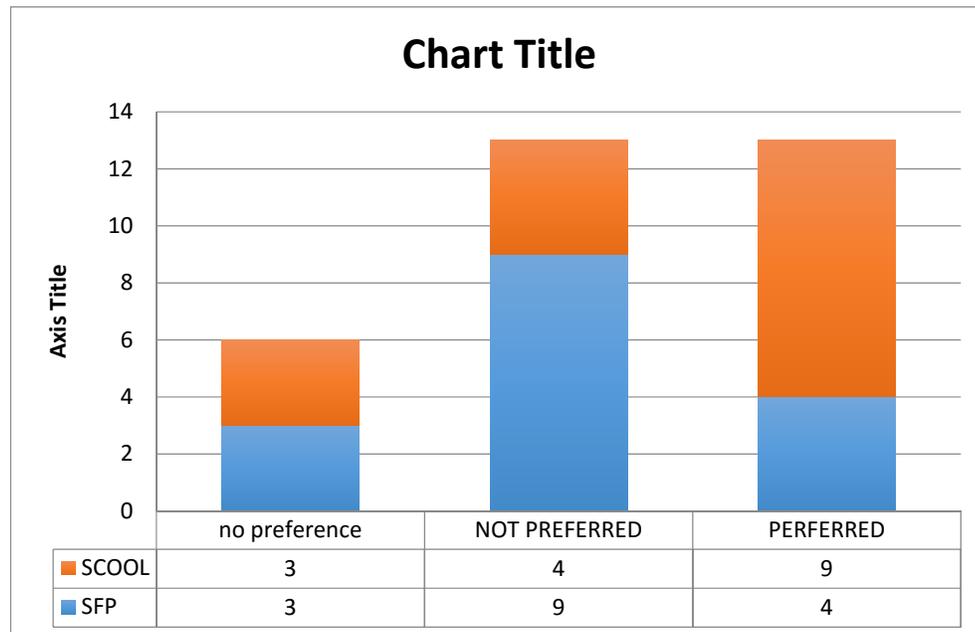


Figure 4.23: Mean scores for overall preference for trained panel

The results as shown in Fig (4.23) indicates that 25% of the panel preferred the alternative SFP meal to the Sc<sub>m</sub> meals whilst 56% indicated that they preferred the Sc<sub>m</sub> meals. The remaining 19% had no preference in that, they either didn't like both meals at all or liked both meals equally. The results of this study are in line with the results from Wolfgang (2015) that suggest children can accurately decipher differences in meals and adequately identify which taste is preferred under study conditions.

However, it is worth noting that accuracy of the results attained predominantly dependent on the simplicity of the sensory test (Oram et al., 2001) and the ability of the researcher (assistant) to control panel interaction during the evaluation process.

### **4.3 SC<sub>m</sub> intervention**

#### **Introduction**

This pilot intervention was an intervention trial to ascertain the efficacy of the developed SC<sub>m</sub> meals in improving nutritional outcomes. It forms the initial effort to test the nutritional impact of the developed meals alongside the meals already being provided under the current Ghana School Feeding Programme and a control.

This chapter consists of three main sections. The first, section describes the pilot study population at baseline and provides information on patterns of dietary intake and food related behaviour. The subsequent sections describe the scale up intervention of the SC<sub>m</sub> meals and measure the impact of the SC<sub>m</sub> meals relative to the GSFP meals and a control.

#### **Summary of Materials and Methods**

Study participants were recruited at the start of term, screen and treated for malaria and worm infestation. The GSFP treatment group continue to receive GSFP without any interference, whilst the non-GSFP groups were sub divided into two, one group received the SC<sub>m</sub> meal and the other (Control) received three portion of fruit a week as incentive.

Together all three groups were followed up for 6 months in the pilot and 9 months in the scale up. Anthropometric and HB measurements were taken at start mid and end point as specified in the study design (Chapter 3).

### 4.3.1 Pilot intervention

#### *Socio-Demographic Characteristics*

At baseline, demographic data was collected to ascertain if the recruited participants had any fundamental (socio-economic and demographic) differences that might cause any biases in the outcomes of the various treatments.

**Table 4.14 Baseline Socio demographic characteristics**

Characteristics		Total	Participating school	Non-participating			
			GSFP	SCm	Control	P values	
Parent	≤20 years	16	7	4	5	0.084	
/guardian	21-30 years	97	26	39	32	0.158	
Mean age	31-40 years	52	20	14	18	0.688	
(years)	≥40 years	15	7	3	5	0.196	
Educationa	No formal	14(8.3)	6	4	4	0.933	
I status (%)	education						
	Primary	59(32.7)	20	20	19	0.700	
	Secondary	97(53.8)	30	32	35	0.622	
	(JSS, SSS)						
	Tertiary	10(5.6)	4	4	2	0.265	
Marital	Single	22 (12.2)	5	7	10		
status	Married	122(67.7)	40	44	38	0.627	
	Divorced	36(20.1)	14	10	12	0.191	
	Separated						
Employment	Unemployed	20(11.1)	7	5	8	0.263	
	Housewife	35(19.4)	11	14	10	0.668	
	Self-	43(23.8)	10	18	15	0.412	
	employed						
	Fixed salary	19(10.7)	8	6	5	0.795	
	Agriculture	63(35)	23	19	21	0.577	
Exclusive breast feeding		5	5.3	4.8	5	0.922	
	(length in months)						

Table 4.14 provides a summary of the socio-demographic index measured at baseline. Out of the 180 school children recruited at baseline

46% of them being girls and the remaining (54%) being boys. The average age of the recruited school children was  $6.54 \pm 1.72$  years with those in the GSFP being on average  $6.68 \pm 1.6$  years old whilst those in SCm group were average  $6.51 \pm 1.3$  years and the control group being on the average  $6.44 \pm 1.9$  years old.

The results showed that the pupils were exclusively breast fed for an average of 4.8 months, which is less than the WHO recommended 6 months. Extensive studies by Uyoga (2016) and Smith et al.,(2015) reported that duration of exclusive breast-feeding is a key predictor of childhood health.

Across treatment groups the average households had a family size of  $5 \pm 1.0$  members with ratio of female to male being 4:1. The household gender ratio and family size reported in this study differs from the district data provided by GSS 2014 and 2010 reports. In all 82.7% (149) of the parents and guardians present, were aged between 21-40 years with the majority 84.4% (152) being female (older sisters, mothers and grandmothers) within the age range 17-72 years.

In the patrilineal system practiced in the LKMD usually leave the efforts of childcare and maintenance to the mother or females in the family; fathers do not often take active part in activities concerning their children. This comes to buttress the other findings by Danquah (2008) who attributes this trend to the fact that in Ghana traditionally, women bear the responsibility of raising children. Pollard (2000) also explains that in a similar patrilineal population in the Solomon Islands, women are not only saddled with the burden of reproduction (continuance of lineage) but this was further compounded with burden of ensuring the maintenance of their homes as well as labouring for the family.

The majority (67.7%) of parents/guardians were married or had been married before (widowed). The rest were single or divorced/separated, more females than males were to be found in this two groups. This gives an indication of Single Female Parent Household. Ntoimo and Odimegwu (2014) reported that children born to single mothers who were not widows were more likely to be stunted (OR 1.79  $p < 0.01$  in Cameroon and 1.69

$p < 0.01$  in DRC). Disparities in economic resources and parental care significantly influenced the higher odds of stunting in single mother households in Cameroon and DRC.

Over half (72.2%) of the parents or guardians present were the sole/primary caregiver with the remaining being relatives or representatives of parents and guardians mainly older siblings and grandparents. This was not out of the ordinary as the indigenes in LMKD practice extended family system and childcare is sometimes shared among relatives. The 2010 census district statistics states that majority (61.7%) of the household population in the Municipality live in extended family households (GSS 2010).

The majority (53.8%) of the parents/guardians had had up to secondary school level education (JSS/SSS), a few more (5.6%) had had tertiary level education whilst the rest had had either up to primary level (32.7%) or no formal education (8.3%). The group with the least level of education were mainly older mothers and grandmothers. This is reflective of the large disparity that existed in female child education in patrilineal societies like LMKD until the last two decade (in LMKD the priority has always been male education).

In terms of employment, the vast majority (35%) were farmers or played a role in the agricultural chain of activities. This was followed by those self-employed (23.8%) partaking in activities such as petty trading, dress making, hair dressing and other arts and craft professions. A few were civil servants or employed in different capacities in the local government office with the majority being male parents/guardians.

This was a reflection of the data reported in the GSS district dataset for 2010 and 2014. It states that the proportion of the population who are employees of the public and the private formal sectors are about - 7.7-8.2 % with more males are likely to be employed here than females. The remaining caregivers indicated that they were either housewife (19.4%) or unemployed (11.1%)

#### 4.3.1.2 Dietary patterns

**Table 4.15 Daily meal consumption frequency and meal sources**

Variable	Total Number Respondents	%	GSFP	CONTROL	SCM
<b>Meals frequency</b>					
Once	18	10	5	2	5
Twice	74	41.1	24	27	23
Thrice	88	48.8	26	30	32
<b>Meals cooked at home</b>					
Once	87	48.3	32	27	28
Twice	20	11.1	4	10	6
Three	73	40.5	20	28	25
<b>Eaten at home</b>					
Break fast	62	34.4	15	27	20
Lunch	23	12.8	2	11	10
Dinner	81	45	23	30	28
None	14	7.8	6	4	4

The FFQ and 24-hour recall showed that the types of meal eaten by the different treatment groups with slight different in eating patterns as shown in Table 4.15. The similarities maybe due to the fact that at baseline the participants were recruited from the same township hence the likelihood of similar socio-economic characteristics as well as food related behaviour with the only distinctive difference being the existence or the non-existence of the school-feeding programme in their respective schools

Information on the meal consumption patterns pertaining to meal sources, frequency of consumption have been summarised in Table 4.15. A total of 88 out of 180 reported that they had three meals a day, 74 respondents indicate that they had an average of two meals a day whilst the remaining 18 indicated that on an average day they had only one meal.

The result showed that almost half of the households cooked just one meal at home, which was usually dinner. Breakfast and Lunch meals like koko (millet porridge) sellers, waakye (rice and beans) were not usually cooked at home but are eaten away from the home.

**Table 4.15 Baseline dietary related characteristics**

	<b>GSFP</b>	<b>SCm</b>	<b>Control</b>
<b>Take Packed Lunch To School</b>	5	12	33
<b>Pocket Money For Food At School</b>	1±0.2ghc	1±0.5g hc	1±0.5gh c
<b>Patronise food vendors around school during lunch</b>	28	36	41

Across the group lunch was the cooked meals usually eaten away from home with 87.2% eating lunch away from home. This observation was in line with the fact that most of the family especially spend most afternoons away from the home. Parents are usually at work and children will be in school.

However the dynamics were not uniform within treatment groups as more pupils from non-GSFP schools reported that eating packed lunch, rather than lunch at home or buying from vendors. Pupils in the control were more likely to take packed lunch to school (33 vs. 12 SCm vs. 5 GSFP). Parents reported to give their children an average of 1ghanaian cedi to school on a daily bases.

The majority of children (105 out of 180) admitted to purchases from food vendors at lunch time, with the majority of those purchased food being in the control group as compared to the other treatment groups (41 vs. 36 in SCm vs. 28 in GSFP) as shown in Table 4.15.

The main motivating factor for those who go home to eat was proximity of school to home, availability of a packed lunch and the availability of lunch money. From the interviews, some pupils in this category indicated that they only go home when they do not have money to buy lunch from vendors in school. It is worth noting that in most schools including GSFP schools, there was both mobile and stationary food vendors plying their trade during the break times and older school children patronised them the

most. These vendors play a vital role in healthy and unhealthy behaviours among school going children (Danquah 2012; Verity 2004)

### **Food consumption patterns**

The dietary patterns were determined from the information gathered from food frequency questionnaire, which was administered before the intervention. The most frequently consumed foods were grouped into food groups (starchy staples, animal products, legumes, fruits and vegetables, fats and oils). The various food groups with their respective frequency of consumption within in the whole population have been presented in Table 4.16 and Figures 4.24-4.26. The most of commodities listed were cultivated / farmed in the district and was indication of people consuming what they had in their immediate environment.

#### ***Starchy staples (root, tubers, cereals and plantain)***

The data in Table 4.16 indicates the main starchy staples consumed are maize, cassava, rice, plantain, yam, sweet potatoes and cocoyam. Maize was frequently consumed in the form of banku (dumpling made from cooked meal of fermented maize and cassava dough), kenkey (dumpling made from fermented maize dough) and kooko (fermented maize porridge).

The rice was the most consumed non-indigenous with 83.9% of the population consuming it at least once a day. Rice was most consumed as rice porridge, plain boiled rice with vegetable (omor k3 zor) or accompanied tomato stew or soup or as jollof (rice boiled in tomato sauce). Rice was also being consumed in other forms such as *omotuo* (rice balls) and waakye (rice and beans), although these mainly purchased from vendors rather than cooked at home

**Table 4:16 Commonly eaten starchy staples with corresponding consumption percentage frequencies**

Commodities	% Response				
	Daily	Weekly	Monthly	Occasionally	Never
Rice	83.9	3.9	6	2.3	3.9
Yam	21.1	52.7	16	10.2	0
Cassava	82.2	5	12.8	0	0
Noodles	67.2	17	2.8	13	0
Cocoyam	16.2	72.8	2.8	8.2	0
Plantain	75	12.2	10	2.8	0
Sweet Potatoes	15	70	10.6	0	4.4
Maize	92.2	5	1.7	0	1.1

Cassava was mainly eaten on its own as a boiled root (*agbele kpoko*), boiled and pounded with plantain (*fufu*) or grated in a cassava dough and added to maize for banku. The most consume form however is gari (roasted fermented cassava flour), which is usually eaten with sugar (sometimes with milk and groundnut) as a main meal or snack. Some respondents mentioned that the consume gari as accompaniment to boiled beans or waakye. Respondents also indicated the consumed other carbohydrate commodities such as cocoyam, sweet potatoes, plantain and yam.

Perhaps much more interesting was the fact that, for a predominately farming area, a large number of the population (84.2%) indicated that they ate dry instant Chinese noodles at least once weekly. Instant noodles are ready to eat noodle usually sold in cups or as blocks. Instant Chinese noodles are usually made from refined flour, oil and seasoned with salt, sugar and flour enhancers like monosodium glutamate. Its consumption has been linked with obesity given its low fibre content and high glycaemic index. It increases risk of developing dyslipidaemia owing to its high oils and fats content (Boonnate et al., 2014), and an increased risk for metabolic syndrome due to its high sodium (Shin et al., 2014).

## Fats and oils

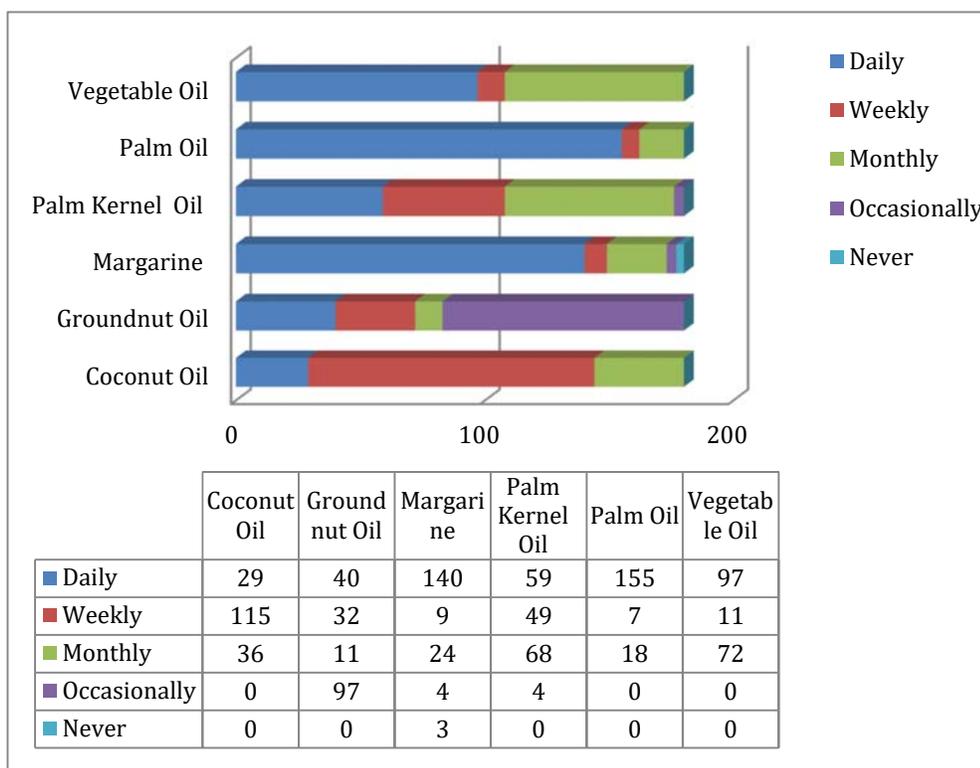


Figure 4.24 Consumption Patterns of Fats and Oils In LMKD Study Population At Baseline

On the whole, palm oil and palm kernel oil were the most frequently used oils and served as the base of many traditional stew, sauces and soups that accompanied the starchy staples. Across the groups an estimated 86.1% reported daily use of palm oil whilst 32.7% used Palm kernel oil. Respondents mentioned that palm oil was ideal because it constituted the main part of traditional sauces like *kamkwada* (barbequed tomato and pepper sauce with fish drizzled with palm oil), kontonmire stew (Spinach stew), okro stew which serves as accompaniment for the starch staples.

Other source of fats and oils consumed by the respondents included coconut oil and refined vegetable cooking oil. Some respondents reported that use of margarine as a commodity for bread with which breakfast, were consumed less frequently because they are expensive. Intifal and Larthey (2014) made the same observation when studying breakfast habits among school children in the LMKD and reported intake of breakfast condiments

like milk, butter, margarine or cheese were low for even children who may require it most because they are expensive.

### ***Animal and animal products***

**Table 4:17 Commonly eaten animal and animal product  
With corresponding consumption percentage frequencies**

Commodities	% Response				
	Daily	Weekly	Monthly	Occasionally	Never
Eggs	5.6	17.8	67.8	4.5	4.4
Chicken/Turkey	15	65	6	10	4
Beef/ Goat	0	2.2	95.6	2.2	0
Cow Foot	3.8	91.1	5.1	0	0
Pork	2.2	27.6	6.1	62.1	2
Tuna	67.7	2	23.3	5	2
Mackerel	7.3	72.7	15	2	3
Anchovies	23	54	18	5	0
Tin Fish	15	11.2	35	38.8	0

For the entire study population fish was the most frequented animal product with a least 98% of the entire population consuming some form of fish once a day. Tuna, mackerel and anchovies were the three most consumed and they were mainly eaten as boiled, smoked or dried and as protein bases for sauces, soups and stews. The daily frequency of eggs consumption was 5.6% with a further 67.8% consuming egg at least once a month. Other protein sources such as red meat specially beef/ goat and cow foot were consumed on monthly bases with an average 81.7% consuming at least one of the two once in a month.

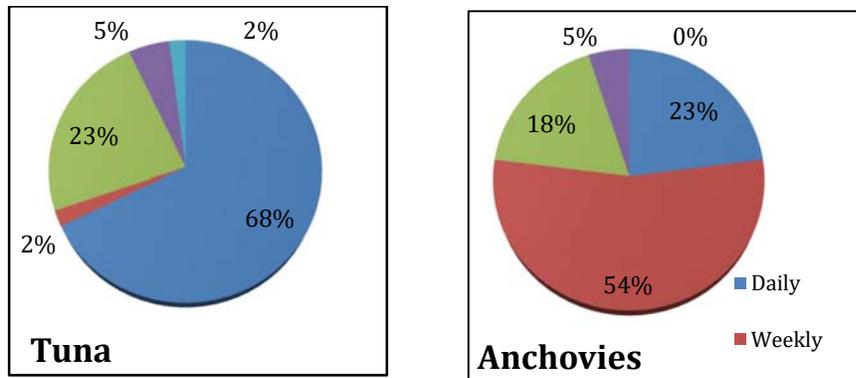


Figure 4.25 a-b clockwise: Consumption Patterns of the two most consumed fish In



LMKD Study Population At Baseline

Figure 4.26 a-b clockwise: photos of the same value cost (50ghc) of the two most consumed fish in LMKD

Despite tuna being the most consumed on the daily bases, in terms of cost, it is not the most cost effective option for the population especially if it is to be considered as a food product for intervention. Figures 4.26a and 4.26b show in terms of cost the same amount (50ghc) in price for the two types of fish. With the same amount of money you get three bags of anchovies or five fillets of tuna. For intervention on a limited budget like GSFP, anchovies are the most economical choice even though they may not be the most indigenously consumed fish.

### **Diary and dairy products**

Consumption of dairy and dairy products in LMKD like most of the southern regions of Ghana (unlike the northern regions of Ghana), has relatively low demand for raw milk, partly owing to low production or as well as safety and quality concerns. In the present study population, there

was no mention of consumption of fresh milk although daily milk consumption was high above 68.8%.

The majority of the population across were consuming powdered milk or evaporated milk with the former being the most consumed daily (66.1% consumed powdered milk vs. 2.7% evaporated milk) due to cost. Milk was typically used as a condiment for porridges, teas, gari-soakings (mixture of gari, water, sugar with or without milk or groundnut).

### ***Legume, nuts and seeds***

The most commonly consumed legumes were groundnut, melon seeds (*Agushi*), cowpea, black-eyed beans and soybeans across the study groups. In the category, *Agushi* was the most commonly consumed oil seed with a daily consumption of 33.8%. It was normally consumed as part of green leafy stew or on its one with palm oil as *Agushi* stew.

Groundnut was the most commonly consumed legume with an average of 85.5% (154) of respondents reported that they consumed groundnuts at least once a week. Groundnuts were often eaten in soup form to accompany fufu or banku and sometimes rice balls or roasted and eaten with ripened plantain as meal.

Some respondents mentioned that they added groundnut paste to bread as part of a breakfast meal. All respondents reported eating Black eye beans at least once a week with gari (*Red-red*) with or without ripe plantain and palm oil. Beans were sometimes added to tomato stew or palm soup and served with eaten any starchy staple.

Respondents also mentioned the consumption of soybeans in the form of chewy meat kebab similarly to tofu as a cheap alternative to meat. There was also mention of other legumes such as bambara beans, sorghum and neri. These were not commonly used and their consumption was occasional.

### ***Fruits and vegetables***

The response to the FFQ showed general fruit consumption in the population 83.9% indicating that at least they take one form of fruit a day. The most commonly consumed fruit included oranges, banana, pineapple, pawpaw, mango and watermelon as shown in Table 4.18. Respondents did not however always have fresh fruits; some had them as juices and drinks. Considering the region is known for its priors as the hub for mango production in Ghana, it was not surprising that 63.8% (115) of respondents indicated that they had some form of mango in a day.

Table 4:18 Fruit and vegetable sources with their consumption frequency patterns

Commodities	% Response				
	Daily	Weekly	Monthly	Occasionally	Never
Green leafy	16.1	84	0	0	0
Garden eggs	32.2	54	53.8	0	0
Okro	10.2	67.2	2.5	20	0
Onions	100	0	0	0	0
Pepper	97.3	1.1	0	1.6	0
Tomatoes	100	0	0	0	0
Oranges	5	16.2	63.8	15	0
Banana	5	20	32.7	42.3	0
Pineapple	16.1	2.7	73	8.2	0
Pawpaw	5	35	20	30	10
Mango	63.8	15	21.2	0	0
Watermelon	0	10	22.7	53.8	13.5

Mango is typically a seasonal fruit hence the expectation was that it would only be consumed when in season. However this did not seem to be the case. The introduction of newer varieties and variant that crossed season means there was some form of mango available throughout the year. Respondents indicated that fruits were not consumed as part of a meal but usually consumed as snacks either in anticipation of the meal or to replace a meal when there is nothing else to eat.

In terms of vegetable, tomatoes, onions, okro, green leafy mainly kontomire, ayoyo, alayfo, cassava leaves, and chilli pepper, garden eggs. Tomatoes and onions were the two most consumed vegetables with 100% of respondents reporting daily consumption.

The combination of tomatoes onions and peppers served as the basis of most stews, soups and sauces that accompany the starchy staples like rice, fufu and banku consumed across the study groups. The green leafy vegetables and garden eggs were either used to prepare sauces to accompany cassava (agblekpoko), plantain, yam, sweet potatoes or cocoyam

### **Snacks**

Table 4: 19. Weekly Snack consumption pattern

Commodities	% Response				
	Daily	Weekly	Monthly	Occasionally	Never
Ice cream	6.2	40	43.8	10	0
Bread	67.7	20	10	2.2	
Pies	0	6.6	31.1	62.3	0
Biscuits / cookies	12.2	53.8	9	15	10
Gari soakings	30	43	17	10	0
Chips	14	6	70	10	0
Fruits	10	65	12.2	0	2.7

Snacks are normally classified small amount portion of food or drink eaten between regular meals as a strategy to ward off short-term hunger or for obtaining additional nutrients. Healthy snacking has been associated with maximizing performance during strenuous physical activity and has been positively associated with maintaining blood glucose levels during long spells of hunger (Kerksic, 2008: Carlsohn, 2012).

In the study population, the most consumed snack was bread (67.7%) specifically sugar bread which was made from wheat flour (bran and the germ layers have been removed), fat and added sugar. Bread is usually eaten alone or with condiments such as margarine, peanut, chocolate spread or condensed milk.

Ten per cent of the respondents indicated than daily consumption of fruits as snacks. Considering that respondents mentioned earlier on that, they usually consumed fruit as snack, the daily consumption of fruit in the snacks column does not tally with the response from the individual fruit consumptions. Also respondents may been eating fruits as main meals instead of snacks.

This indicates the possibility of over-reporting fruit consumption and /or under reporting in the snack on the part of respondents. This trend is quite common in self-reported dietary assessment studies where participants tend to underreport intakes of foods as well as habits and consumption patterns that they perceive to be unhealthy or socially undesirable thus making it difficult for accurate deduction of diet related causality with the presence or absence of nutrition dependent disorders/disease (Mendez et al., 2004, Livingstone et al., 2003; Lissner, 2002; Heitmann, Lissner and Osler, 2000). Results from studies by Schatzkin et al., (2003); Subar et al., (2003) and Black et al., (2001) suggest that some participants also are likely to over-report habits such as consumption of fruit and vegetable and consumption of water (habits deemed as healthy).

### ***Trends in consumption of some of the most common foods***

The overall consumption pattern was similar in all the three treatment groups at base line. Figure 4.24 maps out the few differences in the daily consumption frequencies among the treatment groups. With respect to the starchy staples, GSFP consumed more rice than the other treatment groups (41.1% vs. 31.8% for SCm vs. 27.2% control group).

Whilst the daily consumption frequency for maize based meals was higher in the control group (34.3%) and SCm groups (36.1%) than the GSFP group (29.5%). Consumption frequency for the most consumed protein sources was similar across all groups with GSFP consuming less anchovies than the rest of the groups (26.8% vs. 31.7% control and 41.5%

SCm).

The control group consumed more fruits daily than both the SCm and GSFP groups. With respect to the vegetables consumption frequency were identical across all groups for the most common vegetable (tomatoes, onions and pepper). However for the other varieties like garden eggs and green leafy vegetables the SCm and Control group had slightly high consumption frequencies than the GSFP group as shown in Figure 4.24. GSFP had the highest daily consumption frequency of noodles (52.9%) followed by the SCm group (29.8%) and then the control group (17.4%).

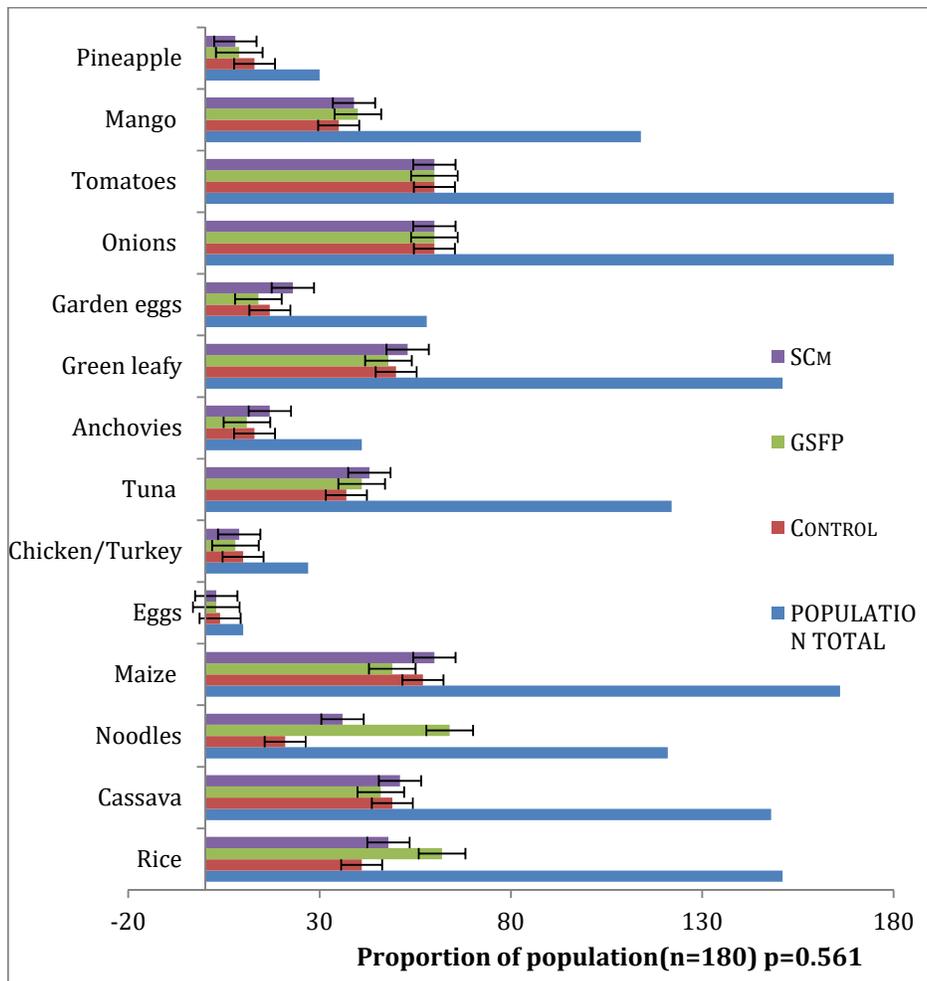


Figure 4.27 Bar chart showing group difference in consumption pattern for the most common foods n=180

In term snacks, GSFP had a higher daily consumption frequency

across all snack except gari soaking. The most consumed snack was bread with an average 67.8% of respondents reporting daily consumption frequency of across groups (67.8%). The GSFP group had a daily bread frequency for 45 out of 60 whilst SCm group and Control groups had 40 out of 60 and 37 out of 60 respectively.

There was no significant difference in energy, fat, carbohydrate, and minerals from food consumption outside school consumption (home consumption) across treatment groups of children aside lunch meals . The results showed the populations across groups GSFP programme and Non-GSFP schools were largely similar in their consumption pattern throughout the typical school days with the difference mainly being the consumption of the afternoon school meals.

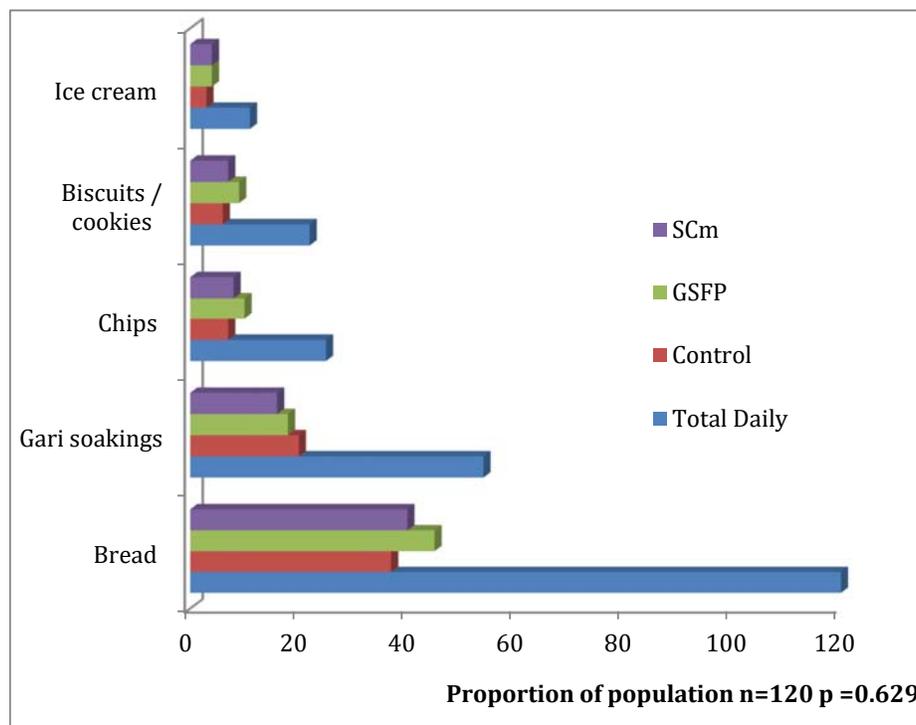


Figure 4.28 Bar chart showing group difference in consumption pattern for the snacks n=120

Table 4.20 gives an overview of the nutrient profile of the average lunch in the various intervention groups at baseline. The table also maps out the difference in lunch meal content. The total energy intake across all

the treatment groups at baseline were less than the 30% DRV recommended by the WFP for SFPs, GSFP were consuming 407.3 kcals (28.4% DRV) versus Controls 378.84kcal (25.2%) and SCm 414kcals (27.6%).

The GSFP treatment group had the higher carbohydrate intake per lunch at 72.37g vs. Control 46.65g vs. Scm 39g. Similarly the GSFP lunch meals were contented 42% DRV (14.56g) fat recommended for SFPs whilst the SCm and Control lunch provide less fat at an average of 24% of the recommended DRV (SCM 7.5g, Control 9.94g). Both trends can be linked to the high dependence on rice-based meals served with stews cooked with large amounts of vegetable oil.

**Table 4:20 Mean intakes during lunch for selected nutrients across study groups at baseline**

<b>Nutrient</b>	<b>30% DRV</b>	<b>GSFP %</b>	<b>% DRV</b>	<b>Control</b>	<b>% DRV</b>	<b>SCm, %</b>	<b>% DRV</b>	<b>P value</b>
<b>Energy kcal</b>	494	407.3	28.4	378.84	25.2	414	27.6	
<b>CHO g</b>	130	72.37	56	46.65	36	50.48	39	
<b>Protein g</b>	8.28	4.53	16.1	5.52	20	4.85	17.3	0.718
<b>Fats g</b>	11	14.56	42	9.34	27	7.5	21	
<b>Vitamin A</b>	105	63	18	147	42	115	33	
<b>Calcium mg</b>	157	84	15	140	25	153	28	0.613
<b>Iron mg</b>	3	2.86	31	4.79	53	3.62	40	0.522
<b>Zinc mg</b>	5	0.87	17	1.48	3	1.62	32	0.278

Lunch intake was significantly higher among Non-GSFP pupils for calcium  $148 \pm 11.31$  (95%CI  $p=0.613$ ), Vitamin A  $131 \pm 22.63$  (95%CI  $p=0.0054$ ), protein  $5.185 \pm 0.47$  (95%CI  $p=0.718$ ) as well as Zinc  $2.55 \pm 1.51$  (95%CI  $p=0.278$ ). The lunch consumed by the Control group had highest protein content 5.52g (20% DRV) compared to the other treatment groups (GSFP 4.53g vs. SCm 4.85g).

The lunch meals consumed by the control group were accompanied by high biological value protein source such as eggs and

chicken hence contributing the greater protein content of control group lunch meals. The SCm group had the calcium content 153g (28%), the closest to the WFP recommended DRV. This may be attributed to their relatively higher dependence on leafy green vegetables and anchovies as a source of protein.

#### 4.3.1.3: Parasitic infestation

Table 4:21 Number of children with parasitic infestation (percentage) at baseline across intervention groups

Parasitology	Total	Control n =47	GSFP n=54	SCm n=49
<b>Ascaris</b>	0	0(0.0)	0(0.0)	0(0.0)
<b>Hookworm</b>	5 (3)	2(4.1)	0(0.0)	3(6.1)
<b>Tt</b>	3(2)	1(2.1)	1(1.85)	1(2.0)
<b>S Mansoni</b>	3 (2)	1(2.1)	2(3.7)	0(0.0)
<b>Malaria</b>	63 (42)	20(42.8)	23(42.6)	20(40.8)
<b>No parasites</b>	76 (50.6)	23(48.9)	28(51.9)	25(51.0)

Baseline screening for worm/ parasite infestation was done for the five parasitic infections (*Ascaris lumbricoides*, *Trichuristrichiura*, *Hookworm*, *Schistosoma mansoni*, and *Plasmodium spp* -Malaria parasite) endemic in the district. At baseline some of the recruited participants did not provide biological samples for the parasitic and haematological for various religious and personal reasons. Hence Table 4.21 shows a reduced number of participants.

Microscopy analysis (Kato-Katz technique) results as seen in Table 4.17 show relatively very little difference in the enteropathy across p=0.734. The results indicate a prevalence of 3% (9) for hookworm infections, 2% (3) for *T. Trichiura* and infections whilst that for *S. mansoni* was 2% (3).

There was no incidence of *Ascaris* infection across all the test groups. There were 63 detected case of malaria parasite infestation in the entire study population with more male 60.31% (38) had malaria than females 39.68% (25) significant (p>0.05). This might have been as a result of the fact that there were more boys than girls in the study population.

The number of malaria parasite infestation was an average of 21 cases per group, which was not unexpected since the eastern corridor of Ghana is noted as malaria endemic region (USAID, 2013, Mba and Aboh 2006). The majority (63%) of those who tested positive for malaria parasites had

asymptotic (uncomplicated) malaria and did not show any sign of illness or disease.

In malaria endemic regions, the incidence of positive malaria parasite detection was high but this did not necessarily result in any clinical outcomes. This phenomenon is often associated to occurrence recurrent episodes of symptomatic parasitemia, in endemic areas hence at every point in time there are trace amount of parasite in the blood (Snow et al., 1997).

Others suggest the lack of symptom or clinical disease in asymptotic malaria within endemic area is likely due to the fact that most endemic population develop (after a few infective bites) some sort of malaria exposure-related immunity (Grobusch and Kremsner, 2007; Gupta et al., 1999). Hence detection malaria parasite levels (uncomplicated malaria) in the blood samples within endemic population may not result in disease (clinical outcomes).

To rule out parasitemia, all participants with dewormed and treated for malaria by the district school health officers. Eight participants with malaria ++ detections (clinically classified as severe malaria) were however excluded from the study and referred to the nearest health facility for immediate treatment. The high malaria infestation level reemphasize the need for the use of food-on-food fortification instead of outright iron supplementation as iron supplementation has been implicated as inductive of malaria episodes. Some studies in young children have suggested that iron supplementation may increase the risk of malaria and death in children living in malaria-endemic regions (WHO, 2015).

#### 4.3.1.3 Nutritional status

**Table 4:22 Comparison of weights, heights and HB across intervention groups at baseline control for gender and age**

Indices	Standard for 7 year old	Average	Average (SD)			P≤0.05
			GSFP	Control	SCM	
<b>HEIGHT (cm)</b>	121	115.8±4.35	117.03±2.87	116.39±4.83	116.±4.08	0.656
<b>WEIGHT (Kg)</b>	22.1	18.94±2.73	19.09±3.46	19.19±3.55	19.53±2.84	0.527
<b>HB (g/dl)</b>	12	10.57±3	10.54±2.3	11.43±3	10.82±3.6	0.604

Table 4.22 shows the means with standard deviation of the baseline anthropometric and hematologic indicators assessed in the pilot study. The average age across the groups was  $6.54 \pm 1.72 \approx 7$  years. The average gender adjusted weight of the entire population was lower than the reference weight required for a 7 year old by 3.16kg (22kg vs. 18.94kg). Similarly the population's gender adjusted height average was (115.83±4.35) was 5.17cm deficit of the WHO reference height for 7-year-old children (121cm).

Within the treatment groups the (sex and age-adjusted) data indicated that at baseline the pupils in the GSFP group were appear to be taller (117.03 vs. 115.45 SCm, 16.06±4.08 Control). The average child in this group was slightly older than those in the other groups hence the difference. Non-GSFP participating pupils (SCm and Control) were relatively heavier than pupils control groups. The observed difference in anthropometric were not significant at  $p>0.05$  across groups.

#### **Weight –for- Age Z score (WAZ)**

In the pilot study, there was positive clinical improvement in mean weight-for-age across all three-study groups with the most statistically significant change being in the GSFP. Increase in WAZ score in GSFP

group can attributed to several things. Considering that at baseline the GSFP had the lower WAZ (although not significantly different from the rest of the groups) there was a 0.137 points increase in WAZ by end of pilot (6 months).

Table 4:23: Comparison of WAZ score across Intervention groups at baseline midpoint and endpoint

INTERVENTION GROUPS	Mean measurements		
	BASELINE (MONTH 0)	MIDPOINT (MONTH 3)	END POINT (MONTH 6)
<b>Control</b>	-0.751 <sup>a</sup>	-0.703	-0.656 <sup>a</sup>
<b>GSFP</b>	-0.819 <sup>a</sup>	-0.778	-0.754 <sup>c</sup>
<b>SCM</b>	-0.786 <sup>a</sup>	-0.759	-0.684 <sup>a</sup>

*\*Numbers with same alphabets in rows are not significantly different Numbers with same alphabets in columns are not significantly different*

Implying that for an average GSFP participant gained weight contrary to data provide by similar studies like such as Agbozo et al., 2017, Danquah et al., 2012: 2009, Owusu et al., 2016. These studies reported that the GSFP meals did not exert any significant weight gains and the WAZ of participating pupils did not show any significant difference from their non-participating counterparts. The positive impact on WAZ was in agreement with Abizari et al., (2014) and Harding et al., (2012) who both attested to the high-energy content of the GSFP meals.

The significant change in WAZ in the current GSFP under study, could be attributed to several dietary facts peculiar to this group. To start with the average GSFP meal contained 407.3±13.2 kcal of energy and although it accounted for 28.4% the recommended DRV, meals were heavily dependent on simple carbohydrates (white rice) unusually served with light to no fibre or protein (4.63g per 100g). Simple carbohydrates like that found in white rice are easily digested and readily enter the blood stream quicker than those with fibre (Chambers, McCrickerda and Yeomansa M., 2015; Spiller, 2001)

In case of prolong excess consumption; the body begins to store simple carbohydrates as fats, which over a period of time may be lead to

increased weight. However considering the portion size provided to the GSFP participating (350g minus 22% loss to plate wastage), this may not necessarily be the direct cause of the weight gain in this pilot study.

There is also added issue of meal frequency.

At baseline, the breakfast meal frequencies for a large number of pupils in the GSFP were lower. The GSFP group had marginally higher probability of going to school hungry compared to the other groups (SCm, Control). This suggests a greater risk of repeat short-term hunger in the mornings. Over an extended period of time (academic term) this could possibly lead to negative coping mechanisms and unhealthy eating habits such as overeating, snacking (Nuru and Mamang, 2017). This adaptive response can translate into weight gain, elevated cholesterol levels as well as poor blood glucose control (Mullan et al., 2014; Lippevelde et al., 2013; Pereira et al., 2011).

Continuous skipping of meals especially breakfast (fasting) with subsequent surge in calorie intake late in the day results distortions in metabolism whereby the body tries to compensate for any future deprivation by storing as much energy as possible leading to post fast weight gain (Van der Heijden et al., 2007; Berkey et al., 2003). In this current study, considering that meals in GSFP schools were served at midday, at least four hours after school starts, this might have contributed to some extent the steep gains in WAZ in the GSFP group.

To a large extent, the weight gain in this group was likely to be as result of substantial calorie addition due to snacking. Although, the portion carbohydrates served in the GSFP meals may not be significant to be classified as excessive intake, their low fibre content and low protein content means they do very little in ensuring satiety.

Quick absorption of simple sugars and inadequate protein affects appetite, satiety and insulin regulatory hormones, which eventually results in overeating and excessive snacking (Nuru and Mamang, 2017; Pereira et al., 2011). Owing to the fact that many unhealthy snack foods derive a substantial number of their calories from fat and sugar, a increased intake

increases risk of weight gain and serves as strong predictor of chronic disease (Garrett and Ruel 2005; Prentice 2006).

The results from the 24hour recall and food frequency (Figure 4) provides additional evidence of snacking in the GSFP group after lunch. This snacking (usually on white bread) could have contributed substantial amounts of extra calories, particularly if they are not consumed in response to hunger before or after school meals like in the current study. Although not entirely conclusive, all the facts together with the natural childhood growth could have contributed to the gains made in the weight for age considering that the energy content of meals were less than 30% of the recommended DRV.

For the other study groups for instance for SCm group, the increase (6%,  $p=0.582$ ) in WAZ can be attributed to superior blend of nutrient in the recipe. The synergistic effect of the various ingredients helps to provide the energy for gradual increase in weight unlike the surge in weight associated with the GSFP.

For the control group positive impact on weight (2.95% increase  $p=0.651$ ) could be attributed to the fact that a large percentage of the children did not skip breakfast and went home to eat lunch with parents. Studies have shown that, in home consumption parents (were housewives) are likely of make the pupils food choices which most often are towards increased intake of healthy foods and restrict their children access to food perceived to be unhealthy (Young et al., 2004; Cullen et al., 2003: 2001; Hardy et al., 2000; Kratt et al., 2000).

Children who eat at home under supervision of parents are more likely to have healthy food preferences and patterns and less likely to snack (Cullen 2003: Kratt 2000; Hearn et al., 1998). The weight gain in this group was not as steep as that of the GSFP due both to their meal frequency and their relatively lower snacking rate. De Castro (1988) suggests that eating breakfast ensures longer lasting satiation and may reduce the tendency of snacking and subsequently regulate the total energy intake throughout the day.

## Height- For -Age Z Scores (HAZ)

Table 4.24 Comparison of HAZ across Intervention groups at baseline, midpoint and endpoint

INTERVENTION GROUPS	Mean measurements		
	BASELINE (0 MONTHS)	MIDPOINT (3 MONTHS)	END POINT (6 MONTHS)
<b>Control group</b>	-0.721 <sup>a</sup>	-0.706	-0.6915 <sup>b</sup>
<b>GSFP group</b>	-0.816 <sup>a</sup>	-0.820	-0.842 <sup>a</sup>
<b>SCM</b>	-0.738 <sup>a</sup>	-0.712	-0.678 <sup>c</sup>

*Numbers with same alphabets in rows are not significantly different Numbers with same alphabets in columns are not significantly different*

Stunting is a measure of linear growth retardation usually as result nutritional inadequacies over an extended period of time. Comparing average HAZ at baseline there was no significant difference across treatment groups ( $p=0.067$ ). Comparing data from start point to endpoint, there were positive improvements in HAZ across all groups with the exception of GSFP where HAZ dips (0.842).

Minimal increments in the height- for- age Z scores (0.81 to 0.842  $p=0.629$ ) within the GSFP treatment group highlights the effects of inadequate intake of proteins. Protein and amino acid synthesis forms the bases of linear growth and bone and elongation. GSFP meals have been shown to lack key macro and micronutrient nutrients like protein, iron, calcium, vitamin C required for linear growth acceleration. This may have potentially limited the impact of GSFP meals on HAZ. Any changes in height that may have been occurred insignificant considering the change in age.

Both control and SCm group significant ( $p<0.05$ ) gains were made in HAZ. The superior nutrient profiles of these treatment meals in together with the deworming treatment at the beginning the pilot facilitated linear growth. A study by Kruger et al., (1996) lends to support this current observation. The notion is that for nutrition interventions to exert impact, they need to be implemented concurrently with other complementary health interventions like deworming, vaccination and nutrition education. In the Kruger study, deworming in combination with consumption of a

nutrient-dense meal improved height than nutrition and deworming alone. Similarly in Zanzibar, children treated with albendazole saved a quarter of litre of blood per year and improved cognitive function significantly (Nokes et al. 1992; Nokes and Bundy, 1994). Other activities such as WASH initiatives, environment hygiene, vaccination and increase fruit and fresh vegetable (Vitamin C) facility linear growth (Maggini et al., 2010; Singh, 2004)

The changes in the HAZ scores within the control group are likely to be associated with their protein intake (20g) at lunch and the increased intake of fruits (three servings of fruit a week). The increase vitamin c intake have positive impacted on the absorption of the protein available in the meals and resulted in corresponding significant improvements in height for age scores of pupils in this group.

In the SCm group, the array of nutrients from the food ingredients used the various formulations may contributed to the relative high increase in HAZ. The synergistic of interaction between the lysine from the Obatanpa variety of maize coupled with vitamin C and protein from *Moringa oleifera* with additional protein from the soya and anchovies as well as vitamin A from the palm oil provided a unique of blend micronutrient that did not only promote weight gain but helped to facilitate linear growth.

The Obatanpa variety of maize has an average lysine profile of 4.0% (2.7-4.5%), which exceeds the average required by 5-8 year olds. The availability of the Lysine from the maize appears to help the body absorb calcium from the *Moringa oleifera*, soyabeans and anchovies which subsequently lead to increased bioavailability proteins need bones and connective tissues growth similar to the mechanism reported by Gibbon et al., (2005) and Moro et al., (1996).

Research findings from the Akuamo-Boateng (2002) study on 422 children, aged 4 and 9 months supports the idea that the use of the Obatanpa maize variety contributes to the nutrient profile of meals. The study evaluated the effect of feeding infants a traditional maize porridge made from Obatanpa or normal maize on two growth indices (weights and heights). The study concluded that infants fed on porridge made from the

Obantapa had significantly fewer sick days and less stunting, compared to children in the normal maize group over a period of 12 months.

Animal studies by Furuta and Murakam (2013) also show that the addition of plant source protein and lysine are capable promoting muscle weight gain and adipose tissue deposition resulting decrease in linear growth suppression among populations that are dependent on plant source protein. This is not to say that high biological proteins are not necessary in diet, but in population where high biological protein are limited or not readily accessible, several combination of plant based proteins in adequate portion can mimic protein profiles that are capable of sustaining linear growth as shown in this pilot.

The use indigenous Ghanaian low-technology food processing (evidence-based) methods may have helped to improve protein profiles of meals by reducing anti-nutrient content and increasing, bioavailability, digestibility and uptake of an array of essential proteins. Considering that the SCm were not totally dependent on animal proteins, it is likely that the indigenous methods such a roasting, malting fermenting may have played a role in increasing bioavailability and uptake of nutrient hence resulting increase linear growth compared to the other groups.

FAO (2010) advocates for the promotion and inclusion of indigenous food biotechnologies in the daily life as well as educational curricula in order to increase awareness and knowledge base in low-income countries on the contribution of such technologies on nutrient composition and food security.

There is also the need to emphasise on the role nutrition education played in the impact of the SCM treatment group. Throughout the pilot, parents were educated on nutrition and taken through different techniques of improving their children home consumption. This advocacy work although not quantified (beyond the scope of this study) may have likely improved meals eaten at home thereby amplifying any effects of the SCm meals.

## Body -Mass -Index -For Age Z score (BAZ)

Table 4.25 Comparison of BAZ across Intervention groups at baseline, midpoint and endpoint

INTERVENTIO N GROUPS	Mean measurements		
	BASELINE (0 MONTHS)	MIDPOINT (3MONTHS)	END POINT (6MONTHS)
Control group	-0.862 <sup>a</sup>	-0.848	-0.814 <sup>a</sup>
GSFP group	-0.895 <sup>a</sup>	-0.849	-0.806 <sup>c</sup>
SCM	-0.881 <sup>a</sup>	-0.853	-0.819 <sup>a</sup>

*Numbers with same alphabets in rows are not significantly different Numbers with same alphabets in columns are not significantly different*

An estimation of WAZ alone in itself is not efficient in for monitoring growth owing to its inability take into account relative height and body mass; hence the provision here of BMI-for-age to complement HAZ and WAZ in the growth assessment of school-aged children is essential to elucidate any effect any of the three treatments may have exerted on growth. BMI-for-age (BAZ) scores is able to adequately capture changes (or lack thereof) in the weight to height with respect age (Flegal et al., 2002)

Table 4.25 charts changes in the BMI-for-age of pupils in the different treatment groups. An examination of the baseline data indicates an average BAZ score of -0.879 for the entire population with the GSFP had the highest average BAZ of -0.895 (95%CI -0.823to -0.97) followed by the SCm group with -0.881(95%CI -0.74 to-0.94) with the control group having lowest BAZ of -0.862(95%CI -0.79 to-0.96).

The nominal differences were however not significant at  $p < 0.05$  and the distribution suggest the possibility of out layers. This implies that in the design intervention for such a population there is a need to take consideration the coexistence of two extremes of BMI in the same population and adjustment have to be made to ensure growth for both extremes without causing an addition health concerns.

Shift in WAZ in this group without corresponding change in height can explain changes in BAZ over the same period of time. The BMI for the

GSFP at endpoint shows a higher fraction of pupils in this treatment group gaining weight without concurrent (magnitude) increase in height. WAZ changed because stunting in this group was increasing whilst underweight was decreasing. The mean BAZ significantly change in the GSFP ( $p=0.037$ ) than all other groups and this likely to be due to the reasons breakfast skipping has been reported to be associated in cross-sectional analyses with a higher BMI.

In light of the result of anthropometric indices presented in this current pilot study and in the context other evidence based studies like Owusu et al., (2016), Danquah et al., (2012): Harding et al., (2012), there is a need to escalate public health concerns about the coexistence of stunting and adiposity in the same population. Increase availability and consumption of energy dense and low micronutrient westernised meals among children especially those in low-income non-urban populations increases risk of double burden of disease among malnutrition endemic population (UNICEF, 2009; Johnson, 2002).

## Biochemical indicator (Hb) for Anaemia

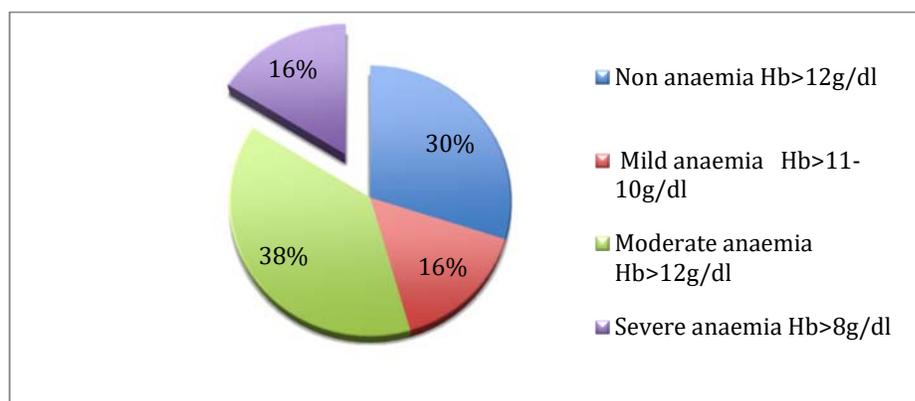


Figure 4.29 Anaemia distributions in total study population at baseline n=

Using HB as proxy for anaemia, Figure 4.29 shows that 68.8% of the entire population irrespective of treatment group had some form of anaemia based on the WHO HB classification. This high prevalence of anaemia in the study population does not deviate from the national average of 71% reported by FAO (2009). Other studies in similar populations have also reported anaemia prevalence of 70% (Fentiman et al., 2001), whilst other studies by Egbi (2012) and Osei-Boadi et al., (2012) reported higher anaemia rates of 72.5% among children aged 2-10 years and 25% among 9 months to 11 years vegans and non-vegans children respectively.

Haemoglobin levels provide an insight in to the protein status of the pupils. Haemoglobin in blood serves as the transport vehicle for oxygen and carbon in the blood and is made "globin group (amino acids) and "heme", group (iron). The HB at baseline (Figure 4.30) showed some clinical difference in the study population across group however the differences were not statistically significant. This result did not sway from the expected in that, the participants recruited randomly from the same community.

Clinically, there was higher number of pupils in SC<sub>m</sub> presented with more severe anaemia (11 vs. 9 vs. 7  $p=0.525$ ) than those in the GSFP and control group. The numbers of pupils in GSFP with moderately anaemia were more compared to SC<sub>m</sub> (24 vs. 20  $p = 0.092$ ) and control group.

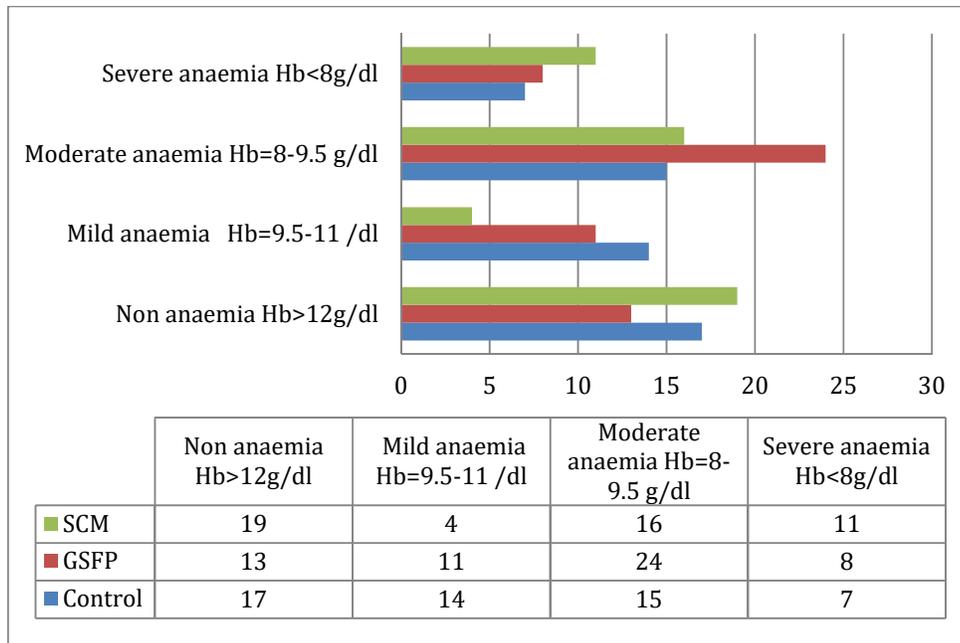


Figure 4.30 Anaemia distributions across study population groups at baseline,  $p=0.127$

Post pilot, the expectation was that all intervention treatment would have some impact on protein energy intake of the children. As expected the total percentage anaemia reduced by 6.9% (68.8 to 62.1) within the six-month time frame. Across all intervention groups, there were increases in the number of children in the non-anaemia category with the greatest change being in the control and SCm groups than the GSFP groups (3 vs. 6 vs. 2).

This may be partially due to non-food factors such as the extensive deworming and malaria screening/treatment exercise done across all treatment groups at the beginning of each term. Beasley et al (1999) study among Tanzania children reported single-dose anthelmintic treatment during term time results in haematological benefits in nearly half of children studied. Similarly in Zanzibar treating with albendazole saved children a quarter of litre of blood per child per year and improved cognitive function (Nokes et al. 1992; Nokes and Bundy, 1994).

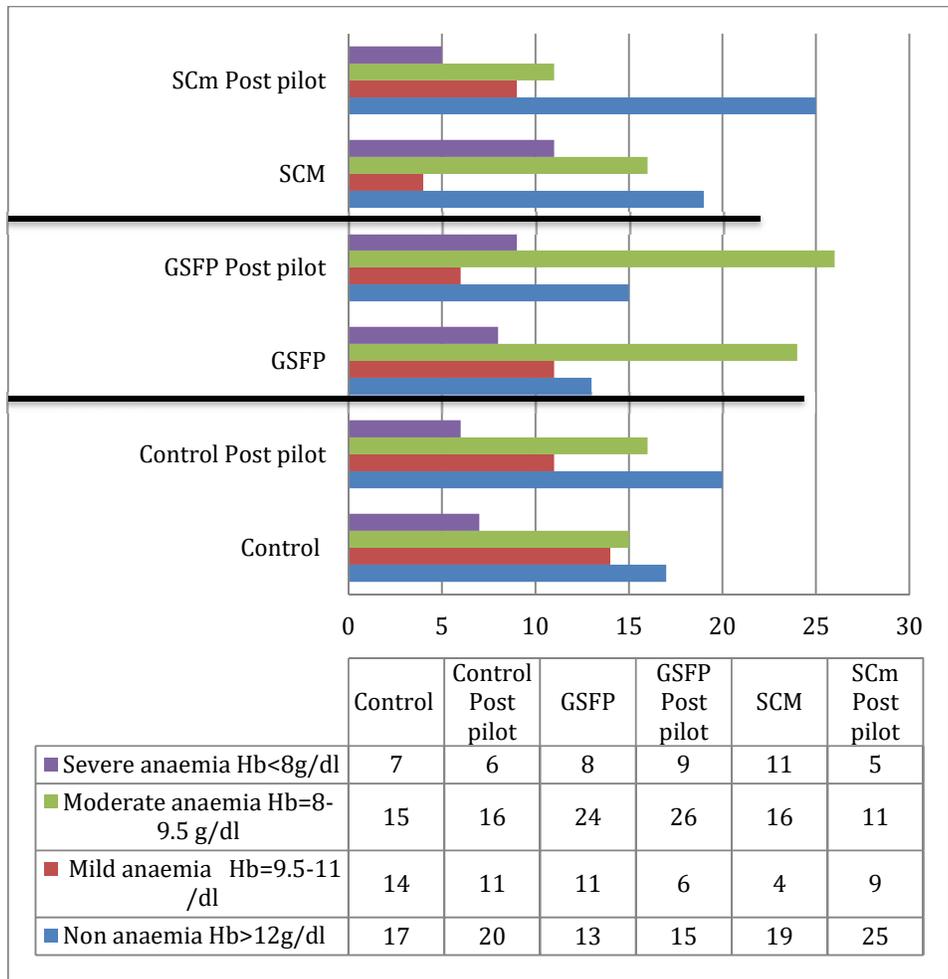


Figure 4.31 Anaemia distributions across study population groups during the pre-intervention and post pilot intervention phase,

In the GSFP group, impact was seen in the mild anaemia individuals where 2 individuals moved into the non-anaemic category. For the rest of the categories, a lot more individuals had deteriorating anaemia status with 3 individuals moving from mild to moderate anaemia and one moving from moderate to severe anaemia by end of pilot.

This trend in tandem with findings by Danquah et al., (2012), who also observed that even though the GSFP meals were high in energy and could alleviate short term hunger, it exerted little to no effect on iron status of children in participating schools. As children grow, there is greater demand on the body's protein stores for muscle and bone formation, growth as well as repair and if this is not readily available in the right proportions over an extended period of time, it can lead to worsening

anaemia status.

Intervention studies have consistently reported that increasing caloric intake alone without focusing on increasing food diversity and micronutrient adequacy usually results in worsen nutritional status of target group (Nair, Flower and Archana, 2016; Tontisirin, Nantel and Bhattacharjee, 2002; Gopalan et al., 1999). School meals should be able to provide both caloric needs as well as the micro and macronutrient combination required to promote growth and health. Low nutrient adequacy may have been the limiting factor of the GSFP meal.

SC<sub>m</sub> seems induced some positive effects on the anaemia status of the pupils in this treatment group. Figure 4.31 shows a change from the start to the end of the pilot, the number of severe anaemia reduced (11 to 5) and 7 individuals migrated into the moderate anaemia category. A similar migration was seen from the mild anaemia whilst resulted in an increase in the normal HB category (19 to 25)

It may be ambitious to say that the positive impact seen in the SC<sub>m</sub> treatment group is sole due to the meals alone, how the changes seem to be to as a result of a combination of reduced worm infestation due to timely deworming, adequate malaria screening and treated which in turn increase absorption of the nutrients from the nutrient dense SC<sub>m</sub> meals. The various recipes and processing method use in SC<sub>m</sub> increased bioavailability and absorption of nutrients. Studies by Amlogu et al, (2014), Zotor et al., (2008), Oduro et al., (2008) and Plahar et al., (1997) have shown indigenous food based food-on-food fortification recipes with similar ingredients as SC<sub>m</sub> enhanced biomarkers and promote healthy growth in target population.

With respect to the control treatment group, there were moderate positive gains as shown in Figure 4.31. This is also consistent with research by Fishman (2000) and WHO 2001. These studies suggest that increased intake vitamin C rich foods enhances the absorption of dietary iron by preventing of the formation of insoluble and un-absorbable iron compounds in the blood stream and facilitating the reduction of ferric to ferrous iron for the uptake of iron into the mucosal cells.

Overall for a population like LMKD where malnutrition is high among school children, it is crucial to ensure that SFPs improve or at least rehabilitate participants towards healthy outcomes. The impact of the GSFP meals in this pilot (although positive on WAZ and BAZ) has to be examined with a degree of caution. In that, although weight increment is a positive sign of growth, it quite risky if this change is not associated with positive increase in height.

It is especially crucial for populations like LMKD where malnutrition is already endemic and the risk of excess weight will further compound the health outcomes of children in this population. The pilot results the SCm meals were able to achieve and sustain relatively modest improvements across all anthropometric (both clinical significance and statistically significance). The results for the control group helped to elucidate the importance of parental participation in nutritional impact. Gains made in this group could be associated to the fact that parents were much more involved in the meals that children had through the day (Pearson coefficient  $r=0.52$ ). This could serve as crucial point in behaviour change communication aspect of any future GSFP meal policy.

### **Evaluation of the qualitative impact**

Through the project duration, SCm team weekly visited all study schools to evaluate and monitor cooking and feeding (process and outcomes): This process involved the constant interaction with pupils, teachers, and caterers as well as on various feeding activities.

Nutrition education was provided to all parent and teachers during the three PTA meeting over the 6months study period.

A qualitative service evaluation survey was administered to parents in the GSFP and SCm last PTA during the, where parents were asked to describe their views on the interventions being carried out in their children school (Data not shown here). In the control group, parents were contacted through the PTA and surveyed about their child intake of the 3 portions of fruit a week.

### **4.3.2 Scale up Intervention**

#### **Introduction**

The pilot study helped determine the efficacy of the three intervention treatments groups on modulating nutritional outcomes in a controlled number of people under ideal clinical circumstances. The efficacy of each treatment has been established to some degree in pilot study so the scale up was designed to measure the degree of any beneficial effect (or lack thereof) over an extended period across a wider population.

#### **Aims and Objectives**

The main aim of the scale-up intervention study was to assess the effectiveness of the SCm meals over an extended period across a wider population and to provide an evidence base for sustainability of the SCm in the target population. The following objectives were set for this phase

- To evaluate the effectiveness of SCm by comparing its impact on Z scores and HB measurements for 9 months
- To investigate and compare effect (or lack therefore) of the all three inventions on height and weight of for the 15-month follow up cohort.

#### **Summary of method**

Based on the sample size calculation provided in previous chapters, inclusion and exclusion started in chapter two, 330 school pupils were recruited consisting of 150 pupils (15 month-cohort) recruited at start of pilot plus an new cohort 180 recruited from the various school in the second week of the September 2015/2016 academic year. Demographic, anthropometric and HB data were taken at start of term as described in the earlier chapter. Participants were followed up every 3 months for anthropometric and HB measurements for 3 academic terms (9months) thereby providing a 15-month follow up data for the original 150 cohort.

#### 4.3.2.1 Socio-Demographic Characteristics

Table 4.28 Characteristics of study population

<b>Characteristics</b>	<b>Total</b>	<b>Boys</b>	<b>Girls</b>
<b>Number</b>	330	161	169
<b>Age</b>		6.75	7
<b>Exclusively Breastfed (Month)</b>		5.5	4.8
<b>Pocket Money For Food At School</b>		1ghc	0.8ghc

Table 4.28 summarises the characteristics of the recruited pupils measured at start of scale up. Out of the 330 pupils recruited, 161 (48.78%) of them were boys and the remaining 169 (51.21 %) were girls. The average age of the school children was  $6.45 \pm 1.75$  year with those in the girls being slight older at an average age of  $6.65 \pm 1.50$  years old whilst those in boys age an average of  $6.75 \pm 1.25$  years. In the treatment groups, the age distribution was an average of in the GSFP group was  $6.80 \pm 0.50$  years; SCm group and Control group were much younger at  $6.40 \pm 1.20$  years and  $6.60 \pm 0.70$  years respectively.

Exclusive breast feeding practices in the entire population was less than the WHO recommended 6 months, the population reported an average of 5 months with boys being breast feed an average of  $5.5 \pm 1.2$  months and girl an average of  $4.8 \pm 1$  months. This provides a vague picture of possibility of high incidence of childhood malnutrition due to poor infant and young feeding practices. Length of exclusive breast-feeding has been linked with continuous episodes of malnutrition and low resilience against disease throughout children and even into adulthood (Prentice 2006, Barker 2007).

At baseline 88.18% (291) of parents/guardians were aged less than 40years with the majority 84.4% (152) falling between the 21 to 30 years age range as shown in Figure 4.32. The majority of parents and guardians were female (older sisters, mothers and grandmothers) with ages varying from as low as 16 to 73 years and the remaining parents men between 21 to 40 years.

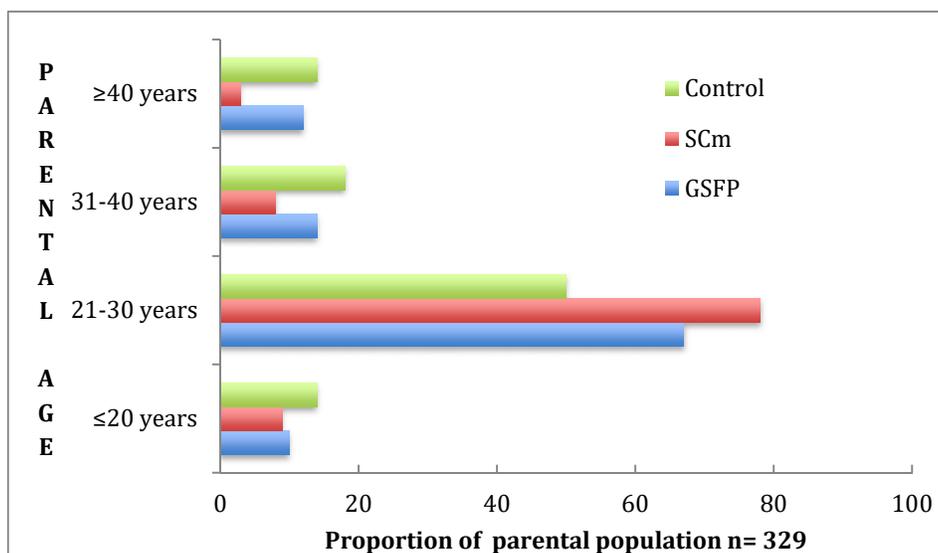


Figure 4.32 Bar chart showing the distribution of parent age across the age classes

Most parents/guardians were married (73.63%) with a few being single or unmarried (4.84%). The remaining had been married before and/or were widowed or divorced (11.52%) as shown in Figure 4.33.

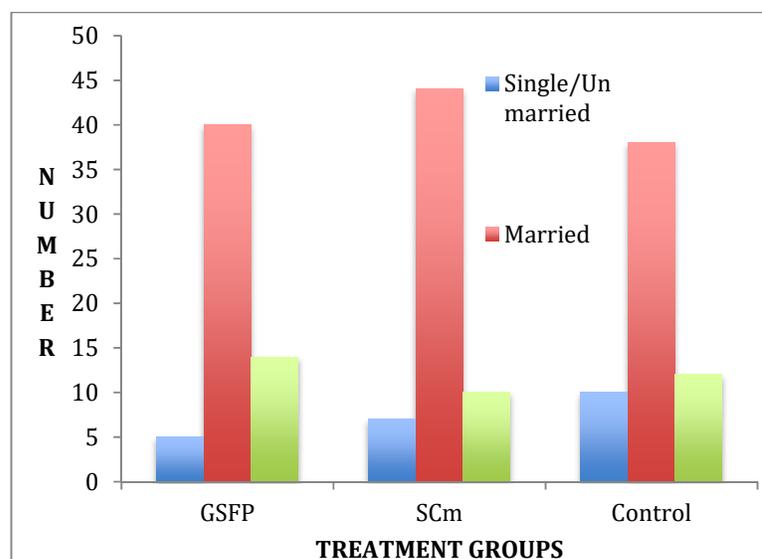


Figure 4.33 Bar chart showing the distribution of marital status across the age classes

Nearly all (87.88%) of the parents or guardians interviewed were the sole/primary caregivers of their child. The remaining 12.12% (40) were nominated carers, relatives' mainly older siblings and grandparents. Most

parents (88.99%) reported that they had had at least primary school education this comprised of 209 (63.33%) who had basic primary education, 42(12.73%) parents/guardians had who had secondary school level education (JSS/SSS), 39 (11.82%) who had had some form of tertiary level education. The remaining 40 (12.12%) had no formal education as shown Figure 4.34. The group with the least level of education were mainly older parents and grandparents similar to the trends observed in the pilot study.

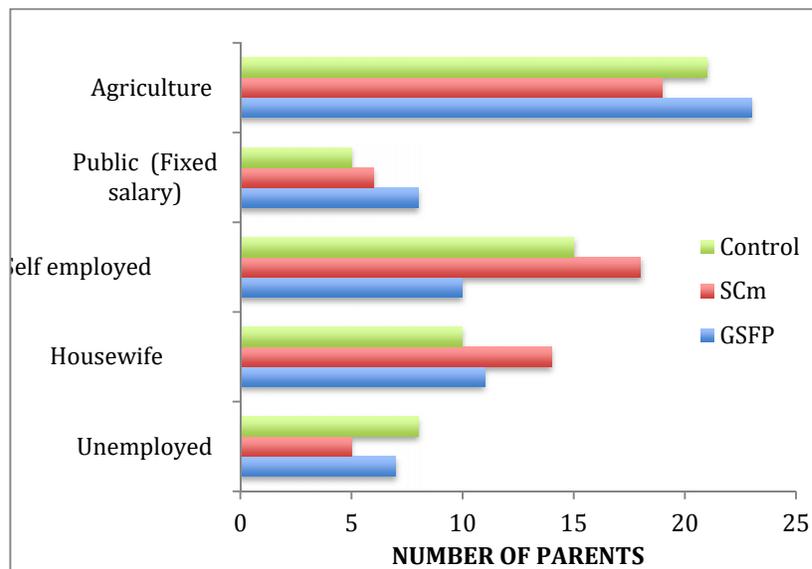


Figure 4.34 Bar chart showing the distribution of parent across employment groups classes n=329

Majority of parents 128 (38.78%) worked in the agricultural sector either as farmers, farmers' labourers, and hunters or in the fishery and animal husbandry sector. Others reported that they were self-employed (25.76%) partaking in petty trading, or artisan activities such as dressmaking, hair dressing, and bead making professions. There were a number of civil servants or people employed in public/government sector 77(23.33%) present in the parent population whilst the remaining were either housewife 85(25.76%) or unemployed 40 (12.12%).

#### 4.3.2.12 Anthropometric and HB Measurements

Anthropometric data and HB measurements were taken from the start of the academic year in September 2015 to the end of year July 2016. Participants were screened for malaria and dewormed as per the protocol discussed in earlier chapters at the beginning of term and after six months.

#### WAZ

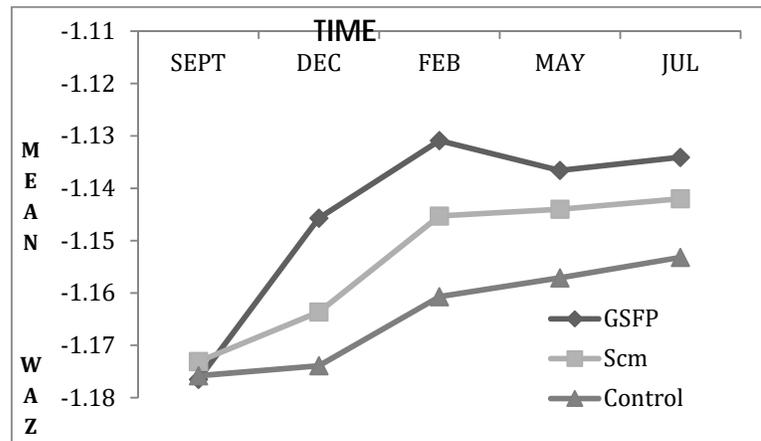


Figure 4.35 Line graph of mean WAZ across treatment groups over 15 months  $n =$

Figure 4.35 charts the progress of the WAZ measurements across the treatment over a period of nine months. Similar to the pilot study, there were improvements in mean weight for age across all three-study groups considering that at baseline, the age and gender adjusted mean showed no statistically significance  $p > 0.05$  between means GSFP, control and SCm.

The WAZ scores in the 9 months intervention, was similar to of the pilot across the three treatment groups. For the control and the SCm groups, the progression WAZ starts steadily from start point to month three whereas the progression in GSFP (-1.17 to 1.14) was much steeper than from baseline to month three likely to a hike in energy intake amongst the pupils in this group.

Measurements for all three groups increased exponentially in by the February as shown in Figure 4.35. This is likely to be as a result of the

increase calorie intake and/or decreased in energy expenditure associated with the Christmas and New Year's festivities. Roberts and Mayer (2000) suggested that holiday weight gain could be an important contributing factor to the increase in annual weight gain, with the weight gained during the Christmas period making up about over half the weight gained over the entire year. Yanovski et al., (2010:2015) studies suggest that, an average of 0.37kg to 0.48 kg weight is attributable to increased intake during Christmas holidays.

For the subsequent months, both the Control and SCm groups experience steady increases in WAZ whilst the GSFP group mean WAZ tends to dip in May then stabilise by July. This trend seem to indicate that post-Christmas the might have been an increase in caloric demand for which subsequent GSFP meals were unable to maintain hence the dip in WAZ. The subsequent stabilisation observed through April to July are likely indications of increased coping mechanism such as increased dietary intake likely to be snacking or to a less extent increase in physical activity levels.

As at post intervention measurements, the GSFP treatment group had the most significant increase in WAZ ( $p=0.048$ .) This contradicts the results of other GSFP related exploratory studies by Abgozo et al., (2016); Danquah et al., (2012); Martens (2007) who reported lack of impact of the GSFP meal on anthropometric measurement of participating school. These studies provided a snapshot of the impact as they were limiting in length of observation and did not follow up as long as the current study hence the lack impact conclusions. Abizari et al., (2014) attested that although not observed in their study, owing to their high carbohydrate content there was a possibility that GSFP meals could have an impact on weight of participants especially in stunting prevalent populations.

However based on the lack of difference in home intake in the present study, the portion size of the GSFP (including plate wastage) and apparent significant gain in WAZ in GSFP, it is possible to conclude that the gains in GSFP can not only be attributed to the meals and perhaps other factors

such as excessive snacking or reduction in physical activity levels may have compounded weight gain over age.

HAZ

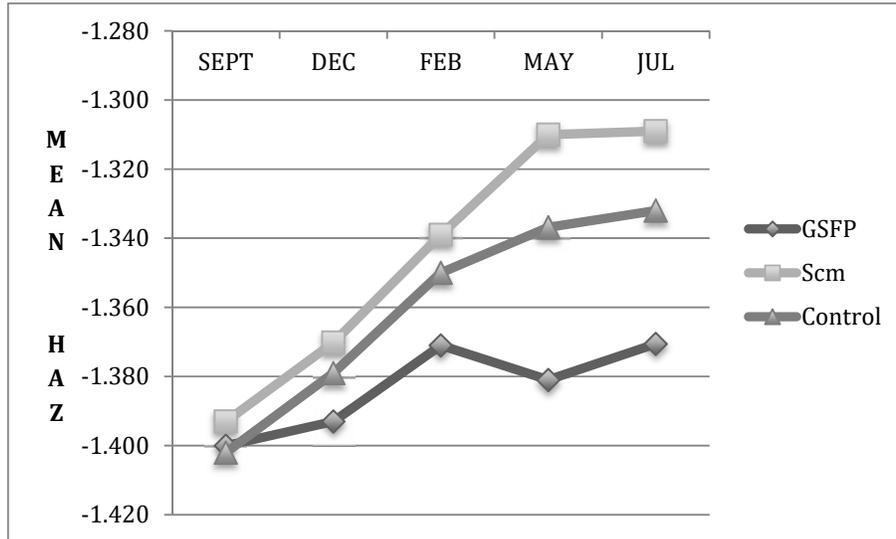


Figure 4.36 Line graph of mean HAZ across treatment groups over 9 months

Considering the HAZ gives insight into the long-term nutritional history of an individual, the population HAZ at baselines indicate an existence of nutrition deficit. The average stunting rate cross group  $42\% \pm 3.6$  which is more than the GDHS 2008 and 2014 estimates of 38% for the Eastern region and national rate on 28% for under-fives. This is an indication that either the current infant and young children measures in the district are not reaching everyone or they are not adequately treating stunting. This further consolidates the need to strength the nutritional component of the GSFP programme.

At start of intervention the GSFP had an average HAZ of  $1.42 \pm 0.61$  their counterparts in the other treatment groups (Scm  $1.39 \pm 0.95$ ), which is in line GDHS 2008 national estimate mean  $-1.03 \pm 1.57$ . The HAZ means across groups were different from those reported by Gelli et al., (2016) who found HAZ to be  $0.963 \pm 1.29$  among 5–15 year old Ghanaian school children. The variation may be due differences in target population’s age or demographic.

There was positive progression in HAZ scores from start point to midpoint across all groups with the exception of GSFP where HAZ falters after the six months mark. The faltering seen in Figure 4.36 is defined by slower-than-expected increase in growth linear growth line from the February measurement through to July.

The minimal increments in HAZ for the GSFP confirm the observation made in the pilot and highlight the nutrient inadequacy of GSFP to support linear growth and that the GSFP participants were still experiencing nutritional deficiencies. Any changes in heights over the 9-month period were not significant considering the change in age. Considering the low protein and micronutrient (less than the 30%DRV recommended by WFP), it is possible that low protein content may have served as limiting factor in linear growth (HAZ faltering) in the GSFP group.

The exact aetiology of the HAZ faltering may be multi-factorial, adequate protein and micronutrient intake has been shown to aid linear growth even in malnourish populations. A 2010 Stephenson study with Nigerian and Kenyan children found increases in Height-for age z score was directly associated with protein intake of the malnourished children.

For both the SCm and Control group, mean HAZ scores were stable even after the six-month mark where half of the population change their age. The dietary patterns and intake of these groups seems to provide some sort resilience against stunting. For the control growth, their increase consumption of fruits during the school week is likely to help in the modest increase in HAZ scores. The increase availability of Vitamin C in blood stream is likely to lead to either increased biosynthesis of connective tissue or increased anti-oxidant activity which in turn promotes growth and reduce energy expenditure on fighting disease (Villacorta, Azzi and Zing 2007; May and Harrison, 2013)

Increased micronutrient intake and protein intake (from the SCm meals) may have resulted in the HAZ gains made in the SCm group ( $r=0.5734$ ,  $p=0.029$ ). The array of nutrients in the SCm meals namely protein (40%DRV), Iron, Phosphorus, Calcium, vitamin C and Zinc are all potentially involved linear growth promotion. The synergic effect of the

combination of these nutrients in the SCm meal together with the deworming and malaria treatment contributed in the significant improvements in HAZ. Studies by Stephenson et al., (2010); Merialdi et al., (2004); Kabir et al., (1998) reported that high protein diet together with worm treatment help to improve the HAZ outcomes of malnourished children.

## BAZ

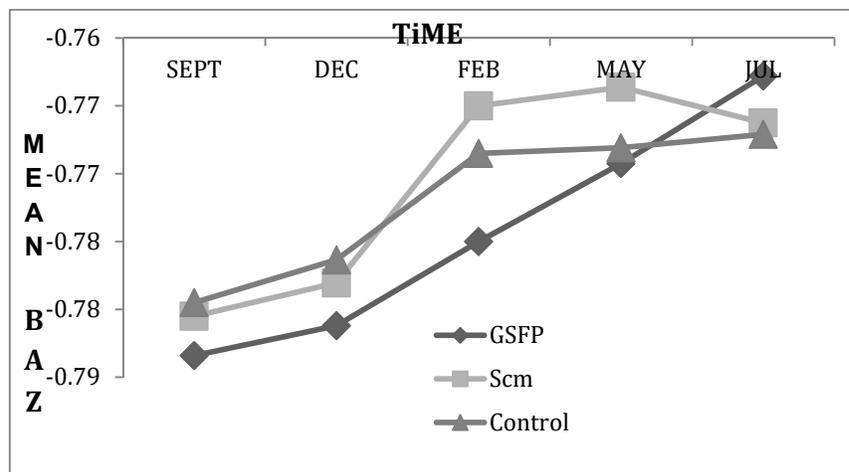


Figure 4.37 Line graph of mean WAZ across treatment groups over 9 months

Figure 4.37 shows the changes in the BMI for age of pupils in the different treatment groups. Similar to the results of the field observation and the pilot study, the GSFP pupils continue to experience relatively higher increments in the BMI for age. The other treatment groups experience an initial increase and a plateauing after the six months mark, which corresponds to the changes in the weight and height with respect to age. Mean progress in BMI-for-age across within the entire population was not significant with the expectation of GSFP (Table 4.30 and 4.31)

An examination of the Table 4.30 chart means and standard deviations for age adjusted WAZ, HAZ, BAZ for all the intervention groups according. In general girls presented a better nutritional status baseline on all three anthropometric indicators.

Tables 4.30 Gender difference in WAZ, BAZ, HAZ across treatment groups at baseline and post intervention

BOYS						
INDICATOR	BASELINE			POST INTERVENTION		
	GSFP	SCM	CONTRO L	GSFP	SCM	CONTROL
	n( 50)	n( 45)	n (46)	n (50)	n (45)	n (46)
<b>WAZ</b>	-1.31± 1.17 <sup>a</sup>	-1.18 ±1.02	-1.16 ±1.158	-1.20- ±1 <sup>a</sup>	-1.16 ±-1.15	-1.15 ±1.003
<b>HAZ</b>	-1.60 ±1.165	-1.48 ±1.24 <sup>b</sup>	-1.40 ±1.028	-1.73 ±1.034	-1.20 ±0.93 <sup>b</sup>	-1.26 ±1.01
<b>BAZ</b>	-0.67 ±0.305	-0.78 ±0.459	-0.77 ±0.548	-0.58 ±0.235	-0.77 ±0.32	-0.75 ±0.387
GIRLS						
INDICATOR	BASELINE			POST INTERVENTION		
	GSFP	SCM	CONTR OL	GSFP	SCM	CONTR OL
	n (53)	n (43)	n (40)	n (53)	n 43)	n (40)
<b>WAZ</b>	-1.21 ±1.06	-1.16 ±1.3	-1.19 ±0.99	-1.15 ±1.281	-1.11 ±1.09	-1.02 ±0.95
<b>HAZ</b>	-1.30 ±1.25	-1.42 ±1.22 <sup>b</sup>	-1.41 ±0.97	-1.23 ±0.87	-1.17 ±0.59 <sup>b</sup>	-1.35 ±0.68
<b>BAZ</b>	-0.89 ±0.82 <sup>8</sup>	-0.74±- 0.321	-0.73 ±0.76	-0.70 ±0.512 <sup>c</sup>	-0.69 ±0.599	-0.71 ±0.323

Post intervention in GSFP treatment group results for boys show significant changes WAZ in boys than girls like due to the fact that caterers in offered males bigger portion sizes than females during food service. The translated into clinical increases in BAZ levels too.

In the SCm treatment groups boys showed clinical improvement in all indicators with improvements in HAZ being significant at  $p=0.043$ . A similar trend was seeing with the girls. Mean scores for girls at end of intervention  $-1.17\pm0.59$  at  $p=0.007$ .

Improving the macro-micronutrient intake of girls does not only promote increased muscle mass, and improve immunity; it empowers them to grow into health adolescents and further health mothers. This help to give girls a head start in life as healthier girls are likely to achieve more in school, health mothers are likely to have healthier babies and break the vicious cycle of malnutrition (Adelman, Gilligan and Lehrer, 2008)

The main trend of major concern in this study is the high increasing occurrence of both weight gain without concurrent decreasing stunting in the GSFP participating children. This study revealed pupils mainly boys were gaining weight without concurrently gain in height. For this set of data snacking is evident within the GSFP treatment could play a major role WAZ and BAZ especially if the participants physical activity is less that the recommend.

#### 4.3.2.1.3 Biochemical indicator (Hb) for Anaemia

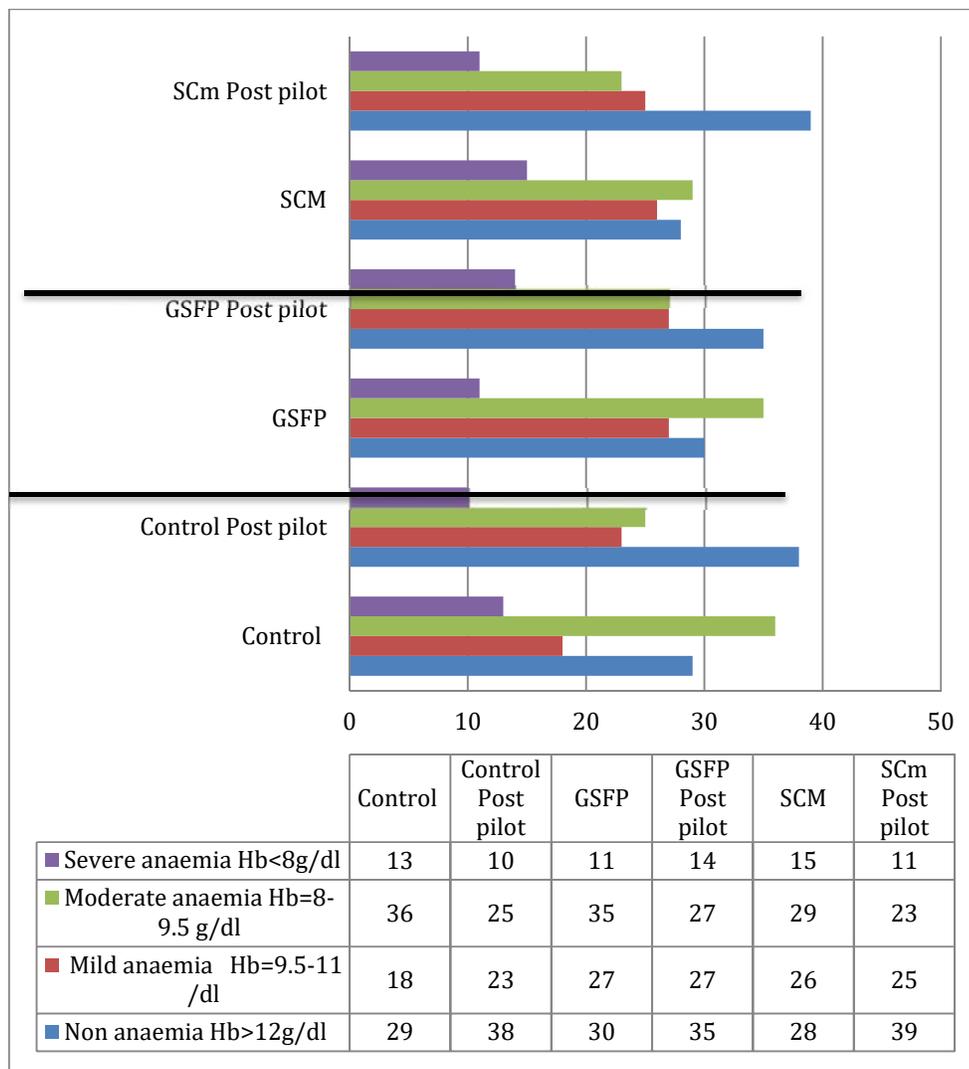


Figure 4.38 Line graph of anaemia distribution across treatment groups pre-intervention and post n=180.

Figure 4.38 charts the average HB for the three treatment groups and shows that at baseline 70.7% of the entire population had some form of anaemia. The anaemia prevalence were 67.7 % ( 95%CI 50.64 to 70.2) for the control, 70.9%(95%CI 56.85 to 75.15) and 71.4%(95%CI 50.51% to 69.89%) for the GSFP and SC<sub>m</sub> groups respectively at  $p=0.957$  ( $F=0.043, F_{crit}=4.25$ ).

The GDHS (2014) report estimates overall prevalence of anaemia as 66% among children under age 5, indicating a moderate reduction (12%) in the prevalence of from 2008. Ewusie et al (2014) also reports overall prevalence of anaemia in under-five children in Ghana was 78.4% (N = 2168, 95% CI: 76.7-80.2) whilst studies like Egbi (2012) reported a prevalence is 76% among 2 to 10 years old and Abizari (2012) 63% of school children aged 5-12 years suffer from anaemia. The results of the current study, together with the results of other studies by Amugsi, Mittelmark and Lartey (2013). Abizari et al., (2014), Agbozo et al., (2016) all reported district values that deviate from published national anaemia prevalence. This deviation (controlling for socio-economic and demographic variation) is an indication worsening levels of anaemia among school age children. The Amugsi, Mittelmark and Lartey (2013) report reiterates the importance of disaggregated analyses of national child malnutrition data in order obtain a true picture of anaemia levels in communities

Considering, the high coverage of intensive USAID anaemia-related programming campaigns on iron-folic acid supplementation (94% coverage) together with the Ghana Health Service's rigorous malaria preventive campaigns and deworming coverage for both children and pregnant increased (less than universally recommended coverage), the current level of anaemia as reported in this current study and previous related studies (Adgozo et al., 2016; Aulo et al., 2016; Abizari et al., 2014; Danquah et al., 2012) still remain high. This questions the sustainability of these interventions and highlights the need to buttress these campaigns with indigenous food-based solutions.

The control and SC<sub>m</sub> had more severely anaemic individuals than

the GSFP (15 and 11 vs. 13). GSFP whilst the GSFP had more moderately anaemia (35 vs. 31 vs.29) compared to SCm and control treatment groups. This gives an indication that the most vulnerable pupils in the population tend to attend schools with the Ghana school feeding programme. It is therefore imperative for additional effort to be directed towards improving the nutrient content/adequacy of meals to ensure that these vulnerable groups (for whom the need is greatest) do not continue to stay in the vicious cycle of malnutrition.

The data at end of intervention shows 8.4% (70.7 to 62.3) decrease in anaemia levels within the entire population at  $p=0.0071$  ( $F=0.288 \geq F_{crit} 0.256$ ). Considering that all pupils were treated for malaria and worms throughout the study, GSFP had the least reduction (4.9% vs. Control 7.29% vs. SCm 11.2%), which is indicative of the nutritional inadequacies of the GSFP meal service. The lack of significant nutritional impact of the GSFP and SFPs in general on anaemia status has been observed elsewhere by Murphy (2003), Ahmed (2004); Afridi (2005); Danguah (2012); Owusu et al., (2016). These studies conclude that SFPs are more effective than increasing caloric intake and have less significant effect on the nutritional status of participating children.

The anaemia prevalence in SCm at end of scale up was 60.4%  $\pm 8.14$  (95%CI 50.5 to 69.9) and the control had prevalence 60.2% $\pm 7.57$  (95%CI 58.64 to 70.2) whilst that of GSFP group was 66.0 $\pm 7.51$ g/dl (95%CI 60.9 to 75.2). The average HB for the SCm group 10.4 $\pm 1.93$ g/dl (95%CI 9.6 to 12.3) changed to 12.7 $\pm 0.97$  (95%CI 10.8 to 13.4), control group mean HB increased from 11.70 $\pm 1.45$ g/dl (95%CI 8.3 to 14.8) to 13.6  $\pm 0.99$ g/dl (95% CI 9 to 14.1).

The decrease in control group was as expected considering that the pupils in this had relatively higher intake of high biological value protein intake (chicken and eggs) and vitamin C (three additional portions of fruit a week). The relatively higher protein ( $\geq 20\%$ ) intake and increased levels of the Vitamin C intake in both the SCm and Control lunches may have likely reduced susceptibility infection and induce modest increased in HB. Whereas GSFP baseline average HB 11.0 $\pm 1.41$  (95%CI 9.6 to 13.1)

changed to  $10.50 \pm 0.89$  (95%CI 8.9 to 12).

The public health implication of these set results, in the context of other available data, (Abizari 2014, Owusu et al., 2016: Danquah 2012) is that for the most vulnerable school children populations the nutrient content of GSFP meals is grossly insufficient in effecting positive changes in nutritional status. To enhance GSFP meals, adequate nutrition inputs (nutrition focused agriculture, meal planning, portion control) buttressed with complementary health inputs such as vaccination, deworming and malaria campaigns should be put on the centre stage of the policy budgeting and programme implementation criteria.

### ***Compliance and lost to follow up***

Participants' compliance was over 95% completing the 15 months intervention. This might be explained by added incentive of daily feeding in the intervention school, the willingness and commitment of parents to undertake proactive action that could potentially improve the health of their children. . In the large-scale study, only 5 participants were lost to the inclusion/exclusion criteria, a further 27 were lost due to lost to follow up. Of those lost to follow up, 13 did not attend school regularly hence missed some follow up measurements, 6 withdrew from the study for personally reason and the remaining dropped out of school for other reasons unrelated to this study. Hence the total attrition rate was 10%.

#### **4.3.3.3 Cumulative effect of treatment meals on 15-month cohort**

In investigating the long-term impact of the study treatments, the original pilot intervention (n=150) recruits were followed up through the nine months in scale-up intervention. The results for this cohort (n=150) have been illustrated in Figure 4.38 a-b and Figure 4.39 a-b further confirmed the observations made in the results obtained from the pilot and scale-up interventions. The major indicators assessed in the 15-month follow-up were height and weight progression.

Figure 4.38a-b and 4.39a-b show progression of the anthropometric measurements for 15 months. On average the population was  $2.28 \pm 0.57$ kg, which was less than the average 3.78kg weight increment recommended for the average 7 year old. All three groups had found some beneficial effects on weight with initial weight gain velocity was higher in the GSFP group than the other treatment groups. The biggest weight gain was among the GSFP (*2.78kg boys vs. 2.58kg girls*), followed by the SCm group (*2.63kg boys vs. 2.31kg girls*) and the control group had the least weight increment (*1.7g boys vs. 1.5kg girls*) as shown in Figure 4.39 a-b.

The inverse was observed in the height measurements with girls having high mean heights gains than boys (*2.9cm girls vs. 2.4cm boys*). The SCm and control group's meals were found to have higher beneficial effect on height with mean increments of  $3.9 \pm 0.24$ cm ( $p=0.031$ ) and  $2.4 \pm 0.57$ cm ( $p=0.006$ ) respectively. Whilst pupils fed with the GSFP meals had a mean increase in height of  $1.6 \pm 0.41$ cm ( $p=0.059$ ) over the 15-month period.

Considering that the fact that growth changes were much more pronounced in girls towards the end of the 15-month study (the average child turns 8), there is a likelihood that some of the girls in the current population may be going through the initial stages of pre-pubescence growth spurt. Recent data (O'Hare, 2017; NHS, 2016; Biro, 2007; Nakamoto, 2000) suggest that although the average although 12.8 years remains the average menarche age for most populations, there is evidence of a lower age limit (8 years) for the onset of pubertal growth. In more recent years especially in countries experiencing nutrition transition, more girls are starting to experience growth spurts associated with puberty at points before and between the ages of 8 and 13 years earlier than boys who start between 9 and 14 years.

The current study's result is similar to result in Ash et al., (1999) in Tanzania and subsequent studies by Sarma et al., (2006). These studies reported school aged children improved their height and weight with increase in nutrient density and adequacy of meals. The Ash et al (1999);

a longitudinal study that intervene with a fortified milk porridge that provided extra calcium together with other micronutrients similar to the SCm, reported significantly higher mean increments in weight (1.79 vs. 1.24 kg), height (3.2cm vs. 2.6 cm) and BMI (0.88 vs. 0.53) were greater than in the control group. Whilst other studies by Manger (2008); Solon (2003); van Stuijvenberg et al., (1999) have reported the opposite. These studies did not find any effects of intervention meals on anthropometric measurements (height or weight). The Solon (2003) and van Stuijvenberg et al., (1999) studies intervened with fortified biscuits and micronutrient powders, which are subject nutrient delivery, bioavailability and assimilation issues especially if deworming was not treated.

In the current study, the impact outcomes seem to be amplified in the SCm group relative to the control and GSFP groups, an considerable part of this impact has to do with the high compliance levels in SCm during the 15-month period. The SCm team's constant interaction with class teachers, pupils and parents ensured that at all time school levels were involved in the day-to-day food service. Compliance is a key component in successful implementation of the delivery of micronutrients among children, SCm team worked diligently with teachers and caterers to ensure meals were served daily throughout the intervention period. Compliance in the control and GSFP may have differed.

This lead to the creation of a pseudo-school nutrition environment where parents, pupils, teachers and the team discuss nutrition and health related matters they any be facing in school and at home. This created a sense of ownership and self-reliance among the indigenes and helped to ensure a high level of compliance

In general the SCm intervention meals do not seem to drastically reverse any deleterious effects of the malnutrition in earlier life, however SCm meals seems to provide some form of leverage and resilience against further deterioration when combine with deworming, malaria treatment and buttressed with behaviour change communication.

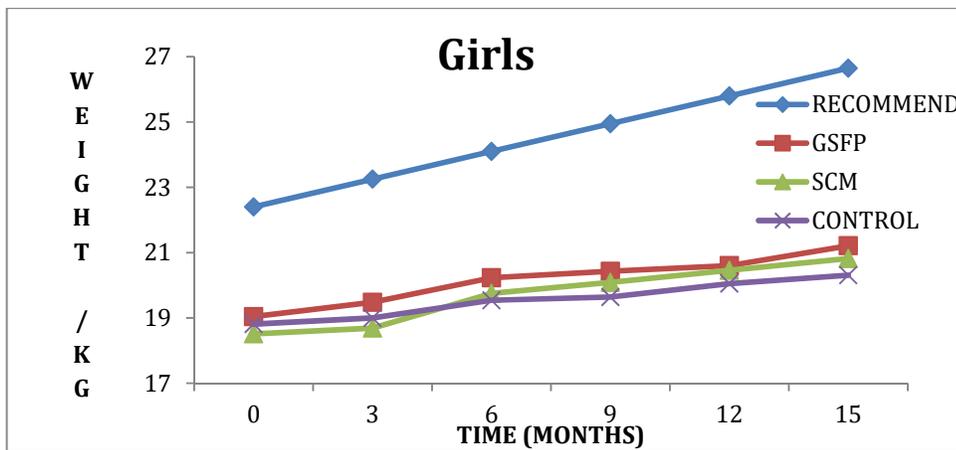
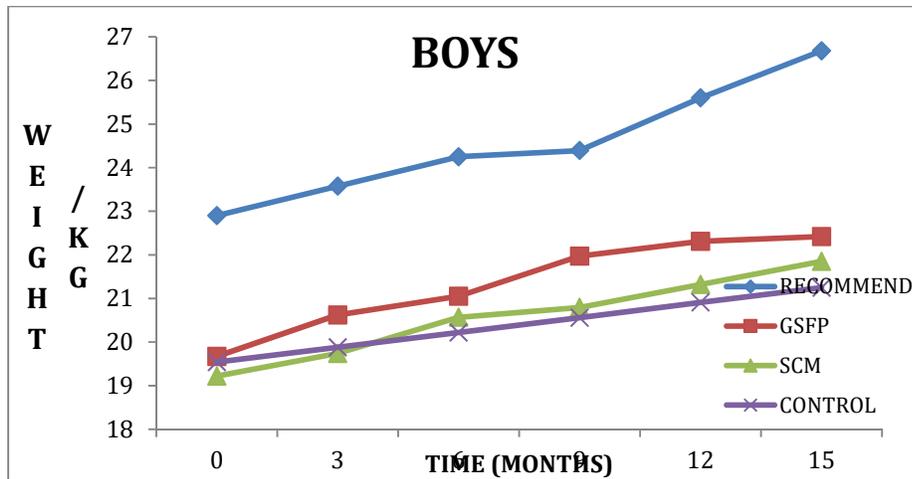


Figure 4.39a-b clockwise Line graph of mean weight for boys and girls across treatment groups over 15months

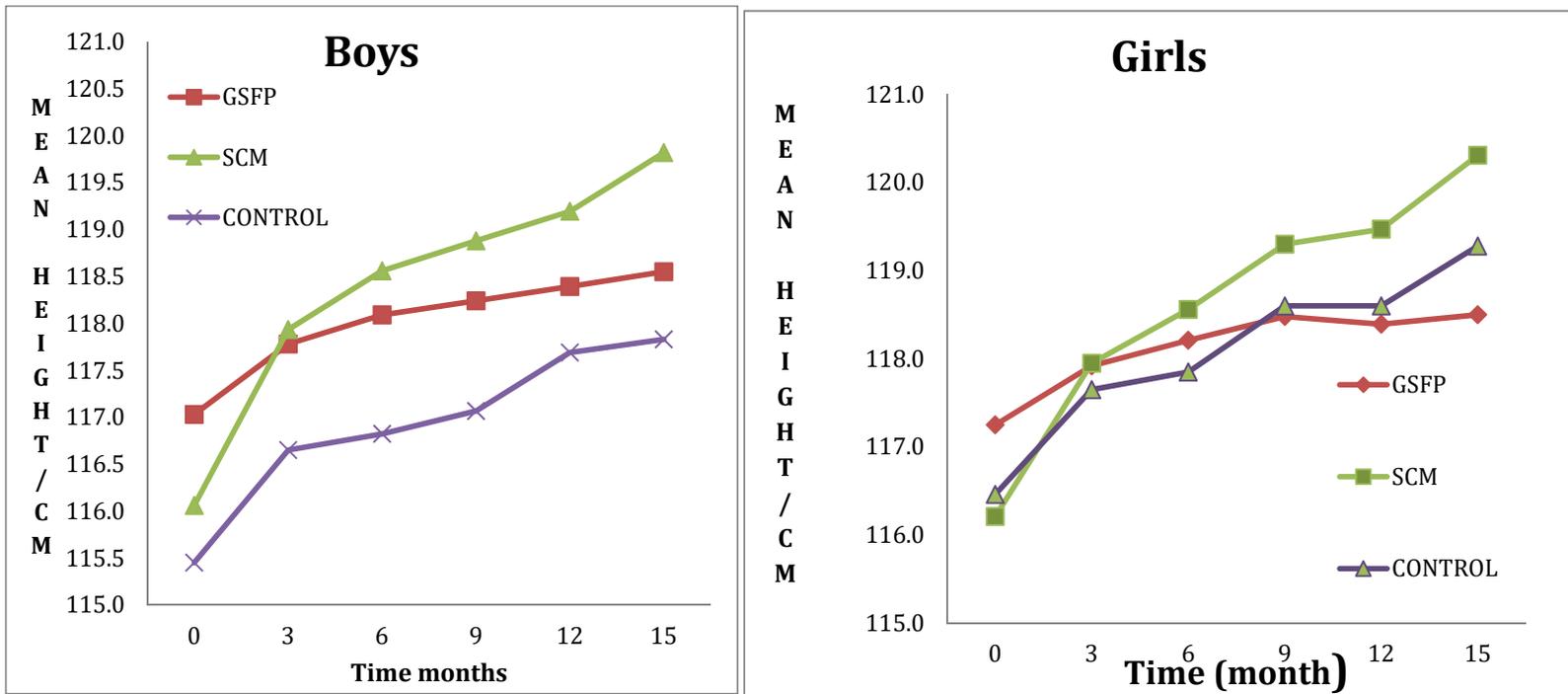


Figure 4.40 a-b clockwise line graph of mean height for boys and girls across treatment groups over 15 months

## **CHAPTER FIVE: SUMMARY OF AUTHOR'S CRITIQUE**

### **Introduction**

The following section elaborates the appropriateness of study design and methods on study outcomes in retrospect. It also discusses important themes that emerged from the study in comparison to other published interventions. There is also a discussion on activities to ensure the sustainability SCm meal intervention outcomes and the possibility of further work in the district.

### **5.1 Author's critical views of the findings in SCm intervention, its relevance in comparison to other published intervention.**

A current Google search of the Ghana School Feeding Program will yield about 295,000 results (in 0.53 seconds) with the majority of articles being reviews and cross sectional studies on the its plan of action, effects on enrolment, school retention, educational outcomes (Abotsi, 2013) and a few studies on it nutrition components and its bearing on the health of school aged children (Danquah et al., 2012; Abizari et al 2014; Owusu et al., 2016 and Agbozo et al., 2017).

Of the nutrition related ones, the large body of work, including surveys and cross sectional studies that look at nutritional activities and their impact in a snapshot with very few being randomised control that follow up over an extended period of time. The common line across these studies (even the non-nutrition based reviews) is the need to promote the consumption of local/indigenous meals and the need to link the GSFP to local agriculture (Danquah et al., 2012; Abizari et al 2014; Owusu et al., 2016 and Agbozo et al., 2017).

Aside the current study, the limited published studies that actually looks at the possibility of applying local agricultural knowledge, ethnobotany, traditional processing methods /recipes to develop relevant food solution for the GSFP. Most intervention studies have looked at the use of micronutrient powders (Aulo et al., 2016), fortified foods (Abizari, 2014).

The cross sectional study and the field observation result showed that the GSFP in the LMKD is highly dependent on retail food stuff, very low trained food service personnel and have very little nutritional education compound. This was in agreement with several other studies (Atta and Manu 2015; Oduro-Ofori and Adwoa-Yeboah, 2014; Sulemana et al., 2013; Danuquah et al., 2012; Martens, 2007)

Taking to account the fact that there currently no active education campaigns in GSFP schools, this result added to the evidence on the need to bridge the gaps in the nutritional knowledge base at the school level. Observations on GSFP specific nutrient intake from the field study phase align with Abizari et al., (2014) study' observation on the high-energy content of meals and Owusu et al., (2016) and Danquah et al., (2012) observations on the low micronutrient content and the heavy dependence on white rice.

Findings from product development phase add to knowledge on the utilisation of indigenous (low-tech) food process/preparation techniques to enhance nutrient profile (FAO, 2010; Dube, 2002), reduce cost of production (FAO, 2010) as well as ensuring cultural acceptance (Ozor and Urama, 2013). The SC<sub>m</sub> recognises that science and indigenous food knowledge and techniques are not mutually exclusive hence the study prioritised the integration of both in the formulation and optimization of SC<sub>m</sub> meals.

The formulating results were similar to the Food Multi Mix (Zotor et al., 2008; Amuna et al., 2004) and Antewa Intervention meal (Amlogu et al., 2012). All these studies, including this current study draw from the synergistic power of combining various food items based on their nutritional strength. This shifts the emphasis from single nutrient fortificants and highlights of the use of a combination of different locally available to produce an array of nutrients that may not have been available if not for the synergistic interactions between food products.

The result from the sensory evaluation gives insight into the fact that ultimately food acceptability for both children and adults are not intrinsically based on somatosensory appeal only but are very much linked

to their experience with those foods. Aftertaste played a crucial role in the acceptability of the SCm, given an indication that intervention that uses foods/recipes that local indigenous the test population are likely to be more acceptable.

Prior children-centred sensory studies have focused visual and flavour accepts of novel foods alone in the hopes that children base their likes and dislikes based on colour and usually ignore the aftertaste (McMackin et al 2012; Bakke and Vickers 2011; Fenko 2009). The result of this study adds to the growing awareness that most individuals associate their perception food taste and flavours with the social contexts and their like or dislike is usually based on flavour perception as well as physiological consequences of previous consumption (more of the latter than the former). This finding is in tandem with other studies (Craigs 2013; James et al., 2009; Small and Prescott, 2005) and is crucial in nutritional intervention planning especially for interventions that seek to develop novel foods for indigenous populations.

Recent recommendations by WFP and FAO other key nutritional intervention stakeholders tend to favour local/indigenous food solutions in malnutrition related disease modulation and prevention. The result of the current study adds to the wealth of evidence provided by dozens of other authors (International Food Policy Research Institute, 2016; Bukari and Hajara, 2015; Sulemana et al., 2013; Lassi et al 2010, Martens, 2007;) on the critical role indigenous foods and food systems play in ensuring a sustainable nutritional impact of interventions.

In a whole, the result of the SCm meal study does not only draw strength from the synergistic interactions between the carefully selected indigenous food crops to provide nutrient densities and profiles that are identical to those recommended by the WHO. However, it is important to understand that the evidence provided in the intervention phase does not only draw from the strength of the meals alone. The evidence provided in the previous section clearly shows the essence of backing food intervention with composite deworming and creating an interactive school nutrition

environment similar to studies by Attah and Manu, 2015 Sulemana et al., 2013; Hauware, 2008; Morgan and Sonnino, 2008).

## **5.2 Author's Critical views on the study design in reference to the outcomes**

The collection of qualitative data from the cross sectional surveys with teachers head teachers and caters has not only enriched the knowledge base of the study, but provided the team the opportunity to have a hands-on experience of the intricacies of the everyday activities of the GSFP at the school level. Interaction with key stakeholders helped the team to obtain an insider's view of the GSFP activities and provide a comprehensive basis for nutritional needs assessment (resource and knowledge needs) of LMKD GSFP.

The qualitative information obtained from the different interviews provided insight on how the presence or lack thereof of key nutrition related elements affected the impact of the GSFP in the district. Vital knowledge that the team would probably have never been able to preview due to lack of plausible published data. Greene, 2007; Caracelli and Greene 1997 have all advocated for the collection of qualitative data in addition to quantitative data as this helps to ensure the validation of observations through cross verification.

The subsequent collection of quantitative data in the field observation helped to provide physical evidence for some of the accessions made by the key informants/stakeholders in the cross-sectional survey. The knowledge generated from the field observation served as the backbone for the product development phase.

Kotler and Armstrong (2006) suggested that preliminary information helps to define the extent of problems, suggest possible hypotheses and solutions. The field observation was a strategic scoping exercise to ascertain the limits of the study and help to develop a broad understanding of the structure of the programme and define the boundaries of the current study.

The nutritional intake data from the field observation provided a rationale to fill the gaps in nutrition and the data on the school nutrition environment provide the basis for the nutrition education aspect of the study. The formulation and sensory data provided evidence of availability/affordability of local food based solutions and the sensory acceptability of the SCm meals.

It is evident in this study that the used mixed methods and the triangulation data provided a wealth of knowledge and allowed investigators to observe phenomenon that are unique to the LMKD population and also helped in finding key explanations to observations made in the intervention phase. Carvalho and White (1997) state that mixed methods are useful in highlighting reasonable explanation (by deduction and inference).

The deliberate repetition of questions in different phases of the study helped to detect possible errors of over reporting or underreporting and also helped for verification of key data points. In 2000, Cohen and Manion explained that triangulation as an "attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint".

### **5.3 Author's critical view on SCm meal intervention outcomes and the possibility of further work**

The study's results indicate the availability of effective local solutions to malnutrition; however, there are issues with capacity building and the failure of the current GSFP to provide adequate nutritional education on healthy indigenous food choices. Owing to the academic nature of this study, limited time was available to carry out extensive adhoc training and education campaigns during this academic exercise.

The study strategy has always been to use an evidenced based approach to gain understanding into the key factors affecting nutrition of children, apply international scientific know-how to indigenous knowledge of ethnobotany to identify and test affordable sustainable e food based solutions that ensure ease social integration of into the LMKD population.

The wealth of knowledge uncovered in this study saves as a rich source of surveillance data for district stakeholders. The study's results indicate the availability of effective local solutions to malnutrition; however, there are issues with capacity building and the failure of the current GSFP to provide adequate nutritional education on healthy indigenous food choices.

The team continuously to carries out the activities in stipulated the in the sustainability plan and the conceptual framework (Appendix 3). The capacity building (training the trainers) sessions were targeted at empowering three unique groups of individuals (caterers, mothers, school children) as potential agents of social change in the fight against malnutrition.

The activities included training on WHO nutrient guidelines for caterers/cooks, nutrition education for teachers and mothers in the community on how to promote healthy eating/healthy food choices messages in the classroom and at home as well as how to monitor child growth as pictured in Figure 4.3.

The belief is that the trickle-down effect of these activities will ensure that the nutritional gains made during this study will be sustained and the practical aspects of the training will help improve the food sovereignty

situation in poor communities as more people will be able to know and plan healthier meals for their children using foods found in their immediate environment. Adequately transferring the technology/skills and the knowledge gained in this study will solidify increase awareness of the role of nutrition in health as well as give local stakeholders the requisite knowledge required to ensure nutrition promotion across the district.



*Figure 4.39 Selection of pictures from Local stakeholders Dissemination workshop*



Figure 4.40 Selection of pictures from school level nutritional education workshops

## 5.4 Limitations

The efficacy of a particular intervention is to deliver the desired outcomes for immediate impact. However, its effectiveness over an extended period of time ultimately determines its sustainability in any given population. This current study has been able to establish to an extent the efficacy and effectiveness of using indigenous foodstuff in school feeding programmes and explores its effect on anthropometric and haemoglobin indices over the short and long term.

The results demonstrate the rigorousness of the study design in unearthing practical truths about the GSFP with respect to the current population under study is unquestionable. However, they are not without limitation and parties seeking to replicate have to consider the following limitations.

In sampling, the study recognises that the randomly sampled area (Odumase Krobo) may have had a lower level of deprivation compared to other townships with the LMKD. Living circumstances and socio-economic conditions may have changed (either positively or negatively) and this may in turn have changed the children's overall health.

During the field observational study, the number of respondents that took part in the HB measurements reduced by an average of 7% (3 children per group). The main reason given for this trend was children's fear for the needles used in collecting samples for the haematological. Hence alternative less invasive methods (Hemocues procedure) was used for subsequent sample collection.

For the intervention phase, there is a possibility of systemic bias due to the fact that some parents and guardians could not adequately provide precise age of children. Also in terms of dietary intake, there seems to be the possibility of under reporting of snacking and over reporting of fruit intake. The use of both 24-hour recalls and FFQ helped to detect these errors.

In addition, during the intervention follow up the schools, the district experienced two teachers' strikes in 2014/2015 academic year, which

affected the data collection process. To make up for lost time, the time lines for intervention extended.

To our knowledge, this is first of study of this nature that fully looks at the use of indigenous food solutions by starting from service observation through product development to intervention. Due to the academic nature of this study, financial and time constraints, HB was used as a crude measure of anaemia. In future studies, the team hopes to undertake addition biochemical test (full blood count, transferrin, ferritin-reactive protein) to provide more depth to the observation. That notwithstanding, considering the current study aims, this study design was vigorous enough to provide useful insights into the nutritional impact of the treatment meals.

Further work will also look at collecting of data on academic performance data throughout the study period in order to compare any effect the treatments might have on cognition. This would give a better perspective on the impact of the treatments on the brain. In the current study, cognition is assessment was beyond the scope of this study but there are further plans to add cognition assessment component to subsequent scale up programmes.

## **CHAPTER SIX: RECOMMENDATION AND CONCLUSION**

### **Introduction**

This chapter discusses the conclusions and recommendations of the study. Firstly, it will provide a brief summary of the research literature review. Secondly, it will summarise the findings and analysis, including the recommendations of the study. Investing in nutrition is critical and cannot be over-emphasised. School feeding potentially helps to achieve not only nutritional impact results in the creation of social safety nets, growth of agribusiness, but also helps to reduce cost of health (present and future)

### **6.1 Recommendations**

As the deadlines of the MDG have been elapsed and new SDGs have been stated for healthcare, once again nutrition has been recognised as pivotal determinants of health. Several donors, and governments, including the Ghana government have renewed their mandate for nutrition specific intervention such as school feeding programme.

At the time of this current study there were several international and national actors in nutrition present in the country and district carrying out various school nutrition interventions in different capacities. For most of these studies, their actions seem to be a duplication of effort within the same populations without any coordination and connectedness. Hence, majority of the projects were not filling the gaps in research but just repeating efforts in the same capacity.

There were a lot of recommendations for the use of indigenous crops in the current published GSFP related literature but no one was actually applying any of the recommendations. Considering that nearly a million school children depending GSFP, it has become imperative for the harmonization of efforts from both international and national actors to ensure interest of these dependents.

Firstly, there is a need to establish, implement and publish national standards for food item procurement, menu planning, meal preparation and distribution that are in line with international standards for nutrition, but

leave room for the utilization of indigenous crops and domestications of recipe to suit local pallet. This result presented in this study with previous studies in this field of endeavour has portrayed with adequate scientific evidence and know-how that local/ indigenous meals and recipes are capable enhancing impact of school meals as well as ensuring sustainability of SFPs.

There is also a need to ensure that efforts by international and national actors in school feeding align their mandate to the Ghana national nutrition agenda and standards. This is to ensure adequate coverage tracking, monitoring and evaluation across the various pockets of research being carried out. This is very important in for nutrition surveillance.

The current vertical programming style, where unilateral decisions are made in national office and trickled down to the district and school level does not adequately address the day- to-day dynamics of the GSFP. There is a need to look towards participatory planning, which includes local health authorities, teachers, head teachers, local farmers and parents in programme design, implementation and evaluation. Previous studies (Sulemana et al., 2013; Buhl, 2012) have reiterated the need to decentralise decision activities away from vertical approach towards a bottom up approach.

The monopoly of running the programme from national offices has resulted in key school stakeholders who are either not aware of their role or are ill prepared to carry out their roles and responsibilities. This was evident in both in the teachers' survey and the field observation phase of this current study. Morgan and Sonnino (2008) also made similar observations and reported that GSFP failed to adequately educate key stakeholders at the beginning of the programme hence the key stakeholders involved in implementation had little or no understanding of the requirements and responsibilities of what the respective roles entail.

Decentralization of activities at national to a district level must create opportunities for the incorporation of other adjunct health promotion activities that will help to enhance the impact of the GSFP. For instance, in the period of this study, the district health secretariat undertook four

deworming sessions as part of the district, due to the coordination between the SC<sub>M</sub> team and the district health secretariat pupils under the study were able to benefit from deworming which translated to greater the nutritional gains seen across the test groups.

We recommend that the deworming programme together with the WASH initiatives be aligned to the GSFP Plan of action in order to enhance the nutritional impact. To do this adequately, planning of GSFP programmes should be decentralised and run at district and school levels and stirring committee that include the district health officer in charge of WASH, deworming a, district nutrition officers, teachers, head teachers, farmers, food retailers, caterers, district executives, chiefs and local politicians with clearly defined roles, responsibility, targets and a hierarchy of accountability.

A vertical approach of running school feeding shares the social responsibility among the key stakeholders at the district and school levels and creates an inert form of self-evaluation and monitoring. This type of approach has been used extensively by the WFP in the northern part of Ghana and has resulted school feeding programmes that are not just impactful but sustainable (Attah and Manu, 2015).

In addition, there is a need to reevaluate the caterer model operation where the power of procurement, storing, menu planning, cooking and distributing lays solely on the food service provider. Similar GSFP evaluation studies have suggested that this model favours the retail food market over local agriculture (Owusu et al., 2013; Agbozo et al., 2016), gives too much control to caterer/food service provider, considering the fact that they are provided have very little training (Attah and Manu, 2015,) and leaves little room for quality control over meals portion, meal quality and cooking procedures (Morgan and Sonnino, 2008).

The caterer model seems to have been adopted as an indirect mechanism of funding, which removes the financial burden off the shoulder of the government. In many cases, the contracts are not awarded to caterers on financial capacity basis, rather, on political alignment and this has resulted in the caterers who do not have adequate credit/ funds to

facility programme leading to irregularity in service provision at the school level. If the caterer model is to be continued there is a need to award contract to catering companies that already have well-established credit systems, this will ensure regularity of meals, adherence to quality standards of meal procurement, meal preparation and distribution.

In light the current financial climate in Ghana, where establishing lines of credit seem to be tough for individual caterers, GSFP needs look for alternative models of operation and adopt best practice from other countries. For instance, establishing Licensed Buying Companies (Food Banks) at district levels, similar to that used in the cocoa industry, which will purchase farm produce directly from the farmers, store them, and then supply to caterers for use in the school-feeding programme using chits system.

Once this is done, caterers will only be paid for the service rendered. This will also ensure traceability foodstuff, monitor quality control and ease the process of ensuring food quality standard from farm to plate. It will also reduce the burden of funding on the caterers, as well as drastically reduce the budgetary allocation for the school-feeding program.

Since the cost seems too high for the government of Ghana to run alone, there has also been suggestion pertaining to the need for government to establish a state trust or endowment fund solely for the school feeding program donors, NGOs, individuals and philanthropists to be able to contribute to (Buhl, 2012).

Others have suggested the introduction of tax similar to that for the national health insurance (NHIS), which is solely to support government's funding of the GSFP. Similar self-funded and independently run SFPs have been run in Ecuador (Sulemana et al., 2013).

Perhaps more critical is a great need for better school and district nutrition environment. There is a need for sensitization and education for all stakeholders (school and district level). The results of this study buttress with several other evidence based studies (Oduro-Ofori & Adwoa-Yeboah, 2014; Sulemana et al., 2013; Buhl, (2012) clearly indicates that

the service providers (caterers and cook) contracted in the GSFP system have very little to no specialist nutrition training in infant and young child nutrition, very little knowledge on food diversification, minimal education in menu planning, nutrient balance or portion. A review by Atta and Manu 2015 about 22% of the cooks employed in the schools studied had no formal nutrition training neither did they have any form of health certificates.

There is a general lack of credentials as well as hands on training in nutrition; there is an almost unspoken assumption that if they can cook then they can be school food service providers. The result of this study goes to attest the fact that it is imperative that some level of training with continuous professional be a crucial part of contract allocation for caterers with the intention to provide service in school.

Extensive training in nutrition, hygiene and young infant nutrition school should be a part of the requirement for employment. An informal curriculum could be developed by an institution like the Noguchi Memorial Institute Of Medical Research and Food research institute who have the requisite expertise and extensive research in applicable indigenous nutrition, young child nutrition, food safety and food science. They could provide the baseline training/certification for prospective service providers or serve as part of orientation before contract allocation.

This needs to be buttressed with extensive sensitization of school children, parents, teachers, chief and the general populace on the role of nutrition in health. The current school nutrition environment is weak and does not support the long-term impact aims of the GSFP.

There is a need to promote nutrition as a key part of classroom activities so as to give pupils an understanding of what is healthy. Such messages should translate the nutrition messages from the classrooms to the meals they are provided in the GSFP programme. The district nutrition office should be equipped to provide nutrition education for teachers and parents, especially, mothers through health durbars and Parent Teacher Association based campaigns aimed to educate these individuals how to promote healthy eating / healthy food choices messages in the classroom

and at home as well as how to monitor child growth. The trickle-down effect of these activities will increase malnutrition awareness and ensure out of school nutrition practices support the GSFP nutrition agenda. This is the only way to facilitate maximum impact of the GSFP activities.

Considering that current available district and dare to say national impact data seem to be poor and to an extent irrelevant or out of touch with the daily realities on the ground in GSPF school. There is a dire need to put in place plausible monitoring and evaluation schemes at the district that ensure that standards are adhered to and that key stakeholders are made accountable for their action and in-action.

For instance, there should be designate nutritionist (similar to the district environment inspector) whose job is to go round school randomly to inspect caterer activities and ensure that standards in food service (nutrition and environmental) are being followed. Data obtained from such activities buttress with termly anthropometric will provide valuable surveillance data required to monitor and evaluate impact of the GSFP as well as help to identify training needs at the school and district levels.

Last but definitely not the least, is a need to reprioritize nutrition as the focal point of the GSFP meal delivery. There is an enormous show of commitment by government towards increasing the numbers in school enrolment and retention with the promise of a school meal. However the is very little effort to actually ensure that the promised meals actually deliver nutrition and health.

The assumption is the provision of meals automatically translates into health. Provision of food is not the same as provisions of nutrition, inability to distinguish between these two terms has led to number of nutritional misconceptions as in this current study and other studies such as Atta and Manu 2015; Owusu et al., 2013, Danquah et al., 2012; Buhl 2012, SNV 2009; Morgan & Sonnino, 2008.

Efforts need to be redirected towards the provision of nutritious meals as stated in the GDFP Plan of Action. In doing this it is important that stakeholders recognize the potential of indigenous traditional foods and recipes and the role they play in linking local agriculture, ethnobotany,

nutrition and health. Conscientious actions need to be taken to enhance their nutrient quality and availability by using the wealth of research from national nutrition stakeholders' such as the Food Research and Crop Research Institutes of the Ghana Centre for Scientific and Industrial Research. These institutes have large portfolio of research pertaining to indigenous crop variety (functional & super foods) extensive research indigenous biotechnologies and processing technologies that improve nutrient profiles and ensure food safety.

All that is required is to tap into this wealth of existing knowledge and shifting priority from rice based meals towards more domestic crops and recipes. Based on the evidence in this document and other bodies of work by Owusu et al., 2013, Amlogu et al 2014, Amuna and Zotor 2008, a number of specific options can be identified for developing indigenous recipes that are not only nutritious but are food secure and safe to ensure maximum impact of the GSFP on health.

### **6.3 Conclusion and future work**

This study was able to establish the plausibility of developing nutrition-balanced meals from indigenous foods to develop with the five SCm developed. Considering that the fact that some of the most nutrient dense SCm meals received poor sensory scores, the study was able to establish the role of palatability and to a greater extent the importance sensory evaluation in intervention food product development. The results of the intervention with the three most accepted SCm meals (FSM123, FSM101 and FSM579) showed that participants in the SCm treatment group had an impact on child growth (average 3.24% increment in height ( $p \leq 0.05$ ) and 13.08% increase in weight ( $p \leq 0.05$ ). The gains were made in nutritional status and general wellbeing of pupils suggest multidimensional advantages of the SCm meals nutrition intervention:

#### Health and Nutrition dimension

By interfacing traditional/indigenous knowledge of food Systems (ethnobotany, food processing and local recipes) with cutting-edge science (material balance, food on food fortification, diet diversity), the study was able to produce palatable yet nutrient adequate meals. The result of the intervention phase demonstrated that when buttressed with deworming and malaria screening and treatment, indigenous meals and recipes are able to meet the nutritional needs of nutritionally vulnerable populations, prevent further deterioration in their health status and contribute towards gains in height and weight.

#### Economic and social dimension

The cost analysis in this current study makes an economic argument for the incorporation local agricultural produce into the GSFP at district and national levels. The relatively lower cost of local indigenous food stuff does not only make economic sense for the resource constrained GSFP but will also help to address poverty; one of the root causes of malnutrition. Increasing procurement of indigenous food crops for the GSFP use will increase economic activity among farming communities by increasing

demand for local food produce which in turn will increase farming capacities/productivity, create job opportunities for small to medium scale industries involved in food processing and stimulate the economic growth of farming communities. By increasing economic activities in the local area, the financial outcomes of indigenes can be redirect towards other activities such a health and education.

#### Food security dimension

The SCm meal concept depends entirely on local agriculture farmers and their produce thereby creating a ready market for local agricultural activities. The results adds to the knowledge that, supporting the indigenous subsistence farming populations, and integrating their efforts with indigenous sustainable low-tech food processing techniques helps to ensure food self-sufficiency, food diversification, extend shelf life and enhance local food security.

#### Sustainability and health promotion

The sustainability of health aspects of this study is embedded in its multi-sector approach. This study suggests that school-based nutrition interventions should be multi-component with the involvement of district health, education, and civil as well as political organisations commitment to ensure homogeneity of effort, which is likely to result in long-term sustainable impact.

In conclusion, the current research results provide core points for action and evidence for nutritional policy planning for the Lower Manya Krobo to enhance the nutritional sensitivity of the programme. The data produced here provides some crucial district nutritional surveillance data however further studies on impact on full blood chemistry and academic performance are needed to establish the full extent of the gains made.

## 6.4 List Of Conference Papers and Publications

- I. ***“S-Cool meals: A new functional food concept for Global School feeding interventions”***. Author(s) J. Mateko Azagba-Nyako, M. Gordge, I. Oduro, G. Folson and I.Tewfik. The 18th International Conference of Functional Food Centre (FFC) and 6th International Symposium of Academic Society for Functional Food and Bioactive Components (ASFFBC) at **Harvard Medical School, Boston, Massachusetts, USA** on the theme **“Functional and Medical Foods: Bioactive Compounds and Biomarkers”** September 15-16, 2015
- II. ***“School based nutritional intervention, the indigenous way”***. Author(s) J. Mateko Azagba-Nyako, W. Ofori Appaw, I. Oduro, G. Folson and I.Tewfik at the **“2016 University of Cape Coast Ghana, Annual Colloquium entitled Indigenous Knowledge in Health”** held from 21st to 23rd March 2016.
- III. ***“The tailored functional recipe approach: Linking local resources with global science to create sustainable school nutrition intervention in Ghana”*** Author(s) J. Mateko Azagba-Nyako, W. Ofori Appaw, I. Oduro, G. Folson and I.Tewfik at the 5th European Nutrition and Dietetics Conference” in Rome, Italy on the theme **“Highlighting latest advancements in Nutrition and Dietetics & Application of Nutrition Knowledge for better and healthier life”** from June 16-18, 2016.
- IV. ***“S-cool meal to enhance the nutritional sensitivity of GSFP”*** Author(s) J. Mateko Azagba-Nyako, W. Ofori Appaw, I. Oduro, G. Folson and I.Tewfik at the **Noguchi Memorial Institute For Medical Research Accra, Ghana** Conference on **“Nutritional sensitive research: Linking Local Resources with Global Scientific collaboration to Empower Sustainable Health Solution”**, on 8th of September, 2016

## CHAPTER SEVEN

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## APPENDIX 1

### PRELIMINARY LETTERS AND CORRESPONDENCE

#### B.ETHICAL APPROVAL



KWAME NKUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY  
**COLLEGE OF HEALTH SCIENCES**

SCHOOL OF MEDICAL SCIENCES / KOMFO ANOKYE TEACHING HOSPITAL  
**COMMITTEE ON HUMAN RESEARCH, PUBLICATION AND ETHICS**



Our Ref: CHRPE/AP/059/14

5<sup>th</sup> March, 2014.

Miss Jolene Mateko A. Nyako  
University of Westminster  
115, New Cavendish ST  
London  
W1W 6UW.

Dear Madam,

#### **LETTER OF APPROVAL**

*Protocol Title: "Evaluating the Nutritional Impact of Ghana School Feeding Programme in Lower Manya Krobo (LMK) District and Enhancing its Effectiveness through a Nutrition Intervention."*

*Proposed Site: Lower Manya Krobo District.*

*Sponsor: Pyrotechnics Ghana Limited.*

Your submission to the Committee on Human Research, Publications and Ethics on the above named protocol refers.

The Committee reviewed the following documents:

- A notification letter of 24<sup>th</sup> January, 2014 from the Lower Manya Krobo Municipal Assembly (study site) indicating approval for the conduct of the study in the Municipality.
- A completed CHRPE Application Form.
- Participant Information Leaflet and Consent Form.
- Research Proposal.
- Questionnaire.

The Committee has considered the ethical merit of your submission and approved the protocol. The approval is for a fixed period of one year, renewable annually thereafter. The Committee may however, suspend or withdraw ethical approval at anytime if your study is found to contravene the approved protocol.

Data gathered for the study should be used for the approved purposes only. Permission should be sought from the Committee if any amendment to the protocol or use, other than submitted, is made of your research data.

The Committee should be notified of the actual start date of the project and would expect a report on your study, annually or at the close of the project, whichever one comes first. It should also be informed of any publication arising from the study.

Thank you Madam, for your application.

Yours faithfully,

Osomfuor Prof. Sir J. W. Achedimpong MD, FWACP  
**Chairman**

**C. LETTER FROM CORRESPONDING DISTRICT  
ASSEMBLY**



REPUBLIC OF GHANA

*Lower Manya Krobo Municipal Assembly*

P.O. Box 39, Odumase-Krobo, Eastern Region



Our Ref: LMKMA /BH..7/2/01/5

Your Ref: .....

24<sup>th</sup> January, 2014

**TO WHOM IT MAY CONCERN**

We write to confirm that we have been adequately informed of the project entitled **Evaluating the Nutritional Impact of Ghana School Feeding Programme in Lower Manya Krobo (LMK) Municipality, and Promoting its Effectiveness through a Nutrition Intervention** to be undertaken by Miss Jolene Mateko Azagba Nyako as part of her PhD.

- We have extended a hand of cooperation and we are looking forward to working together.
- Any courtesies extended her will be very much appreciated.

.....  
**DANIEL KONEY**  
ASSISTANT DIRECTOR I  
For: MUNICIPAL CHIEF EXECUTIVE

/DK/MD\*/

## D. LETTER FROM CORRESPONDING GHANA EDUCATION SERVICE

### GHANA EDUCATION SERVICE

In case of reply the number and date of this letter should be quoted

My Ref. No. GES/ER/LMKM/M.181/Vol.2/04

Our Ref No: .....



MUNICIPAL EDUCATION OFFICE  
P. O. BOX 49  
ODUMASE – KROBO

15<sup>TH</sup> JANUARY, 2015.

#### PERMISSION TO CONDUCT RESEARCH IN BASIC SCHOOLS ON THE SCHOOL FEEDING PROGRAMME

Miss Jolene Mateko Nyako is a PHD Student at the University of Westminster in the United Kingdom. As part of her study programme, she is requested to conduct a research into the nutritional value of the food that is served to Pupils in school where the feeding programme is operational and to give advice where applicable.

She has been granted permission to observe what goes on in the schools on the school feeding programme.

All headteachers of Feeding Programme Schools are entreated to grant her the necessary assistance on her arrival.

I count on your usual cooperation.

A handwritten signature in blue ink, appearing to read 'M. Vormawor'.

MARGARET A. VORMAWOR  
MUNICIPAL DIRECTOR OF EDUCATION  
LOWER MANYA KROBO

MIN. DIRECTOR OF EDUCATION  
LOWER MANYA  
ODUMASE KROBO

**DISTRIBUTION**  
ALL HEADTEACHERS OF  
SCHOOL FEEDING PROGRAMME SCHOOLS  
LOWER MANYA KROBO

Cc:

Miss Jolene Mateko Nyako  
University of Westminster  
United Kingdom

**E. LETTER FROM CORRESPONDING RESEARCH FACILITY**



**Council for Scientific and Industrial Research**  
**Food Research Institute**  
(a SANAS Accredited Testing Laboratory No. T0279)

**Bankers:** Ghana Commercial Bank  
**Telephone:** 233-302-519091-5  
**Fax:** 233-302-500331 / 233-302-519096  
**E-mail:** [director@foodresearchgh.org](mailto:director@foodresearchgh.org)  
**Website:** [www.foodresearchgh.org](http://www.foodresearchgh.org)

P.O.Box M20  
Accra, Ghana

ALL COMMUNICATIONS SHOULD BE  
ADDRESSED TO THE DIRECTOR

CSIR/FRI/IRP/IT.8/VOL.1

17<sup>th</sup> February, 2014

**Our Ref:**.....

**Date:**.....

Ms. Jolene Mateko Nyako  
University of Westminster  
309 Regent Street,  
London W1B 2UW.

[j.azagba-nyako@my.westminster.ac.uk](mailto:j.azagba-nyako@my.westminster.ac.uk)  
+44 (0) 74 559 1245

Dear Madam,

**RE: REQUEST TO USE RESEARCH FACILITIES**

Further to your letter on the above subject, we wish to thank you for expressing interest in the Institute.

I am pleased to inform you that your application has been accepted for you to use the Institute's facilities for your PhD programme.

We are looking forward to seeing you.

Thank you.

Yours Faithfully,

BENJAMIN ADDI OKAE  
AG. HEAD OF ADMIN  
FOR: DIRECTOR



T0279

## F. INTRODUCTORY LETTER

**UNIVERSITY OF  
LEADING  
THE WAY  
WESTMINSTER** 

The Headmaster

.....  
Lower Manya Krobo Municipal

Dear Sir/Madam

**RE: INTRODUCTORY LETTER**

I write to inform you that the project entitled on the topic: ***Evaluating the Nutritional Impact of Ghana School Feeding Programme in Lower Manya Krobo (LMK) District, and Enhancing Its Effectiveness through A Nutrition Intervention*** has received ethical approval and will officially start at the beginning of the primary school three term starting this May.

As part of the above mentioned project, I will be visiting some your facilities for field observation of the school feeding programme. Kindly see the attached copy of the ethical approval. Counting on your usual cooperation.

Yours faithfully,

.....  
(MISS JOLENE MATEKO A NYAKO)

## APPENDIX 2

### QUESTIONNAIRES

#### **A. THE HEAD TEACHER / CLASS TEACHER QUESTIONNAIRE**

##### **Consent**

This questionnaire is meant for the purpose of academic research only and it is entirely voluntary. Your opinion will be treated with a lot of confidentiality in accordance with the Data Protection Act 1998 Yes / No

Gender Male  Female

1. Age 23 - 30yrs  31-40 yrs  40 and above
2. Teaching experience 1-5 yrs  6-10 yrs  11-15 yrs  15 yrs and above
3. How many years have you been in the present station? 1-5 yrs  6-10 yrs  11-15 yrs  above 15yrs
4. How many learners do you have in the class/school? Boys  Girls  Total
5. Are you a nutrition trained Teacher or do you have a nutrition trained teacher on your staff? Yes  No
6. Does your school currently have a feeding programme? Yes  No
7. If yes, can you state the most important impact of feeding programme in your school?  
.....  
.....
8. Do you ever have a discussions with your staff on the school feeding programme better? Yes  No
9. If yes to (8) above, how often Occasionally  Often  Very often
10. What are some of the issues you discuss in the meetings in relation to school feeding programme and performance?  
.....  
.....
11. Do the meetings have any impact towards the feeding programme at all ? Yes  No
12. If yes above (11) how?  
.....  
.....
13. What challenges do you face in sustaining the feeding programme in your school?  
.....  
.....
14. How can you grade your school feeding programme? Very Good  Good  Fair  Poor
15. . What are the effects of feeding programme on nutritional health of your pupils? Very Good  Good  Fair  Poor
16. What are children's favourite meals? .....
17. Do you have any role as far as school feeding programme is concerned? Yes  No
18. If Yes what part.....
19. Have you ever discussed school feeding programme in your staff meetings?  
.....  
.....
20. Do the discussions during the meetings have any impact on improving the feeding programme? Yes  No
21. If yes above (11) how?  
.....  
.....
22. What are the effects of feeding programme on performance? Very Good  Good  Fair  Poor
23. Comment on children's participation in activities  
Before meals .....
- After meals .....
24. What do you think can be done to improve the school feeding programme in your scho

## B. CATERER QUESTIONNAIRE

### Evaluating the nutritional impact of the Ghana school feeding programme in Lower Manya Krobo District and enhancing its effectiveness using a nutritional intervention

#### Caterer Questionnaire

Name	A1. Age
A2. Sex 1. F 2. M	Caterer ID number (office use only)
School name:	Town
A3. Number of schools being catered	A4. Total number of children catered for in current schools
B1. Education qualification of caterer? 1. Primary 2. JSS 3. SSCE 4.HND 5. Higher degree 6. Informal	
B2. How many cooks/ catering aides do you employ? 1. 1-3 people 2. 3-5 people 3. more than 5people	
B3. Do you cook the meals yourself? 1. Yes (Skip Q£) 2. No(if No to)	
B4. Education qualification of main cook? 1. Primary 2. JSS 3. SSCE 4.HND 5. Higher degree 6. Informal	
B5. Where is meal prepared? 1. On site (school) 2. District kitchen 3. Caterers/cooks kitchen	
B6. What type of structure is it? 1. Traditional kitchen 2. Open area 3. Formal structure with sinks	
B7. How longer has main cook/caterer been catering for school children? 1. Less than a year 2. 1-3years 3. More than 4 years	
B8. Time since last training of caterer/ main cook? 1. Less than a year 2. 1-3years 3. More than 4 years. 4. No formal training	
B. Do you offer any training for your cooks and cooking aides? 1. Yes 2.No	

## D. CATERER FOCUS GROUP DISCUSSION GUIDE

### ***Evaluating the nutritional impact of the Ghana school feeding programme in Lower Manya Krobo District and enhancing its effectiveness using a nutritional intervention***

#### **Caterer focus group discussion guide**

#### **Part 1: Role of nutrition in health**

##### Preamble

In this section, we seek to develop background of the caterer's knowledge of the role nutrition in health

##### Procedures

Begin this section by saying

*"We will like to ask you about feeding school children. Can you tell us why we give children meals at school? Why is it necessary to feed children in general?"*

\*Record answers in the order in which they are mentioned in the recording sheet. If they stop talking and in case all the answers mentioned do not relate health please redirect question. By saying

*"So far no one has mentioned anything about health and the role of food in child's growth? Does food affect health of children and how?"*

*Keywords to look out for*

*Energy, hunger prevention, disease prevention, growth, sustenance,  
Response sheet: Nutrition in Health*

## Part two: Guided discussion on meal content and balanced diet

### Focus

This part is seeks to examine the caterer's knowledge of food groups. This is to enable us to discover where the concept of balanced diet fit into the caterers' quest to prepare of school meals.

### Procedure

Scan the free list in part one and put a mark on the comments that have the keywords

Start the discussion by saying

*You have mentioned a number of different things that food does to the body in terms of health. We will like to ask you a little about food in general.*

Then ask

- *Foods are classified into groups according to their function, do you know them?*
- *Can you please name them?*
- *Can you tell us what each of this groups does for the body?*

### Focus

We would like to explore the caterers understanding of well-balanced that. To do this start by saying

*"Now that you have mentioned the different food groups, we will like to know if you have heard about well-balanced diet".*

Wait for the response and proceed based on the result by asking

- What are the qualities of a well-planned meal? Rephrase to: **What makes a meal well balanced?** if needed*
- Can you mention some of the things you do in order to prepare a well-balanced school meal?*

*Keywords to look out for*

*Food groups, variety, quantity and quality, combination meals from food groups,*

*Response sheet: balance diet*

### **Part three: Menu planning and portion size control**

#### Focus

This section of the discussion is to develop a list of the factors that the caterers consider in respect to menu/ meal planning. Its sole aim is to establish the importance of standardisation of menu guidelines and portion size control.

#### Procedure

*So now that we have mention what goes into preparing well balanced die, we will like you to list some of the factors you keep in mind when deciding on what to cook for the children in your schools?*

To narrow down answers, ask the following questions

1. *Who decides what to cook and when to cook?*
2. *Do you have any guidelines?*

If the response to question 2 is positive ask the following

- 2a. *Who provided you with those guidelines?*
- 2b. *In your view are those guidelines working?*

Proceed to say

*“Now that you have mentioned how you plan the school meals, can you tell us about how you decide on how much each child eats?”*

Probe further by asking the following questions

3. *What are the factors you consider when sharing the meals?*
4. *Which one is of the factors you mentioned above is the most important?*
5. *Do you have any standard guidelines?*

Based on the response to question 5 ask the following

- 5a. *Who provided you with those guidelines?*

Rephrase to:

*“Where did you get these guidelines from?”*

- 5b. *In your view are those guidelines working?*

**D. FIELD OBSERVATION Sheet**

School Name: ..... School ID code: .....

Name of enumerator.....Date:.....

<b>ELEMENTS OF GOOD PRACTICE</b>	
<b>A. Personnel and Facilities</b>	
<b>Questions</b>	<b>Observations</b>
A1. Number of kitchen personnel	
A2. Education qualification of main cook? 1. Primary 2. SSCE 3.HND 4. Higher degree 5. Informal	
A3. How longer has main cook been catering for school children? 1. Less than a year 2. 1-3years 3. more than 4years	
A4. Time since last training? 1. Less than a year 2. 1-3years 3. More than 4 years. 4. No training	
A5. Who provided the last training? 1. District assembly 2. Personal arrangements 3. NGO	
A6. Where is meal prepared? 1. On site (school) 2. District kitchen 3. Caterers/cooks kitchen	
A7. What type of structure is it? 1. Traditional kitchen 2. Open area 3. Formal structure with sinks	
<b>B. Available guidelines/ policy/ protocols</b>	
B1. Are there any food procurement guidelines? 1.Yes 2.No	
B2. Are there any displayed Menu? 1.Yes 2.No	
B3. Who plans the meals? 1. Traditional cook 2. Head caterer 3. Nutritionist 4. Others specify.....	
B4. Are there guidelines for portion size? 1.Yes 2.No	
B5. What is the <b>main</b> factor considered in portioning out meals? 1. Age group 2. Sex 3. Class 4. Amount of food available 5. Sick Children	
<b>C. Meal content/ Meal planning</b>	

C1. What is the <b>main</b> source of raw materials? 1. Local Market 2. Farmer 3. Supermarket 4 School Garden 5. District Assembly stores	
C2. How often are raw materials purchased? 1. Weekly 2. Daily 3. Monthly 4. Termly 5. As and when its needed	
C3. How many meals are fried meals are consumed in a week? 1. Once 2. Two – four times 3. Daily	
C4. How many times children are served red meat week? 1. Once 2. Two – four times 3. Daily	
C5. How many times children are served eggs week? 1. Once 2. Two – four times 3. Daily	
C6. How many times children are served fish meat week? 1. Once 2. Two – four times 3. Daily	
C8. How many times children are served fruits meat week? 1. Once 2. Two – four times 3. Daily	
C9. What additives are added to the meals? 1. Cubes 2. Natural Herbs 3. Salt 4. Meat stock 5. Others specify.....	
<b>D. Food hygiene and safety</b>	
<b>Questions</b>	<b>Observations</b>
D1. Is there a food storage facility? 1. Yes 2. No Describe	
D2. What is the main source of water for cooking? 1. Pipe 2. Borehole 3. River/stream 4. Rainwater 5. Other specify	
D3. Do caters/cook wash hands before cooking? 1.Yes 2.No	
D4. When are the utensils washed? 1. After meals 2. Before meals 3.After school 4. Before and after meals	
D5. Are child asked to wash hands before meals? 1.Yes 2.No	
D6. Are they supervised during hand washing? 1.Yes 2.No (Skip D7)	
D7. Who supervises hand washing? 1. Teacher 2. Caterer/cook 3. Head pupil 4. Head teacher	
D8. What are the sanitary facilities available on site? 1. Urinal 2. Toilet 3. Toilet and urinal 4. No facilities	
D10. What type toilet facility is available? 1.Pit latrine 2.KVIP 3.WC	



GENERAL REMARKS

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**F. PARENTS QUESTIONNAIRE**  
**PARTICIPANT INFORMATION**

Dear Parent/Guardian,

We are conducting a study to find out about the GSFP in your child's school. We will like you to answer some questions to that effect

The questionnaire is divided into two sections. In Section A, you will be required to tick one of the options provided and sign or thumbprint if you would like to participate. In Section B, you will be required to fill in the sheets provided based on the instructions provided. An assistant will help you fill in Section C. As part of the assessment, we will take the height and weight of your child monthly together with blood samples.

This is purely voluntary and you are free to take part or not in this study. You can withdraw from participation at any time without any reasons given. The information you provide will be stored securely and will not be made available to anyone else not involved in the project. Your name or that of your child will not be required on the questionnaire but each questionnaire will be assigned a code to aid counting. Only the investigators have access to these codes. All data and personal information will be stored securely in accordance with the terms of the Data Protection Act 1998 and will be accessed only by researchers

Your data will be statistically analysed together with all the other participants' data, and **ONLY** findings from this analysis will be communicated to other researchers and scientists. All data will be made anonymous (i.e. all personal information associated with your data will be removed) throughout the study. As part of the project, you will be informed and given a talk on child nutrition during an event jointly organised by us and your child's school.

Please return the consent forms together with the questionnaire to your child's teacher in the envelope provided. If you have any questions, please contact Miss Jolene A. Nyako.  
Tel: 02083318336

Thank you

Miss Jolene Mateko Azagba-Nyako

<b>School code</b>	
Title <b><i>Evaluating the nutritional impact of the Ghana school feeding programme in Lower Manya Krobo District and enhancing its effectiveness using a nutritional intervention</i></b>	
Investigator's name: Jolene Azagba-Nyako	Supervisor:
<b><i>to be completed by the subject/volunteer</i></b>	
1. Have you read the information sheet about this study?	YES/NO YES/NO
2. Have the details been explained to your understanding?	YES/NO
3. Have you had an opportunity to ask questions and discuss this study?	YES/NO YES/NO
4. Have you received satisfactory answers to all your questions?	
5. Have you received enough information about this study?	YES/NO YES/NO
6. Do you understand that you are free to withdraw from this study? <ul style="list-style-type: none"> <li>• at any time</li> <li>• without giving a reason for withdrawing</li> <li>• without affecting your future</li> </ul>	YES/NO
7. Do you agree to take part in this study?	YES/NO
<b>Signed</b>	Date
Name in block letters	
Thumbprint	Signature of witness if participant is not literate

**SECTION B**

Code -----  
(Office use only)

Date ...../...../ 2013  
School.....  
CID.....

Daughter/Son's information: Age..... Gender M  F

At what age did he/she start to attend this school? .....

**PARENT/GUARDIAN'S INFORMATION**

Parent/guardian age.....

**Marital status**

- Single
- Married
- Separated
- Divorced
- Unmarried
- Partnership

**Family relationship with the pupil**

- Father
- Mother

Other specify.....

**Educational status**

- No formal education
- Primary school
- Secondary school
- Academic degree

**Employment**

- |                    | <b>M</b>                 | <b>F</b>                 |
|--------------------|--------------------------|--------------------------|
| Unemployed         | <input type="checkbox"/> | <input type="checkbox"/> |
| Housewife          | <input type="checkbox"/> | <input type="checkbox"/> |
| Self employed      | <input type="checkbox"/> | <input type="checkbox"/> |
| Public sector      | <input type="checkbox"/> | <input type="checkbox"/> |
| Private sector     | <input type="checkbox"/> | <input type="checkbox"/> |
| Other specify..... |                          |                          |

- I. How many members are there in your family? .....Total ...M.....F.....
- II. Was your child breastfed exclusively for 6 months? A. Yes. B. No If **No** how long .....
- III. Does your child eat breakfast at home before school? A. Yes B. No C. Sometimes
- IV. Does your child partake in the Ghana School feeding programme? Yes No (if NO go to question 5)
- V. Why does your child not take part in the school-feeding programme? A. Not available in his/her school B. Your child does not like the food served. C. You don't like you the food served D. Other (specify).....
- VI. Does your child take lunch to school? A. Yes B. No C. I give him/her money D. Sometimes
- VII. Do you give your child money for food at school? A Yes b. No C. Sometimes
- VIII. If yes how much.....

**SECTION C Please put a tick (✓) on every line**

FOOD	AVERAGE INTAKE IN THE LAST MONTH								
	Never	1-3 mnth	Once /wk	2-4x /wk	5-8 /wk	1/ day	2-3 /day	4-5 /day	6+ /day
Proteins									
Eggs									
CHICKEN									
BEEF									
Ofals									
Cow foot									
Pork									
Turkey									
Oil fish/ Salmon									
Anchovies									
Tin fish									
Staples									
Rice									
Maize									
Potatoes									
Yam									
Cassava									
Noodles									
Cocoyam									
Plantain									



Toffees									
chocolates									
Ice cream									
Bread									
Pies									
Biscuits / cookies									

**G. RIGHT TO WITHDRAW**

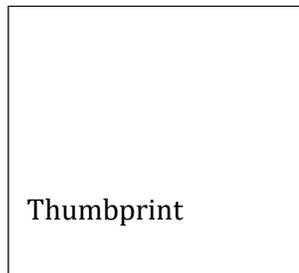
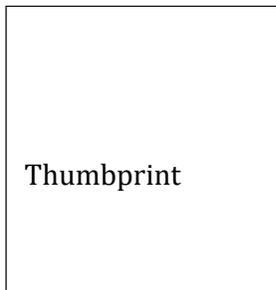
I ....., parent /guardian of  
.....write, to request that my ward be withdraw from the current  
S-cool meal intervention.

**CONDITIONAL CLAUSE**

I shall appreciate it  
If **ALL** data including those **ALREADY** collected concerning my ward be removed entirely  
from the study results.  
Signed .....

Or

I provide that authority that data **ALREADY COLLECTED** can be used in the study  
Signed .....



**G: TASTE IDENTIFICATION TEST**

Aim:

To encourage panel to develop an awareness of the basic tastes - sweet, sour, salt and bitter. Materials required per panelist 4 cups. Code the cups 1, 2, 3 and 4. 1 glass of water (to rinse mouth)

Procedure 1.

Prepare the cups as follows:

Cup 1 250ml water + 1 teasp. sugar.....Sweet

Cup 2 250ml water + ½ teasp. salt.....Salt

Cup 3 250ml water + 2 teasp. lemon juice.....Sour

Cup 4 250ml water + 100ml tonic water (decarbonated) .....Bitter

.....  
.....

Score card

Taste Identification Test

Tray number.....

Name.....

You are presented with 4 samples of solutions which represent the basic taste sensations of sweet, sour, salt and bitter. Starting in any order, choose a cup, take a sip from it, hold it in your mouth for 10 seconds and note the taste. Proceed through the other samples in a similar manner, rinsing your mouth between each. Fill in the taste identified in each case

Solution	Taste Identified	Actual taste
1		
2		
3		

- Put the diced potato, whole onion and tomatoes in a small pot with 5 cups of water. Bring it to a boil, then
- Take out the steamed tomatoes with the onion ,puree and pour over the potatoes
- Lower the heat and allow cook until the potatoes is soft (20-30 minutes).
- Add the add SCm formulation
- Add salt and pepper to taste allow to simmer for 5 minut

**H: TRAINED PANEL SENSORY ACCEPTABILITY TEST QUESTIONNAIRE**

PANELIST NAME.....

DATE .....

SAMPLE CODE.....

	Colour	Taste	Consistency	Mouth feel	Aroma	Aftertaste
Like Extremely						
Like Very Much						
Like Moderately						
Like Slightly						
Neither like nor dislike						
Dislike Slightly						
Dislike Moderately						
Dislike Very Much						
Like Extremely						

Comments

.....

.....

.....

.....

**I: UNTRAINED PANEL ACCEPTABILITY SENSORY EVALUATION QUESTIONNAIRE**

Scale	Aroma	Taste	Colour
LIKE			
NEITHER LIKE OR DISLIKE			
DISLIKE			

**J: UNTRAINED PANEL PREFERENCE SENSORY EVALUATION QUESTIONNAIRE**

Name		Sample arrangement	
Panellist number....		Date	
Instruction  You have been given a two pair of samples. Indicate which sample u prefer in terms of colour and overall acceptability by writing the code on the preferred cup. Please write down any comments			
Sample pair code			
SCOO			
SFP			
Comments			





**POST PILOT EVALUATION QUESTIONNAIRE**

Code -----  
(Office use only)

Date ...../...../ 2015 School.....  
Child name .....  
Daughter/Son's: Age..... Gender M  F

**PARENT/GUARDIAN'S INFORMATION**

**Marital status**

- Single
- Married
- Separated
- Divorced
- Unmarried
- Partnership

**Family relationship with the pupil**

- Father
- Mother
- Other specify.....

**Educational status**

- No formal education
- Primary school
- Secondary school
- Academic degree

**Employment**

- |                    | <b>M</b>                 | <b>F</b>                 |
|--------------------|--------------------------|--------------------------|
| Unemployed         | <input type="checkbox"/> | <input type="checkbox"/> |
| Housewife          | <input type="checkbox"/> | <input type="checkbox"/> |
| Self employed      | <input type="checkbox"/> | <input type="checkbox"/> |
| Public sector      | <input type="checkbox"/> | <input type="checkbox"/> |
| Private sector     | <input type="checkbox"/> | <input type="checkbox"/> |
| Other specify..... |                          |                          |

1. Was your child sick this term? A.Yes B. No what was wrong .....
2. Has your child complained of hunger in school this term?
3. Have you heard about the Scool meal A.Yes B.No
4. Has your child been eating the Scool meals this term? A.Yes B.No (if NO go to question 7) C. Sometimes
5. What does your child say about the Scool meals?.....  
.....
6. What do you think of the Scool meals?.....  
.....
7. Why does your child not take part in the school feeding programme? A. Not available in his/her school B. Your child does not like the food served. C. You don't like you the food served d. Other (specify).....

**APPENDIX 4**  
**Sample size calculation and key elements**

A. Sample size calculation for SCm main intervention

Based on prevalence  $N = \frac{t^2 \times p \times (1-p)}{m^2}$

n = required sample size

t = confidence level at 95% (standard value of 1.96)

p = estimated prevalence of malnutrition in the project area

m = margin of error at 5% (standard value of 0.05)

Malnutrition prevalence

With malnutrition prevalence of 38.0%

$$\begin{aligned} \text{Sample population} &= \frac{1.96^2 \times 0.38 \times (1-0.38)}{0.05^2} \\ &= \frac{3.842 \times 0.224}{0.0025} \end{aligned}$$

Sample Size = 293.95

Accounting for an average 11% attrition as reported in previous studies Abizari et al., (2016): Aulo et al., (2014)

$$\begin{aligned} \text{Sample Size} &= 293.95 + \frac{(11 \times 293)}{100} \\ &= 330 \text{ school children} \end{aligned}$$

B. Sample size calculation for pilot run was calculated as half of the scale up =  $330 \div 2 = 165$  children at an attrition of 9

$$\begin{aligned} \text{Sample Size} &= 165 + \frac{(9 \times 165)}{100} \\ \text{Sample Size} &= 180 \end{aligned}$$

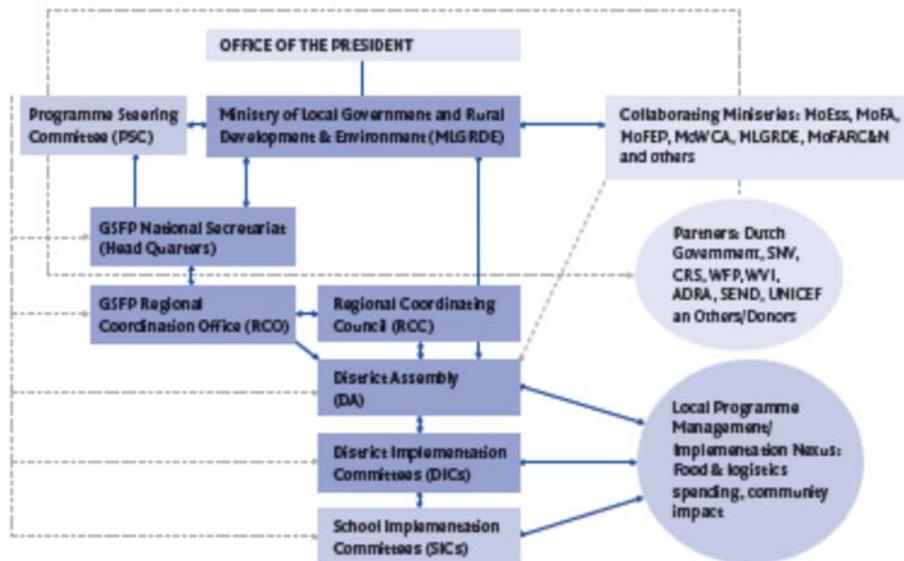


Figure 1: Organizational structure of the Ghana school feeding programme

A. Table 1: Elements of the British National Nutritional Standards for school lunches in primary schools.

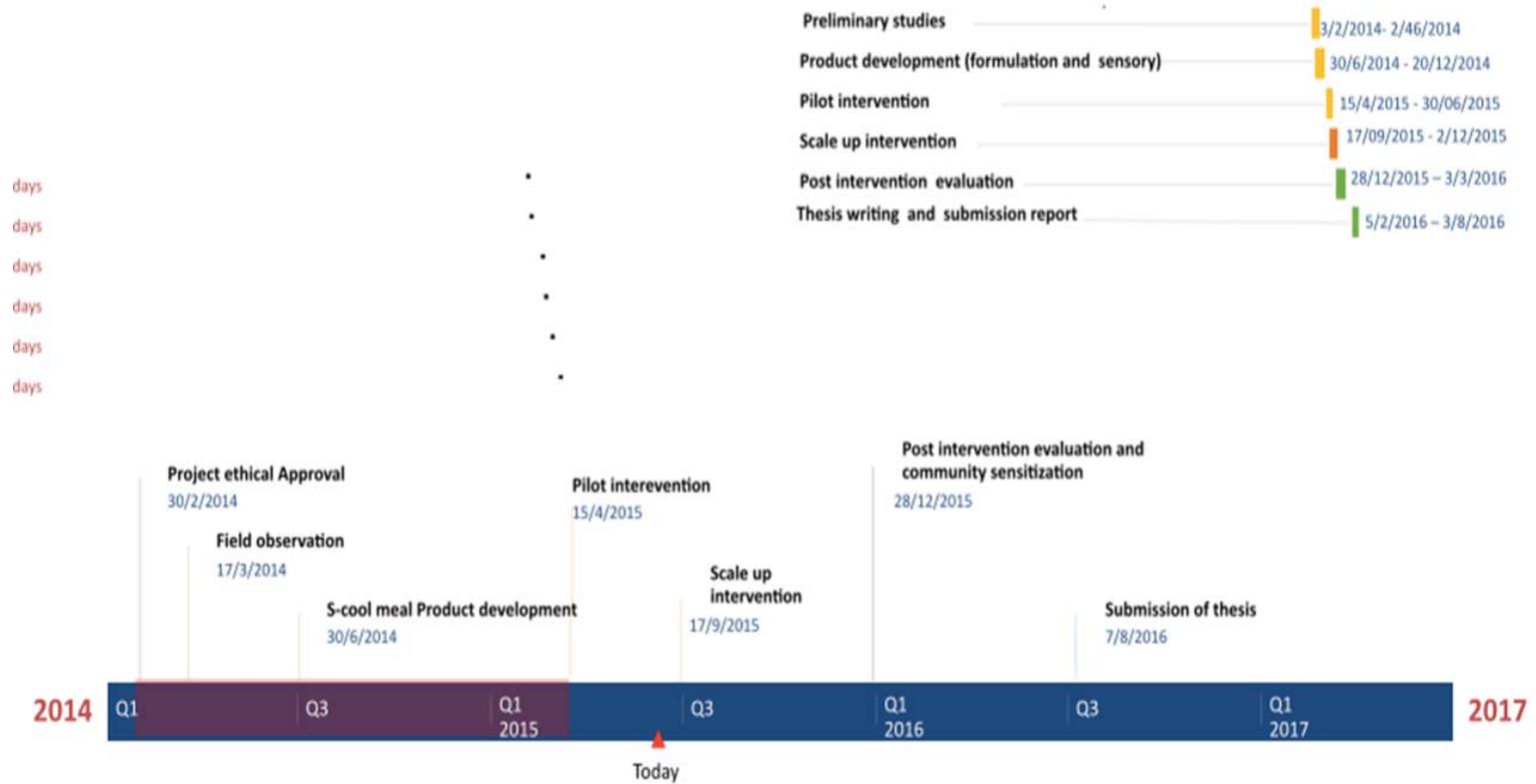
1. Starchy foods At least one item from this group must be available every day
2. Starchy food cooked in oil or fat should not be served more than three times a week
3. Vegetables and fruit A vegetable must be available every day
4. A fruit must be available every day
5. Fruit-based desserts must be available twice a week
6. Milk and dairy foods. At least one item from this group must be available every day
7. Meat, fish and alternative sources of protein
8. At least one item from each group must be available every day

Table: 2. Crop production in Lower Manya Krobo District

Crop Name	Tones produced per annum
Maize	50.6
Cassava	39.3
Vegetables	7.0
Plantains	3.0
Rice	15.8
Vegetables	65.0
Yam	15.0
Sweet Potatoes	10.0
Cocoyam	2.5
Mango	20.7

Source <http://lowermanya.ghanadistricts.gov.gh/?arrow=atd&=74&sa=2189>

## K: PROJECT STAGES AND PROJECTED TIMELINES



## APPENDIX 4 METHODS, PROCEDURES AND RESULTS

### A: MEAL RECIPES

1 *The recipe below is taken from the Ministry of Food and Agriculture.*

#### **Ingredients:**

1. 2 cups heaped roasted corn flour (like the type made to use Tom Brown)
2. 1 serving spoonful palm oil
3. 2 medium-sized tomatoes
4. 1 medium-sized onion
5. 1 small piece smoked fish
6. Salted fish/momoni (optional)
7. ½ cup of beans (optional)
8. Pepper and salt to taste
9. Crabs (optional)

#### **Method:**

- Wash and boil beans until tender and set aside
- Put palm oil on fire
- Add sliced onion to fry till brown
- Add momoni and allow to fry for 5minutes
- Add ground pepper and tomato and then fish
- Allow to cook whilst stirring occasionally
- Add water, cover and allow to boil
- Add boiled beans
- Add the roasted corn flour and stir till well cooked

### **B. Mportormportor Recipe**

#### Ingredients

- About 3 sweet potato]
- 1 medium onion (about 4 oz)
- A couple of tomatoes (about 4 oz)
- 1/4 cup dried anchovies
- 1/2 teaspoon salt, or to taste

#### Procedure

- Pound the anchovies if whole, in a mortar and pestle
- Wash and peel the potato and cut into 1/2 inch cubes.
- Peel the onion, leaving it whole.
- Rinse the tomatoes, leaving them whole.
- Put the diced potato, whole onion and tomatoes in a small pot with 5 cups of water. Bring it to a boil, then
- Take out the steamed tomatoes with the onion ,puree and pour over the potatoes
- Lower the heat and allow cook until the potatoes is soft (20-30 minutes).
- Add the add SCm formulation
- Add salt and pepper to taste allow to simmer for 5 minute

## E: DETAILED PROXIMATE PROCEDURES

Analysis of each S-cool meal formulation was analysed using standard AOAC methods: moisture content (AOAC 925.10, 1990); ash content (AOAC 923.03, 2000); crude fat content: (AOAC 920.39 C (2000); and crude protein (AOAC 979.09, 2000). Carbohydrate content was determined by difference. Gross energy was determined by calculation from fat, carbohydrate and protein content using the Atwater's conversion factor; 16.7 kJ/g for protein, 37.4 kJ/g fat and 16.7 kJ/g for carbohydrate. Iron and zinc contents were determined using atomic absorption spectrophotometer. All nutritional analysis were carried out in the Chemistry Laboratory of the Food Research Institute of Ghana (Centre for Scientific and Industrial Research) which ISO and SANAS certified Laboratory. **Expect vitamin A analysis which was carried out by at the Natural Resource Laboratory of the Kwame Nkrumah University of Science and technology using** .All weight measuring instruments were calibrate using standard known weights provided by the Ghana Standards Authority. All ovens, furnace and burners used were fitted with external thermometers.

### **1: Sampling**

For each formulation 200g of bulk sample was put aside as for nutrient analysis. The particle size of the samples were further reduced using a Milomat 152 Hammer mill to ease the nutrient extraction. The coning and quartering" techniques was used to the analytical sample from the bulk product (IUPAC, 2007). In doing this the laboratory sample was heaped on a dry oven tray into a conical shape, flattened and then radially divided into equal quarters; two quarters which sit opposite one another were discarded, while the other two are combined and constitute the analytical sample.

### **2 Determination of moisture:**

Ten clean pre-coded porcelain crucible (0.5 to 2 cm in diameter) were dried in a Forced Draft oven at 105°C for 20 minutes to dry out any water particles after which the dish was transferred to a desiccator using tongs and allowed to cool. The weight of the cooled crucible was taken using an analytical balance and the weight recorded as  $W_c$ . About 2 g of the sample was placed in the crucible and the weight noted as  $W_{wet}$  plus the code of

the crucible. The crucible containing the sample were transferred into Forced Draft oven 4 hours. **The dried samples were** transferred in to desiccator **to cool and then weighed** with an analytical balance and the weight recorded as  $W_{dry}$ . The percent moisture was calculated using the formula one shown in Appendix

### **3 Determination of ash**

For the determination of ash, clean empty precoded crucibles were placed in a muffle furnace at

600°C for an hour, cooled in desiccator and then weight of empty crucibles were noted ( $W_x$  + crucible's code). About 5g of each sample was weighed into the crucible and decarbonize on Bunsen flame until no more smoke was produced. The decarbonized sample into muffle furnace using a long armed thong and ashed for 8 hours at 550°C. The ashed samples in the crucibles were cooled in a desiccator to room temperature after which the crucibles containing the samples were weighed and the weight noted as ( $W_z$  + crucible's code). Percent ash was calculated using the formula two shown in

### **Appendix**

#### **4. Crude protein using Macro Kjehadl**

To determine percent protein, 1-2 g of each sample was weighed and transferred in to a Kjeldahl flask and 25 ml of concentrated sulphuric acid and 8 g of catalyst tablet was added and swirled to produce an even mixture uniformly wet. The flask was placed on the digestion rack and heated gently to prevent loss of volatile nitrogen in initial stages until frothing ceased. The temperature was gradually increased so that the liquid just boils with occasional swirled until the contents appear clear. The digest was then allow to cool and then diluted with 100 ml of distilled water into 500 ml Kjeldahl distilling flask. The diluted digest was washed further with distilled water to produce a total volume of about 250ml and connected up to the distillation apparatus. Distillation was continued for at least 10 minutes and  $NH_3$  produced was collected as  $NH_3OH$  in a distillate receiving conical flask containing 25 ml of 2% boric acid solution (containing screened methyl red indicator) in a 300 or 500 ml flask. The distillate was then titrated against standard 0.1 N HCl solution till

a visible colour change was observed and the end point value recorded. Percentage crude protein content of each sample was calculated using nitrogen factor N=6.25 (See Appendix for formula and sample calculation). This was repeated for all samples including two in house standards in duplicates.

#### **Instrumentation Reagents:**

Concentrated 0.1N HCl (standard)

Concentrated sulphuric acid

Concentrated Sodium hydroxide solution 40% w/w

Concentrated Digestion tablet mixture: Potassium Sulphate (K<sub>2</sub>SO<sub>4</sub>) and Copper Sulphate (CuSO<sub>4</sub>)

Concentrated Boric acid: Dissolved 40 g of boric acid in sufficient distilled water and made the volume up to 100 ml.

Indicator: Methyl red

#### **Reactions**

N(food)  $\square$  (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> (1)

The relevant reactions are: Organic substance

(CHNO)  $\rightarrow$  NH<sub>4</sub><sup>+</sup> + CO<sub>2</sub> + H<sub>2</sub>O NH<sub>4</sub><sup>+</sup> + OH<sup>-</sup>

$\rightarrow$  NH<sub>3</sub> + H<sub>2</sub>O NH<sub>3</sub> + HCl  $\rightarrow$  NH<sub>4</sub><sup>+</sup> + Cl<sup>-</sup> + NaOH  $\rightarrow$  NaCl + H<sub>2</sub>O

NH<sub>3</sub> + H<sub>3</sub>BO<sub>3</sub> (boric acid)  $\square$  NH<sub>4</sub><sup>+</sup> + H<sub>2</sub>BO<sub>3</sub><sup>-</sup> (borate ion) (3)

#### **5 Determination of crude fat by Soxhlet Method**

About 2 g of the previously dried sample was wrapped in filter paper, weighed and placed into a clean extraction thimble and a wad of fat-free cotton wool was inserted on the top of the sample in the thimble. The thimble with the sample was placed in the extractor tube of the Soxhlet apparatus. The receiving beaker of the apparatus was cleaned, dried, weighed and filled with petroleum ether to about one and a half times the full volume of the extraction unit up to the point where it is just about to siphon over. Then the beaker was fitted to the lower end of the extraction unit. The extractor and the extraction flask

was attached to the reflux condenser and placed on the electric thermal unit. Cold distilled water was passed through the condenser and the electric thermal unit was switched on. The heater was adjust to allow the solvent to drop from the condenser onto the centre of the thimble at the rate of 5 to 6 drops per second.

After 8 hours of extraction, heating was discontinued and the flask was placed on a water-bath to evaporate traces of ether. This was continued until no odour of ether remained. The outside of flask was wiped clean and the flask with its content were dried in the oven at 101°C for an hour. The flask and its contents were transferred to a desiccator, cool, weighed and the weight recorded. The percent crude fat was determined by using the following formula shown in

#### 6. Carbohydrate by difference

The carbohydrate component was determined using the calculated difference that is 100% minus the sum of all the other macronutrients. % available carbohydrate = 100 - [% moisture + % ash + % fat + % protein + % fibre]

#### 6 Energy value by calculation:

<i>Constituent</i>	<i>Constituent Calorific Value (kJ/g)</i>	<i>Calorific Value (kcal/g)</i>
<i>Available Carbohydrate</i>	17	4
<i>Protein</i>	17	4
<i>Fat</i>	37	9

The percent calories in samples were calculated by multiplying the percentage of crude protein and carbohydrate with 4 and crude fat with 9. The values were then converted to calories per 100g of the sample. The energy value (calorific value) was calculated in kJ/100g using the formula [(% CHO x 17) + (% protein x 17) + (% fat x 37)]

Table 1: Energy conversion factors for the various macronutrients

#### 7 Atomic Absorption Spectrometry graphs

Iron and Zinc contents of S-cool Meals were determined by atomic absorption spectrometry in accordance with the AOAC (2003) methods. About 2.0g of previously ashed sample

was weighed using a salter scale and transferred into a clean porcelain crucible. Then 5ml of HCl was added and mixed thoroughly. The resultant mixture was heated on a Bunsen burner until all the ash had dissolved. After which the mixture was filtered using a Whitman filter No<sup>1</sup> into a 100ml volumetric flask and topped to the mark with distilled water. Minerals was analysed using a Zeeman Polarised Atomic Absorption Spectrophotometer and the resultant curves were compared to stand graphs to determine the various minerals present and their proportions.

#### **8. Procedure for calcium determination**

About 40 ml of the ash solution is prepared using distilled was pipetted into a 150 ml beaker, 10 ml hydrochloric acid was added to the solution and topped with distilled water to produce 50 to 70 ml. Two drops of screened methyl red indicator was added and the solution was brought to a boil. Then 15 ml of saturated ammonium oxalate solution and 5 g of urea were added and the solution was boiled for a further 10 minutes. As soon as the visible colour change was observed, dilute ammonia solution was added drop-wise with stirring until the liquid is neutral or faintly alkaline (colour change from red to yellow). The solution was covered with a watch glass and allowed to stand for at least 4 hours.

The solution was filtered through a coarse filter paper (Whatman No.1) taking care not to disturb the precipitate. The precipitate was washed with small volumes of cold water until free from chloride. The filter paper with the precipitate were transferred to the original beaker and the precipitate was dissolved with hot dilute sulphuric acid (about 30 - 50ml of 2N sulphuric acid)

This is to liberate oxalic acid from the calcium oxalate. After which the resultant calcium oxalate was titrated with standard N/50 potassium permanganate maintaining the liquid at 60°C. At the end point, a colour change was observed (colourless to pink which persists for 30 seconds). At this point, all the oxalate would have been used up and any more coloured permanganate added will not have any free oxalic acid to react with and therefore remain in solution giving a pink coloured solution. Some samples produced very little precipitate with a titre value of less than 1 ml of N/50 permanganate hence their corresponding duplicates were titrated with a solution of N/100 permanganate instead.

For every determination and evaluation, a standard curve of mass of calcium (mg) versus N/100 permanganate was plotted. A conversion factor rate of every 1 ml of N/100 permanganate equals 0.2 mg calcium

#### Calcium

- Principle Underlying Calcium Determination
- The ash was dissolved in 10 ml 5N HCl and made up to 50 ml
- Calcium is precipitated by Ammonium oxalate
- $\text{CaCb} + (\text{NH}_4)_2\text{C}_2\text{O}_4 \rightarrow 2\text{NH}_4\text{Cl} + \text{CaC}_2\text{O}_4 \text{ (ppt)}$  (Ammonium oxalate) (Calcium oxalate)
- Calcium oxalate is converted to oxalic acid by sulphuric acid
- $\text{Ca C}_2\text{O}_4 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{H}_2\text{C}_2\text{O}_4$
- Oxalate  $\xrightarrow{2\text{NH}_2\text{SO}_4}$  Oxalic acid
  - Oxalic acid is titrated against 0.02N Potassium permanganate
  - $$5\text{H}_2\text{C}_2\text{O}_4 + 2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 \longrightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 8\text{H}_2\text{O} + 10\text{CO}_2$$

Calculate the amount of calcium from the titer value

- 1 ml 0.02N Potassium permanganate = 0.00049 Ca.

## A: RESULT OF STATISTICAL ANALYSIS

**Table 1. Pearson correlation coefficients across attributes and nutrient content with reference to trained panel acceptability test.**

	Moisture	Ash/g	Fat/g	Protein /g	Carbohydrate/g	Energy /kcal	Calcium/mg	Iron/g	Zinc/g
	-	-	-	-	-	-	-	-	-
Fat/g	0.27628 7145	0.64580 0851	1						
Protein/g	0.41876 1284	0.33726 499	0.08425 9626	1					
Carbohydrate/g	0.19617 1546	0.13294 8957	0.74275 5463	0.71329 5007	1				
Energy/kcal	0.40742 5095	0.74969 283	0.98810 637	0.00249 677	0.661672 023	1			
Calcium/mg	0.70595 994	0.99691 2851	0.63743 2051	0.40158 3959	0.091380 51	0.74100 4954	1		
Iron/g	0.88204 2083	0.36490 9824	0.10869 9014	0.11079 8745	0.099316 523	0.20638 2792	0.33246 86	1	
Zinc/g	0.34586 0215	0.72993 0132	0.11986 521	0.57343 6176	0.356333 185	0.22193 7944	0.75746 6205	0.10628 5263	1
Colour	0.21918 7041	0.72004 1976	0.24924 8488	0.04000 435	0.060704 057	0.32635 2187	0.70817 0178	0.12673 1129	0.8385 1673
Taste	0.65945 4401	0.94092 8289	0.67556 2061	0.00713 7097	0.356039 454	0.76456 8211	0.91230 2049	0.40870 4317	0.5646 99032
Consistency	0.53817 6362	0.93613 1477	0.44690 3485	0.33714 3097	0.003729 539	0.55197 6415	0.93772 5526	0.13102 8344	0.8975 95597
Mouth f.	0.72718 296	0.98879 1038	0.69791 7869	0.21276 5564	0.245949 011	0.79529 1358	0.97538 5226	0.42297 8528	0.6338 96701
Aroma	0.52830 4435	0.88270 2711	0.58472 928	0.10367 5683	0.364164 824	0.66708 6627	0.84888 4651	0.27961 0506	0.5996 58933
Aftertaste	0.68636 2683	0.93128 9864	0.63548 1422	0.00151 5618	0.327600 899	0.72976 1626	0.89998 3686	0.45099 205	0.5547 37743
O.A	0.60799 5962	0.95066 0592	0.61746 0995	0.06062 9278	0.281945 721	0.71038 7497	0.92773 1112	0.31004 1111	0.6737 11755

**Table 2: (One-Way)Analysis of Variance of sensory acceptability (untrained panel)**

<b>Summary</b>						
Groups	Sample size	Sum	Mean	Variance		
COLOUR	46	127.	2.76087	0.36377		
TASTE	46	132.	2.86957	0.24928		
AROMA	46	129.	2.80435	0.24976		
O.A	46	129.33333	2.81159	0.10199		
<b>ANOVA</b>						
Source of Variation	SS	df	MS	F	p-level	F crit
Between Groups	0.27536	3	0.09179	0.38055	0.77	2.65479
Within Groups	43.41546	180	0.2412			
Total	43.69082	183				

**Table 3.: Pearson correlation coefficients across attributes in un trained panel acceptability test.**

Variable vs. Variable	R	p VALUE
COLOUR vs. OVERALL	0.94221	0.0014
TASTE vs. OVERALL	0.8346	0.00001
COLOUR vs. TASTE	0.632	0.03697
AROMA vs. COLOUR	0.39186	0.2333
AROMA vs. OVERALL	0.10986	0.7478

**Preference test Results**

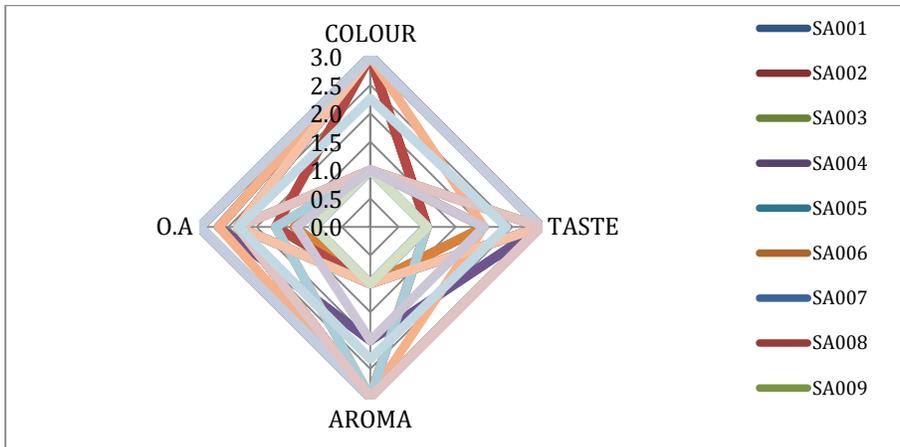


Figure 1: Mean Scores For All Attributes Of Sample Fsm579

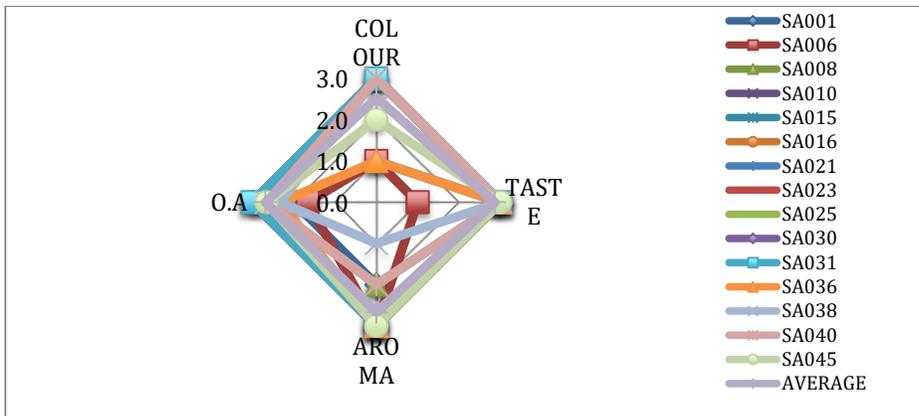


Fig3: Mean Scores For All Attributes Of Sample Fsm123