EFFECT OF SOYBEAN (*Glycine max*) FORTIFIED PORRIDGES ON THE NUTRITIONAL STATUS OF CHILDREN 36-60 MONTHS OLD IN MATEKA EARLY CHILDHOOD DEVELOPMENT CENTRE, BUNGOMA COUNTY, KENYA

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DECLARATION

Declaration by the candidate

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DEDICATION

This work is dedicated to children who come from humble socio-economic backgrounds and who in the quest for education; have to bear with many challenges.

ABSTRACT

Protein energy deficiency is still common in developing countries, particularly among pre-school children and therefore there should be sustainable ways to alleviate this. Bungoma is one of the counties with high prevalence of Protein Energy under nutrition among young children. The purpose of this study was to evaluate the effect of soybean fortified porridges on the nutritional status of children 36-60 months old in Mateka Early Childhood Development Centre, Bungoma County. A longitudinal survey and experimental designs were employed in this study. One hundred and twenty five (125) children selected from three Eearly Childhood Development classes in the school formed the sample size. Purposive and simple random sampling techniques were used to select the study area and the children respectively. The treatments were; 100% maize, 75:25 maize:soybean and 50:25:25 maize:sorghum: soybean porridges, randomly assigned to the baby, middle and top classes. The treatment groups were fed on maize-sorghum-soybean fortified porridges while the control was fed on a maize-only porridge. Structured questionnaires were administered to the caregivers of the children. Information on demographics, socio-economic status, and food consumption patterns were gathered. Anthropometric measurements (weight, height, mid upper arm circumference) were used to assess the nutritional status of the children at baseline and at monthly intervals for six months and the ninth month. Anthropometric measurements were analyzed using the ENA for SMART computer program, nutrient adequacy data was analyzed using Nutri-survey for Windows (2007) while the rest of the data was analyzed using the Statistical Package for Social Sciences (SPSS) Version 21 (2007). A P value of < 0.05 was considered statistically significant. Results revealed that most of the children were deficient of Energy, Protein, Vitamin A, Iron and Zinc. Majority (55.2%) of the children had a low dietary diversity score. Findings revealed that the prevalence of under nutrition at baseline 30.1% stunting, 6.7% wasting and 10.8% underweight. Introduction of soybean as a fortificant in an experimental study revealed reduced levels of wasting to 3.8% and underweight (5.4%). It can be concluded that most of the households were of poor socio-demographic characteristics, there was nutrient inadequacy among the children, and that soybean fortified porridges improved the nutritional status of the children. It is recommended that most o awareness of the nutritional benefits of soybean should be raised to increase consumption at household level and in the school feeding programs to alleviate Protein Energy under nutrition.

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LIST OF ACRONYMS

AIDS	Acquired Immuno-Deficiency Syndrome
ASF	Animal Source Foods
BIA	Bio-Impedance Analysis
CRD	Complete Randomized Design
CSB	Corn-Soy Blend
DALYS	Disability Adjusted Life Years
DDS	Dietary Diversity Score
ECD	Early Childhood Development
EER	Estimated Energy Requirement
FEWSNET	Famine Early Warning Systems Network
HAZ	Height-for-Age Z-Scores
IDDS	Individual Diet Diversity Score
HIV	Human Immunodeficiency Virus
HQPM	High Quality Protein Maize
IDA	Iron Deficiency Anemia
IFPRI	International Food Policy Research Institute
IOM	International Organization of Medicine
IREC	Institutional Research and GlobalEthics Committee
Kcal	Kilocalories
KDHS	Kenya Demographic Health Survey
Kj	Kilojoules
KNBS	Kenya National Bureau of Statistics

MT	Metric Tonnes
MUAC	Mid Upper-Arm Circumference
MZ	Maize only porridge
NACOSTI	National Commission for Science Technology and Innovation
OFSP	Orange Fleshed Sweet Potato
PDCAAS	Protein Digestibility Corrected Amino Acid Score
PEM	Protein Energy Under nutrition
RDA	Recommended Dietary Allowance
RUCF	Ready to Use Complementary Food
RUTF	Ready to Use Therapeutic Food
SD	Standard Deviation
SID	Society for International Development
SM	Soybean-Maize porridge
SMS	Sorghum-Maize-Soybean porridge
SSA	Sub-Saharan Africa
UNICEF	United Nations Children's Fund
USDA	United States Drug and Administration
VA	Vitamin A
VAD	Vitamin A Deficiency
VLIR – UOS	Vlaamse Interuniversitaire Raad-University Development Cooperation
WAZ	Weight-for-Age Z-scores
WFP	World Food Program

WHES	World Hunger Education Service
WHO	World Health Organization
WHZ	Weight-for-Height Z-scores

DEFINITION OF OPERATIONAL TERMS

Corn-soy blend: A mix of maize and soybean flour that is used as a supplementary food for children with under nutrition in the community

Diet diversity: The number or types of foods from different food groups consumed over a 24 hour period by an individual

Fortification: Addition of nutrients to food that were not previously present in the food, or they were present in minute amounts for the purpose of making it more wholesome

Koko: A Ghanaian food made from maize that is used as a weaning food for young children

Nutritional adequacy: A diet is described as nutritionally adequate if it meets the requirements for energy and all other essential nutrients for the growth of young children

Nutritional status: The physiological condition of an individual that results from the balance between nutrient requirements and intake and the ability of the body to utilize these nutrients

Porridge: A soft food made of cereal, tuber or legume flour, or a combination of flours boiled to a thick consistency in water

Socio-economic factors: Proxy indicators such as occupation and ownership of assets

Stunting: Low Height-for-Age as a result of chronic inadequate food intake

Under nutrition: A syndrome of inadequate intake of protein, energy and micronutrients by an individual which results in poor growth and body size.

Underweight: A combination of wasting and stunting as a result of exposure to acute food shortage

Wasting: Low Weight-for-Height where a child is thin for his/her height

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To all, may God bless you!

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Under nutrition is a serious global health problem brought about by inequalities in the economic systems and social injustices resulting in incidences of wasting, underweight and stunting among children (International Food Policy and Research Institute (IFPRI), 2016). In 2014 alone, 6.3 million children were reported globally to have died of under nutrition by the World Health Education Service (WHES, 2015). Protein Energy under nutrition is considered the worst form of under nutrition associated with lack of energy and proteins (De Lange *et al*., 2010) and a major deficiency disease that affects children in Asia and other developing countries (United Nations Children's Fund (UNICEF)/World Health Organization/World Bank, 2015).

Increasing Protein Energy under nutrition levels in Sub-Saharan Africa and Asia is attributed to high levels of poverty (Food and Agriculture Organization of the United Nations (FAO), 2015) such that most families in these countries cannot afford to include animal protein in their diets owed to their high cost. In this regard, these people consume plant based diets as they are cheaper, though their quality is poorer compared to animal proteins that contain all indispensable amino acids and have high digestibility (Hoffman & Falvo, 2004).

Since legumes and cereal grains are the most important sources of plant proteins in the context of human protein nutrition, there is need to utilize them as an alternative source of cheap, high quality protein for people in developing countries. Furthermore, it has been documented that compositing legume proteins with those from cereal and root crops has a complementation effect producing complete and well balanced amino acid profiles that meet human physiological requirements (Michaelsen *et al.*, 2009).

Soybean (*Glycine max)* among legumes is recognized for its high nutritional value as it contains about 40% protein, 23% carbohydrate, 20% oil and 4% minerals (Shiriki *et al*., 2015). It has a protein content twice that of pulses, groundnuts, meat and fish. Soy protein contains eight essential amino acids, and is superior to other plant proteins (Singh *et al.*, 2008). Soybean is an excellent source of mineral elements such as potassium, and vitamins such as riboflavin, vholine, thiamine and pantothenic acid and high energy due to its oil content (Swick, 2007). It is a cheap source of protein and a sustainable protein that can be used to alleviate under nutrition in developing countries through complementation of cereals with legumes to boost their protein and amino acid content (Kolapo, 2011). Cereals such as maize and sorghum provide an easy vehicle for delivering protein in the diet as they are the most consumed staples in developing countries.

The use of corn-soy blends (CSB) has been promoted as one of the sustainable ways of alleviating PEM in developing countries (Akomo *et al.*, 2016). In Western Kenya where the levels of PEM are high among pre-school children, soybean has been introduced in an effort to reduce the prevalence by Vlaamse Interuniversitaire Raad-University Development Cooperation (VLIR – UOS). Efficacy of these soybean fortified cereals should be tested on their ability to improve the nutritional status of the children. Therefore, the aim of this study was to evaluate the effect of soybean fortified porridges on the nutritional status of 3-5 year old children attending Mateka Primary School in Bungoma County.

1.2 Statement of the problem

Hunger and under nutrition are burdens that are pronounced in developing countries where they manifest themselves in the forms of protein energy under nutrition (UNICEF, WHO/ World Bank, 2015). Under nutrition compromises the child's immune system leading to direct mortality and increased vulnerability to infectious diseases, stunting and poor brain development, which hinder academic achievement in school going children (Khanam *et al.,* 2011) and reduced work capacity in adulthood (Carba *et al.,* 2009).

In Western Kenya, children are largely fed on starchy staple cereals that are inadequate in their nutritional quality and quantity (Grant *et al.,* 2016). Furthermore families may not afford animal rich proteins, and also lack adequate knowledge on the importance of feeding their children amino acid rich proteins (Kinyuru *et al.,* 2012). This becomes an exacerbating factor for the children to develop PEM. Cereal-legume mixes have been shown to have a higher protein quality and quantity compared to pure cereals. While many families cannot afford animal protein because of the high cost, plant protein can be used as a good measure to alleviate and bridge the gap in terms of protein inadequacy in the diet (Eshun, 2009) as the plant protein is cheap and easy to grow (Kolapo, 2011). Therefore, there is need to seek for alternative sources of high quality cheap protein, and in most developing countries, this is provided by legumes which account for 66% of the world's edible proteins (Kolapo, 2011). One of these vegetables proteins is soybean.

Even though Bungoma County is one of the leading soybean producing areas in Western Kenya, the levels of under nutrition are still unacceptably high. Soybean grain which is high in essential amino acids can be used to alleviate PEM in the County. The rates of under nutrition in Bungoma County stand at 24.4% stunting, underweight incidence at 2.9% and wasting at 9% (Kenya National Bureau of Statistics (KNBS& ICF Macro, 2015). The levels of under nutrition are higher than the national figures and this warrants attention to combat under nutrition in this region. The poverty rates in the County stand at 53% and food insecurity stands at 20-50% depending on the sampled area (KNBS & Society for International Development (SID), 2013). The levels of poverty are a pointer that most of the households cannot afford to incorporate animal proteins in their diets.

According to the County Early Childhood Education Bill (2014) (GoK, 2014), every County Education Board should carry out feeding programs in early education centres in areas where children are affected by under nutrition or have special nutritional needs. The Act further says that the feeding programs should provide adequate and nutritious foods based on the physiological needs and regional demands. Children in feeding centres in Bungoma County are fed on the porridges made from starchy staples and often have low quality proteins. This shows that these porridges do not meet the protein needs of the growing child. Therefore this study sought to evaluate the effect of soybean fortified porridges on the nutritional status of the 36-60 months children.

1.3 Objectives of the study

1.3.1 Broad objective

To evaluate the effect of soybean fortified porridges on the nutritional status of children 36-60 months old in Mateka Early Childhood Development Centre, Bungoma County, Kenya

1.3.2 Specific objectives

1. To assess the socio-economic status and demographic characteristics of the 36-60 months old childrens' households in Mateka Early Childhood Development Centre, Bungoma County, Kenya
2. To establish the nutritional adequacy of the diets of the children 36-60 months old in Mateka Early Childhood Development Centre, Bungoma County, Kenya
3. To evaluate the effect of different soybean fortified porridges on the nutritional status of 36-60 months old children in Mateka Early Childhood Development Centre, Bungoma County, Kenya
4. To establish the relationship between selected socio-demographic factors and nutritional status of the 36-60 months old children in Mateka Early Childhood Development Centre, Bungoma County, Kenya

1.4 Hypotheses

H_{A1}: There is a significant difference between intake of soybean fortified porridges and improvement in the nutritional status of the 36-60 months old children in Mateka Early Childhood Development Centre, Bungoma County, Kenya

H_{01}: There is no significant difference between intake of soybean fortified porridges and improvement in the nutritional status of the 36-60 months old children in Mateka Early Childhood Development Centre, Bungoma County, Kenya

H_{A2}: There is a significant relationship between household demographic characteristics and nutritional adequacy of diet for children 3-5 years old.

H_{02}: There is no significant relationship between household demographic characteristics and nutritional adequacy of diet for children 3-5 years old.

1.5 Significance of the study

This study will give an insight to parents and care givers on the importance of soybean flour on improving the diet quality of their children. Furthermore, the results from this study will assist the community to work towards sustainable ways of feeding their children to alleviate under nutrition by the use of locally produced foods such as soybeans and cereals such as maize and sorghum. The Ministry of health will benefit as the results from this study will give an insight into one of the ways in which the nutritional status of pre-school children can be improved by the use of soybean fortified porridges. It is hoped that the Ministry of Education will benefit, incorporate the use of soybean fortified porridges in school feeding programs aimed at ensuring good nutritional status of pre-school children, increasing school enrollment and keeping the children satisfied so that they can be able to concentrate in class.

This research will also increase the body of knowledge on evaluation of the effect of soybean fortified flours on the nutritional status of pre-school children of a similar study setting, and therefore form basis for intervention studies in which the prevalence of under nutrition can be reduced.

1.6 Assumptions of the study

1. This study assumed that the children were going to attend school consistently
2. This study assumed that all the children participating in the study regularly ate the porridge and enjoyed it.

1.7 Limitations of the study

1. The researcher did not have control over other foods the children were fed on apart from the porridge. To control this, the nutritional adequacy of the children was determined at baseline before the feeding program was implemented to establish the deficiency of critical nutrients at baseline.
2. This study was carried out in a rural area where most households are subsistent farmers so generalizations to other areas should be done with caution.

1.8 Conceptual framework

This study adapted the UNICEF (1990) conceptual framework for determinants of under nutrition in young children (Fig 1.1). The causes of PEM are multi-factorial having a number of interwoven factors operating simultaneously (UNICEF, 2015). These causes are categorized as immediate, underlying and basic causes as described by the UNICEF (1990) conceptual framework. The causes reflect relationships among factors and their possible influences on the child's nutritional status. This study will use the immediate (diet diversity and nutrient adequacy) and the underlying factors (household demographic factors and household income) to under nutrition as the framework to explain the study.

People of low socio-economic status are most vulnerable to food insecurity since their purchasing power serves as the main determinant of the ability to afford foods that are nutritionally adequate. Households that cannot obtain nutritious foods due to low income are most associated with inadequate diet and disease that leads to under nutrition (Black *et al*., 2013). Furthermore, the child's nutritional status is greatly influenced by diversity of their diet. When the dietary diversity is low, it means that the child is not adequately fed and therefore not meeting their nutrient intakes. This has an effect on the nutritional status of the child.

Inadequate education and knowledge among the parents of the children is one of the factors that affect the nutritional status of the young children. If the parent has no knowledge on how to feed their children well, the child is most likely to have inadequate nutrient intakes and therefore the child will be under-nourished. In this study the relationship between the caregiver level of education was established. Household size determines the inter-household food distribution, where in a poor household with many members, the children are likely to suffer from under nutrition.

In conclusion, the immediate causes affect individuals, the underlying causes relate to the household while the basic causes are related to the community and the nation. This study looked into possible way of alleviating protein deficiencies in the diets of the children with special reference to the use of soybean fortified porridges to bridge the protein gap. This conceptual framework is useful as it highlights the factors that contribute to under nutrition and how they relate to each other, such as household economic status, nutritional adequacy and maternal level of education. A better insight of the underlying causal factors of under nutrition is essential for planning appropriate interventions (USAID, 2006). The framework has been integrated into this study by use of variables such as nutrient adequacy socio-economic factors and how they have an effect on the nutritional status of the child. The same variables were be used in testing of the hypotheses of the study.

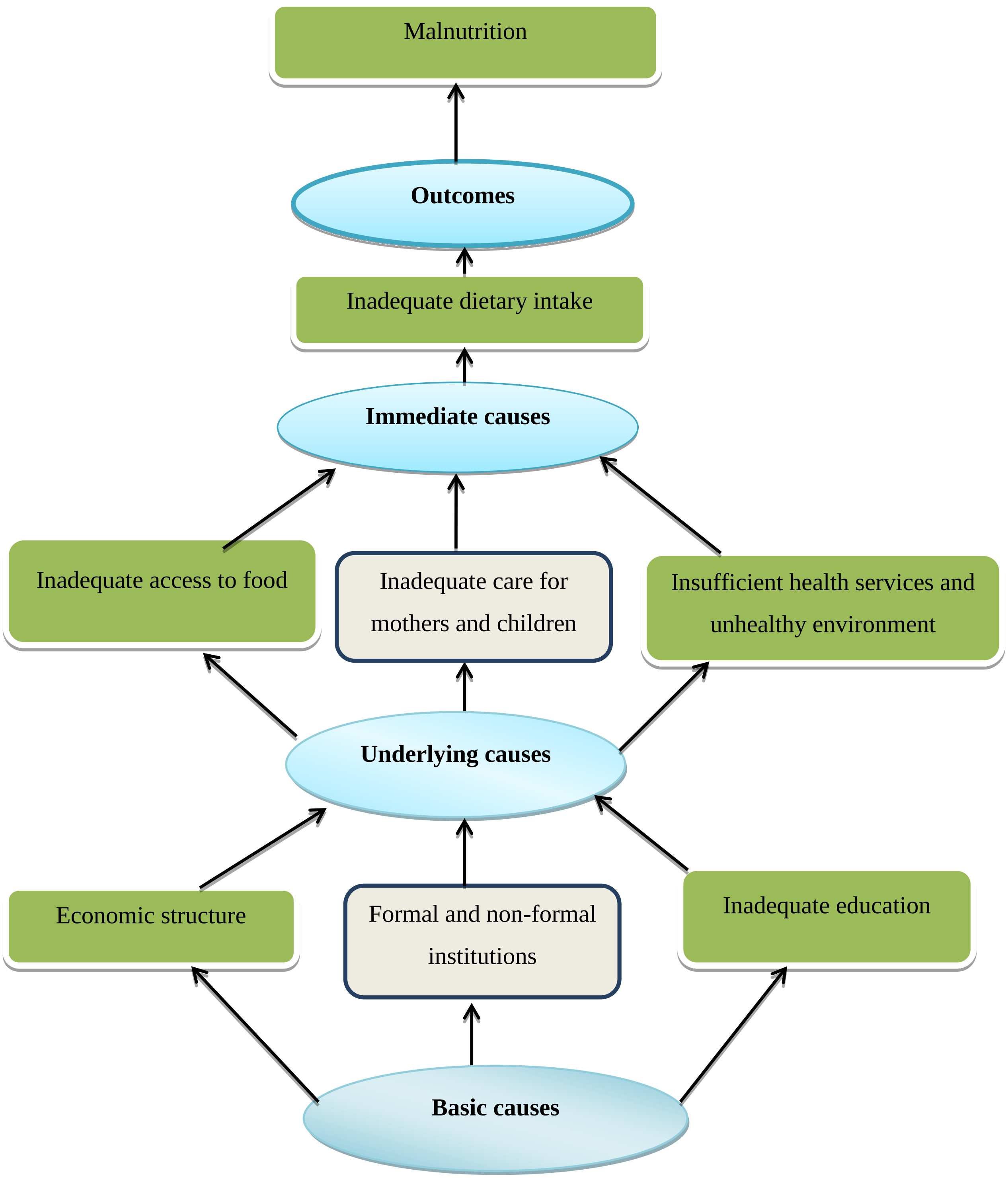


Figure 1.1: ***Source: Adapted from UNICEF (1990)*. (The green colored boxes show the section of the flow chart that directly relate to this study)**

CHAPTER TWO

LITERATURE REVIEW

2.1 Definition of under nutrition and consequences on young children

Under nutrition is defined as the physiological condition of an individual that results from inadequate intake of nutrients and often leads to decreased inability of the body to maintain natural body capacities such as growth, resisting infections and recovering from disease, learning and physical work, and pregnancy and lactation in women (UNICEF/WHO/World Bank, 2015). Under nutrition includes being underweight for one's age, too short for one's age (stunted), too thin for one's height (wasted) and deficient in vitamins and minerals (micronutrient under nutrition) (UNICEF/WHO/World Bank, 2015). However, this review focuses mainly on wasting, stunting and underweight.

Under nutrition is the most compelling risk factor to mortality and morbidity affecting millions of children and pregnant women globally (WHES, 2015). It is currently the leading cause of global burden of disease accounting for 54% of mortality in children under 5 years in developing countries (UNICEF, 2013a). Based on the UNICEF (2015) report, under nutrition has been recognized to create the highest burden of diseases in the world, accounting for 16% of all calculated Disability-Adjusted Life Years (DALY's). Distribution of under nutrition in the world is uneven and the burden of it weight is mostly felt in Sub-Saharan Africa and South Asia, and in poor communities found in these regions (UNICEF, 2013b).

Protein Energy Under nutrition is considered the most lethal form of under nutrition caused by lack of energy and proteins (DeLange, 2010). PEM may be present at any time during the life cycle, but it is more common in the extreme ages, which is, during infancy or childhood and in the elderly (Castaneda *et al.*, 1995). Under nutrition is a problem in many developing countries, most commonly affecting children between the ages of 6 months and 5 years because that is the age that most of the children are introduced to complementary foods. The condition may result from lack of food or from infections that cause loss of appetite while increasing the body's nutrient requirements and losses. Children between 12 and 36 months old are especially at risk since they are the most vulnerable to infections such as gastroenteritis and measles (UNICEF, 2013b) which is an exacerbating pro.

Wasting is manifested by low body weight to Height; and occurs when the Z-score is below the median by -2SD. Low weight for Height -3SD from the median is referred to as severe wasting (UNICEF, 2013b). Wasting is more prevalent in children facing acute starvation and those having a protracted disease discourse, which in turn results to severe under nutrition (DeLange, 2010). The implication of this condition is acute under nutrition in a chronically stunted child. This is due to poor food quality and quantity which translates to the child becoming underweight (UNICEF/WHO/World Bank, 2015).

An underweight child is common and an important presentation of PEM, which is missed a lot of times (UNICEF/WHO/World Bank, 2015). Children are considered moderately malnourished when the weight for age is below the median by -2SD, severe underweight is when the proportions of z scores are below the median by -3SD (UNICEF/WHO/World

Bank, 2014).This condition is manifested in children when the diet is deficient or insufficient in protein or energy. This will lead to a slowdown in the linear growth, loss of weight, and failure to gain weight (DeLange, 2010). Underweight is commonly seen in children who have been exposed to acute food shortage (UNICEF/WHO/World Bank, 2014).

Stunting is a severe problem as compared to underweight and wasting (UNICEF, 2009b) and is an indicator of nutrient deficiencies. Stunting is defined as low height for age and occurs when the Z-score is below the median by more than -2SD (UNICEF/WHO/World Bank, 2015). It is the failure to achieve linear growth and is more pronounced in children with long term insufficient intake of nutrients and those with a protracted infection and disease discourse. Stunting below the age of two years causes irreversible poor motor and cognitive development (UNICEF, 2009b).

2.2 Prevalence and trends of under nutrition

The Food and Agriculture Organization of the United Nations estimates that about 795 million people of the 7.3 billion people in the world were suffering from chronic undernourishment in 2014 (FAO, 2015). This translates to one in nine people. It is further estimated that almost all the hungry people are living in developing countries which represents 12.9%, or one in eight people of the population of developing countries (WHES, 2016). Hunger continues to take its largest toll in Southern Asia, which includes the countries of India, Pakistan and Bangladesh. The estimate of 276 million chronically undernourished people in 2014 to 2016 is only marginally lower than the number in 1990 to 1992. Eastern Asia and South-eastern Asia have reduced under nutrition substantially (FAO, 2015).

The vast majority of hungry people live in developing regions, which saw a 42 percent reduction in the prevalence of undernourished people between 1990–92 and 2012–14. Despite this progress, about one in eight people, or 13.5 percent of the overall population, remain chronically undernourished in these regions, down from 23.4 percent in 1990 to 1992. As the most populous region in the world, Asia is home to two out of three of the world's undernourished people. According to the Global Nutrition Report 2016 there has been least progress in reduction of the prevalence of under nutrition in the Sub-Saharan Africa region, where more than one in four people remain undernourished, which is the highest prevalence in any part of the world (IFPRI, 2016). Nevertheless, the prevalence of undernourishment in sub-Saharan Africa has declined from 33.2 percent in 1990 to 1992 to 23.2 percent in 2014 to 2016, although the number of undernourished people has actually increased (FAO, 2015).

Children are the most visible victims of under nutrition. Black *et al*., (2013) estimate that under nutrition in the aggregate—including fetal growth restriction, stunting, wasting, and deficiencies of vitamin A and zinc along with suboptimum breastfeeding—is a cause of 3·1 million child deaths annually or 45% of all child deaths in 2011. According to Global Nutrition Report 2016, globally, 161 million under-five year olds were estimated to be stunted in 2013. The global trend in stunting prevalence and numbers affected is decreasing. Between 2000 and 2013 stunting prevalence declined from 33% to 25% and numbers declined from 199 million to 161 million. In 2013, about half of all stunted children lived in Asia and over one third in Africa (UNICEF/WHO/World Bank, 2014).

Globally, 51 million under-five year olds were wasted and 17 million were severely wasted in 2013. Globally, wasting prevalence in 2013 was estimated at almost 8% and nearly a third of that was for severe wasting, totaling 3%. In 2013, approximately two thirds of all wasted children lived in Asia and almost one third in Africa, with similar proportions for severely wasted children (UNICEF /WHO/World Bank, 2014). Globally, 99 million under-five year olds were underweight in 2013, two thirds of whom lived in Asia and about one third in Africa. The global trend in underweight prevalence continues to decrease; going from 25 per cent to 15 per cent between 1990 and 2013. Africa has experienced the smallest relative decrease, with underweight prevalence of 17% in 2013 down from 23% in 1990, while in Asia for same period it reduced from 32% to 18% and in Latin America and the Caribbean from 8% to 3%.

In Kenya, the prevalence of under nutrition has decreased in the last five years, even though the values are still high (KNBS & ICF Macro, 2015.) In the 2008-09 KDHS, at the national level, 35% of children under five were stunted, 16% underweight and 7% wasted. According to the 2014 KDHS, at national level, 26% of children under the age of 5 were stunted which is a sign of chronic under nutrition. Stunting is more common in rural areas than urban areas (29% versus 20%). Four percent of children under five are wasted, or too thin for their height. This is a sign of acute under nutrition. Overall, 11% of children are underweight, indicating that their weight is too low for their age. A comparison of the two DHS shows that children’s nutritional status has improved in recent years. Stunting has dropped from 35% in 2008-09 to 26% in 2014. Wasting and underweight have also dropped slightly (KNBS & ICF Macro, 2015).

2.3 Under nutrition and pre-school g children

Studies that have examined the effect of under-nutrition on cognitive ability, even though not entirely conclusive; have found that chronic under-nutrition is associated with lower academic achievement levels among children. Studies have found a significant association between stunting and the first two years of life and lower scores in school age (8-11 years) where chronic under nutrition lowers language and mathematic test scores (Sarma *et al*., 2013). Others have found that short stature may lead to late enrolment for primary school children (Le Thuc, 2009; Sanchez, 2009).

Both hunger and under nutrition have been implicated for negatively impinging on education of school age children. Incidences of absenteeism in countries such as Uganda and Ghana have been blamed partly on inadequate or lack of nutritious foods (UNICEF, /WHO/World Bank, 2015). It has been documented that children especially those from developing countries would rather stay home than go to school and endure hunger (Bundy *et al.*, 2009). The consequences of under-nutrition such as increased morbidity or some forms of physical incapacity have been shown to have negative implications on the education progress of young children (Mangusho *et al*., 2010).

The cyclic and synergistic relationship between hunger and under nutrition on one side and child education on the other has been established (Aubery, 2012). Nutrition deficiencies contribute to a vicious cycle of under nutrition, underdevelopment and poverty affecting already underprivileged populations since nutritionally deficient adults are less productive, less innovative and more susceptible to diseases. The relationship between IDA and iodine deficiency and cognitive development, ability to concentrate and innovativeness has been established (Zimmerman & Anderson, 2012). Furthermore, while education has been viewed as a tool to improve livelihoods to fight poverty, disease, hunger and under nutrition, in the face of the latter, education is compromised (UNICEF, 2013a). Therefore there is need to look into ways of improving the nutritional status of school age children, as the effects of under nutrition at this critical phase of growth can have negative effects on generations to come.

2.4 School feeding programs in developing countries

For millions of school going children today, hunger is one of the pervasive and damaging dilemmas, and it has far reaching effects on the development of individuals and nations (WFP, 2017). According to WFP (2017), 66 million primary school age children attend school hungry where 23 million are in Africa alone. Additionally, 75 million school-age children (55% of them girls) do not attend school, with 47% of them living in Sub-Saharan Africa (World Bank, 2013). WFP has been supporting school feeding programs in most developing countries and the major objectives of the program are to attract and retain children in school, improve school enrolment, improve attendance, increase attention span of school going children and reduce gender equality in the education sector, improve the child's nutritional status and act as a vehicle for fighting disease (WFP, 2017; Lawson, 2012).

Most of the meals provided in school feeding programs are not adequate to meet the nutritional needs of the school going children (Kenya Kids Can Organization, 2017). In Kenya, most of the programs feed children on porridge made of staples such as maize, sorghum and millet, and in some instances, *githeri,* a boiled mixture of maize and beans

(Kenya Kids Can, 2017). This shows that the protein quality and quantity of these foods is low. According to Kearney (2008) foods used for school feeding programs should have a high nutritional value, rich in energy, proteins and micronutrients, and moderate in fats and sugar.

According to the WFP, the standard formula used to calculate the average serving size for pre-school and primary school meals for school feeding is that pre-school children aged 36-60 months receive on average 6720 kilojoules (kJ) with 32 g protein. Primary schoolchildren aged six to twelve years should receive 8400 kJ with 40 g protein (WFP, 2005). Nutrition composition of school feeding program menus of Kenyan children aged 10-12 years showed that it provided 24.8g (50% of RDA) of protein and 706 Kcal (32% of RDA) (Aliyar *et al.*, 2015).This shows that the energy content of these meals may not be adequate considering that energy expenditure in schoolchildren in developing countries also tends to be higher due to the methods and distance of travel to school (Aliyar *et al.*, 2015). This can be a challenge in a country like Kenya where high level of stunting has been reported (KNBS & ICF Macro, 2015). This shows that there is need to develop a snack that is nutrient dense to meet the protein and the energy requirements of these school going children.

In Kenya, in an effort to transition away from WFP assistance and create a more sustainable and locally integrated program, the Ministry of Education began implementing a Homegrown School Feeding Program (HGSFP) in 2009 (Espejo, 2009). The HGSFP Program targets about 600,000 Kenyan children (de Lara and Sidane, 2011). The aim of

HGSFP is encouraging and facilitating increased consumption of locally produced food items, including the promotion of innovative school feeding programs that use food items sourced from the local farming community (USDA, 2009). Increasingly, HGSF is being adopted to not only improve education outcomes but also farmers' livelihoods through increased production, market access and improved nutrition (Kalaluka, 2011). This shows that there is need to promote locally produced foods as recommended by the County Early Childhood Education Bill (GoK, 2014) to improve the nutritional status of school going children.

2.5 Nutritional needs of children 36-60 months old

Adequate nutrition is important in the health and development of young children. Adequacy and quality of diet influences the child's cognitive, physical and psychosocial growth. In this sense, children are supposed to be fed in nutritionally adequate foods so that children can have adequate intakes of carbohydrates, proteins, iron, zinc, iodine, calcium and vitamin A (Akhtar & Ashgar, 2011). Furthermore, these critical nutrients should be highly bio-available so that they can be absorbed and utilized in large amounts. The requirements for these nutrients in the children's diet in relation to Recommended Dietary Allowances (RDA) or different age groups to meet growth and development needs of the children have been shown in the Table 2.1.

Table 2.1: Nutrient requirements for children 36-60 months old

Nutrient	Unit	36months	48-60 months
Energy	Kcal	992-1046	1642-1742
Protein	G	13	19
Vitamin A	µg	300	400
Iron	Mg	7	10
Vitamin E	Mg	6	7
Vitamin B_1	Mg	0.5	0.6
Vitamin B_2	Mg	0.5	0.6
Vitamin B_6	Mg	0.5	0.6
Folic acid	µg	150	200
Calcium	Mg	500	800
Magnesium	Mg	80	130
Phosphorous	Mg	460	500
Zinc	Mg	3	5

Source: Institute of Medicine (IOM) (2000)

Energy: Energy is essential for growing children as they expend more of this during the growth process and that their bodies are developing. The major sources of energy include staples and starches and lipids. The energy density of a meal is most important for wasted children, as they require increased energy for catch-up growth (Michealsen *et al*., 2009). Furthermore, deficiency of energy increases the chances of the children developing protein energy under nutrition.

Proteins: Proteins are essential for human cells and body cells as they form the basic parts within the cells. Proteins are responsible for providing amino acids and nitrogen which is required for non-essential amino acids and nitrogen balance in the body (FAO, 2011). The amino acids are important in linear growth, repair and maintenance of body tissues, formation of antibodies to defend the body against infections, control body electrolytes and fluid balance, regulate acid balance, transport nutrients and provide energy (Rolfes *et al.*, 2014). Protein from animals is complete as they contain all the essential amino acids, while majority of the plant proteins are incomplete. It is recommended that the protein intake of the total energy intake should be between 5-20% of the total energy intake.

Vitamin A: The term vitamin A is used to refer to a group of compounds with biologic activity of all trans-retinol. Vitamin A plays an important role in vision, bone growth, reproduction, cell division, and cell differentiation (Jason *et al*., 2002). There are two categories of vitamin A: Preformed vitamin A from animal sources and pro-vitamin A (carotenoids) from plant sources. In humans, either form of vitamin A when ingested becomes available as retinol (active form). Vitamin A is well known as an anti-infective vitamin because of its role in the immune system (Mangusho *et al*., 2010). Retinol and its metabolites are required for maintaining the integrity and functioning of the skin and mucosal cells (cells lining the surfaces of the respiratory, urinary and intestinal tracts) which form the body's line of defense (Jason *et al.,* 2002). Vitamin A also has a role in the activation of the lymphocytes. The main sources in the diet are dark green leafy vegetables and deep yellow and orange fleshed foods. The Recommended Dietary Intake for children 2-3 years and 4-6 year children is 400 µg and 500 µg respectively (IOM, 2000).

Zinc: This is one of the critical micronutrients that is required in the growth and development of young children. Zinc is responsible for cell division and differentiation in children and therefore inadequate zinc intake predisposes children to stunting (Hambidge *et al.,* 2008). Deficiency also results in reduction in the appetite, poor taste acuity and increased morbidity to childhood illnesses such as diarrhea and respiratory infections as it is important in the development of the innate and acquired immunity in children (Rolfes &

Whitney, 2014). The main sources of zinc in the diet are animal source foods such as beef, poultry and organ meats. Legumes and nuts also rich sources of zinc, however the presence of phytates inhibits their bio-availability of zinc (Akomo *et al.,* 2016).

Iron: There are two major sources of iron in the body, the haem and the non-haem sources. Haem sources are those from animal source foods and are highly bioavailable. Non-haem sources are those of plant origin and include majorly green leafy vegetables, legumes, nuts and cereals. The bio-availability of iron in these foods is low. Iron is critical in the process of blood formation. Low intake of dietary iron is associated with increased levels of iron deficiency anemia. Iron deficiency has been implicated for poor cognitive development, low levels of concentration and low productivity in children (Rolfes & Whitney, 2014)

2.6 Nutritional quality and adequacy of African diets

Cereal and tuber based foods such as maize and cassava provide the major source of nutrients for young children and adults in many countries of SSA. These foods are usually low in proteins and other major minerals. In SSA as in other developing countries, protein deficiency in the diets is common and it is usually associated with deficiencies in calories leading to endemic protein energy under nutrition with attendant health consequences particularly in infants and children (Onoja *et al.*, 2014). In Kenya and other African countries, children are fed on porridges that are commonly prepared from locally grown starchy staples such as maize, sorghum and millet. These staples do not satisfy the energy and other nutrient needs of the growing children (Onoja and Obizoba, 2009). The gruel is too watery and thus has low energy density or too bulky (thick porridge) which cannot be consumed in sufficient amounts by the infant. On cooking the starch granules in the staples swell and therefore resulting in gruel of high viscosity which needs to be further diluted with water to give a consistency appropriate for a child's feeding (Onoja *et al*., 2014). The dilution therefore decreases the energy and the nutrient density of the gruel and makes it practically impossible for the child to meet their nutrient requirements due to their limited gastric capacity.

Intake of traditional cereal-only foods is a key driver to increased levels of under nutrition particularly in SSA. For example a study by Appor and Krekling (2005) showed that *Koko* a traditional cereal-only food from Ghana provides insufficient energy, proteins, fat and micronutrients to support child growth development and health, and has been linked to poor nutritional status of Ghanaian children. Therefore the use of legumes to complement the proteins in the cereals and tubers is an important way of combating under nutrition in young children in developing countries.

2.7 Nutritional adequacy among children from Western Kenya

According to Ochola and Masibo (2014), the diets of school-age children in developing countries are very limited in diversity, and the pattern is characterized by minimal intake of animal foods, fruits and vegetables. Children aged 2-5 years from Western Kenya have been described as the vulnerable group to under nutrition because diversity of their diets is limited (Stephenson *et al.,* 2010).

A study in Western Kenya among children 2-5 years old in cassava consuming households showed that there was an inadequate protein intake among 53% of the children. The results of the study further showed that most of the energy intake was derived from dietary staples, mainly cassava. Cassava intake was negatively associated with inadequacies in the protein intake, and the consumption of animal source foods. Heavy reliance on monotonous staples was associated with higher levels of stunting. The study concluded that the diet of the children was not diverse (Stephenson *et al.,* 2010).

A study by Masibo (2013) among school children and adolescents (n = 220) from Western Kenya showed that energy intake was below the estimated energy requirement for 66% of the children. Furthermore, there was low intake of fat, vitamin A, calcium, zinc and selenium based on RDA. Contrary to other studies, the study found out that protein and vitamin C was above the RDA and EAR respectively. Semproli *et al.,* (2011) in a study among 5-17 year old children (n=1442) found that that their diet was deficient in sodium, calcium and potassium. Nutrient adequacy ratios were correlated to anthropometric measures particularly in males. Furthermore Walingo & Ekesa (2013) in a study in Matungu Division, Butere-Mumias, Western Kenya, among pre-school children (n=164) showed that the consumption of meat/meat products, roots/tubers, fruits/vegetables, pulses/nuts and fats/oil was generally poor. Only 3.5 and 0.7% of the pre-school children consumed more than five (5) varieties of cereals and of fruits and vegetables respectively. Further, most of the pre-school children were not meeting half of the RDA for energy (21%), vitamin A (23%), calcium (44%), zinc (14%) and none of the children met the RDA for fat. However, 97%, 79% and 69% of the pre-school children met more than 100% of the daily RDAs for Iron, Vitamin C and proteins respectively.

The socio-economic status of the households in Western Kenya has been shown to have an effect on diet diversity. According to Walingo & Kidake (2013), the income of the caregivers is an indicator of food security status of these families, which also has an effect on the coping strategies in the event of food insecurity. Diet diversity was positively correlated with household food security. In the study, pre-school children were fed mostly on cereals and milk, a common recipe for porridge which is often used as a weaning diet among rural folk. Further, their diet comprised of more plant proteins than meat and meat products due to price complications. Similar results have been reported by Walingo & Ekesa (2013).

Agri-biodiversity is one of the factors that affect the diet diversity of children in Western Kenya. This encompasses the variety and variability of animals, plants and micro-organisms that are necessary to sustain the key functions of the agro-system, its processes and structure, for and in support of food production and security (FAO, 2015). Therefore agro-biodiversity composes biodiversity at inter and intra-specific levels of edible food crops and animals.

A study by Walingo & Ekesa (2013) showed that the level of crop and bio-diversity was low in Western Kenya, where there was limited crops grown and animals reared in the households. According to the study there was a strong relationship between agricultural biodiversity and dietary diversity. Similar results have been reported by Ekesa *et al.*, (2008a), who found that almost 50% of the changes in dietary intake of pre-school children were due to changes in agricultural biodiversity. This implies that improving biodiversity can improve diet diversity, which in turn can lead to an improvement in the nutritional status. A study by M'Kaibi *et al.*, (2015) in Western Kenya further showed that there was a significant relationship between agricultural biodiversity, dietary diversity and dietary adequacy among pre-school children.

2.8 Soybean fortification and nutritional status

A study by Niyibituronsa *et al.*, (2014) that involved improving the nutritional status of malnourished children in Rwanda using soy milk and soybean flour found that the soybean products had a significant effect on weight gain and rehabilitation of the malnourished children. Kamau *et al.*, (2008) in which they investigated the effect of corn-soybean blend (CSB) supplementation on the nutrition status of school children from HIV affected households in Western Kenya, found that under nutrition levels among the treatment group reduced significantly. The children were fed with CSB for a period of three months in school. The control group did not show significant changes in the under nutrition indices. They recommended that soybean has the potential to curb protein PEM and its utilization in HIV/AIDS affected areas to alleviate under nutrition. A similar study by Ohiokpehai *et al*., (2009a) found that intake of soybean fortified porridge improved the zinc profile in children living in HIV affected households. Similar results on improvement on the serum zinc status were reported by Were *et al*., (2010).

A study by Ghatge (2013) in India involved feeding of malnourished pre-school children with soyaladoo, a snack prepared from soybeans. In the supplementary feeding program, children were given 50 g of the snack for a period of 6 months and biochemical markers of nutritional status were monitored. It was found that soyaladoo supplementation had highly significant effect on increasing blood glucose level, hemoglobin, serum protein, vitamin A, iron and zinc status of the pre-school children. The researcher concluded that the snack were effective in improving the nutritional status of malnourished pre-school children.

A study by Ernst *et al*., (2008) in Turbo, Western Kenya, involving supplementation of children 1-5 years old with meat and soybean supplements, both providing 14 g protein/day, showed that the supplements resulted in positive growth, development and activity of the children. The changes in growth were assessed using bio-impedance analysis (BIA) methodology with arm muscle area calculated from triceps skin fold and Mid Upper Arm Circumference measures.

Effects of soybean fortified foods on the growth of animals in controlled feeding trials have been documented. A study by Kamau *et al.*, (2014) found that the growth rates of Winstar rats fed on cassava-soy, sorghum-soy and millet-soy diets were similar to the growth rates of the reference protein (casein). It was concluded that if the soy fortified foods supported growth in rats, which have higher amino acid requirements than children, the growth patterns observed in the study could be extrapolated to 1- 2 year old children who consume foods from the soybean fortified flours.

A study by Amankwah *et al*., (2009) which used two diet formulations; fermented maize (51.33%), soybean (25.97%) and rice (22.50%) and fermented maize (43.96%), rice (31.81%), soybean (20.09%) and fishmeal (4.14%) showed that the protein content of the formulation containing the fishmeal and without fishmeal were 19.13 and 17.18/100 g respectively with corresponding 1690 and 1650 kJ/100 g as energy; both satisfying the

Codex Standard specifications for proteins and energy. The authors recommended that the foods could be used to lessen protein energy under nutrition as the energy and the protein content were adequate to ensure rehabilitation in young children as shown by their feeding trial of rats.

A study by Amankwah *et al*., (2010) that used diets formulated from fermented maize flour (64%), soybean (32%) and groundnut (4%) showed that the blend had excellent growth response in rats; where the weight at the end of a 10 week period (190 to 230 verses 180 to 185 g, respectively, for blend and maize only diet respectively). The hemoglobin levels were 12.5-14.0 g/dL for the blend verses 10.5 to 12.0 g/dL for maize only diet. The blend was therefore recommended as complementary food for infants and young children to improve the nutritional status as compared to the fermented maize only flour diet. Studies by Plahar *et al*., (2003a, 2003b) that used maize (75%), groundnut (10%) and soybeans (15%, either roasted or not roasted), showed that the extruded non-roasted and extruded pre-roasted weaning formulations had higher protein (17/100 g) than roasted maize only flour (9.2/100 g), even though they both had similar energy content (1600 verses 1580g/100 g, respectively). The extruded formulations had excellent rat growth rate response than the roasted maize formulation, indicating high protein quality of the cereal-legume blends. A study by Phuka *et al*., (2009) in Malawi used a Randomized Controlled Trial (RCT) where children aged 6-18 months (n=176) were randomized into two groups. One group (FS group) was fed on a fortified spread 50g/day providing 256 kcal/day, and the other group (M/S group) was fed on maize/soybean flour 71g/day providing 282 kcal/day. The baseline nutritional status of the children were those with

WAZ <-2. The results of the study showed that that underweight was significantly reduced in both intervention groups. The results also showed that neither intervention had a significant impact on stunting.

A study by Maleta *et al*., (2004) in Malawi involved malnourished children (n=61) whose baseline nutritional status were those with HAZ or WAZ <-2. The subjects were randomized into two groups. One RUTF group who were given 92 g/day of supplemental food in addition to customary food intake providing 534 kcal/day. The second group (M/S group) received maize/soy flour 140 g/day in as supplementary food to customary food intake, and which provided 531 kcal/day. Each of the foods was taken in 3-4 rations/day within the intervention period of 12 weeks. The results of the study showed that both groups showed a modest weight gain even though the weight increase was better sustained in the RUTF group. No significant effect on linear growth was observed in both groups. From these studies therefore, it can be concluded that soybean improves the nutritional adequacy of diets fed to malnourished children, and this leads to improved nutritional status in the children.

2.9 Protein quality of soybean fortified foods

Akibode and Maredia (2011) indicated that many of the poorest countries in the world derive 10-20% or more of their protein from grain legumes. This shows that many of these countries have inadequate intake of protein intake both in quality and quantity. The quality of proteins is very important in supporting the growth particularly in infants and young children (FAO, 2011). Low lysine content is the limiting constraint in cereal dominated diets relative to human amino acid balance which includes the commonly consumed maize-based diets in Eastern and Southern Africa (CGIAR, 2012). Therefore complementation of cereals with legumes improves the amino acid profile of the cereal-legume blend. This is because legumes supply the lysine which cereals lack, while the cereals provide cysteine and methionine which are low in legumes (Serrem *et al*., 2011).

The current WHO-endorsed index for protein quality is the protein digestibility corrected amino acids score (PDCAAS) that estimates the true value of dietary protein for the human body. Recommendation by experts indicate that foodstuffs of at least 70% PDCAAS should be consumed (Michaelsen *et al*., 2009). The PDCAAS value of cereals is around 35%, indicating that if they are consumed in isolation, the protein quality index may not be met. Michaelsen *et al*., (2009) suggest that cereal legume combinations in the proportions of 70/30 (weight/weight) can usually reach or exceed this PDCAAS threshold. Similar results were reported by Kamau *et al.,* (2014), where fortification of maize flour with soybean flour resulted in a PDCAAS of 70%, which met the threshold for the WHO endorsed index. A study by Serrem *et al*., (2011) found that complementation of soybean and sorghum in the ratio of 50:50 could yield a PDCAAS that meets the threshold for children aged 1-10 years old. Studies by Kamau *et al.,* (2014) and Kure and Wyasu (2013) found that fortification of commonly consumed staples with soy increases the amino acids levels. A study by Kamau *et al*., (2014) showed that soybean fortification resulted in an increase in indispensable amino acids, isoleucine, leucine, lysine, tryptophan, threonine, and valine in maize. Kure and Wyasu (2013) found out that fortifying sorghum with soybeans increased the levels of lysine, methionine and tryptophan. Therefore this is a confirmation that fortification of cereals with soybeans increases the protein quality of foods through complementation of amino acids. This shows that even in countries where a cereal is the dominant source of protein, every gram of legume potentiates another gram of cereal protein (CGIAR, 2012).

2.10 Summary of literature review and gaps in knowledge

Literature has shown that there is limited information on the utilization of soybean as a fortificant for foods commonly fed to pre-school children in Early Childhood Development Centres, particularly in developing countries. Therefore, this is the gap this research will fill.

CHAPTER THREE

METHODOLOGY

3.1 Research design

This study adopted a longitudinal survey. This is a study design in which data is gathered from the same subjects more than once over a period of time (Mugenda & Mugenda, 2003). The longitudinal survey was used to gather information on socio-demographic information of the households and data on nutritional adequacy of the children's diet. Randomization was used in the assignment of the porridges to the children using a Completely Randomized Design (CRD).

3.2 Target population

This study comprised all the children in Early Childhood Education (ECD) (Baby, Middle and Top) classes aged 36-60 old attending Mateka Primary school in Bungoma County. These school children and their caregivers were the target population. The estimated number of children in this study area aged 1-10 years is 237, 399 (Kenya Open Data, 2015). The group was selected because they are still growing and the resultant effects of intervention can be attributed to the modifications in their diet (Bisimwa *et al*., 2012).

3.3 Sampling procedures

Bungoma County and Mateka Primary school was purposely selected because they are found in an area where the VLIR-UOS project was sensitizing farmers on the utilization of the soybean grain. Children were randomly selected from the ECD classes. One hundred and twenty five parents (125) were be randomly sampled to answer the questionnaire on household socio-demographics and the household diet diversity questionnaire.

3.4 Sample size determination

In this study, based on Fischer's formula (1991) and the prevalence of under nutrition in the study area (24.4%, KNBS & ICF Macro, (2015), the calculated sample size was;

Fischer's Formula $$n = \frac{Z^2 \times P \times Q}{\sigma^2}$$

Where;

n= desired sample size

Z= standard numerical deviation responding to 95% confidence interval

σ= Error (0.06)

P= Estimated population of malnourished children in Bungoma County (24.4%, KNBS & ICF Macro, 2015).

Q= 1-p (0.756)

Therefore n = $$\frac{1.96^2 x 0.244 x 0.756}{0.06^2} = 100 children$$

An attrition of 25% was added to arrive at 125 children.

Therefore the sample size was 125 children.

3.5 Study area

This study was conducted in Mateka primary school, Bungoma County, Western Kenya. Mateka is found in Bumula Location. Bungoma County is located in Western Kenya along the Ugandan border with a population of 1, 375, 063 people (Census, 2009). It covers an area of 20, 693 Km^2. It borders Busia, Kakamega and Trans-Nzoia counties. The climatic factors favor agriculture as temperatures range between a minimum of 15^0C and a maximum of 27 ^{0} C with an average rainfall of 1500 ml. Soybean was being introduced in this study area and households being sensitized on the nutritional value and utilization methods of the legume. The roasting of soybeans, compositing of the flours and packaging was done in the Food laboratory of the University of Eldoret.

3.6 Materials

Maize (*Zea mays*), soybeans (*Glycine max)* and sorghum (*Sorghum bicolor*) were used as the ingredients to composite the flours. These ingredients were bought from Eldoret Municipal market. Sugar was commercially available in Eldoret.

3.7 Methods

3.7.1 Processing of grains

The soybean grains were sorted to remove those that were diseased, those with damaged seed coats and those infested by pests; they were then winnowed to manually separate the chaff and the grains. Then, they were roasted for 20 minutes in the oven at 180^0C, while stirring occasionally, to reduce the levels of antinutrient factors, inactivate lipoxygenase enzymes and improve flavor (Bonifacio *et al.,* 2009). All the grains were then cooled at room temperature.

3.7.2 Formulation of flours

The first formulation constituted maize, sorghum and soybean flours in the ratio 50:25:25 by weight. The second formulation constituted maize, and soybean flours in the ratio 75:25 respectively. The third composite were made of 100% maize flour, which were used as the control. The grains were mixed together in their respective ratios and then milled using a commercial hammer mill (Powerline®, BM-35, Kirloskar, India) in Eldoret, fitted with a 2.0 mm opening screen. They were then mixed to homogenize and then weighed into clear water-proof polythene bags in packages of 3kgs each, and each flour type well labeled with codes. Analysis of the flours was done at the University of Eldoret Chemistry Laboratory. The service was provided by the laboratory technician. For the chemical analyses, the following methods were used: Moisture content by the oven drying method: AOAC (Method 934.01, 1995), Protein content by Kjeldahl method: AOAC (Method 984.13, 1995), crude fat by Soxhlet extraction method: AOAC (Method 920.29, 1995), ash by AOAC (Method 923.03, 1995) and carbohydrate content by difference method (FAO, 2003). Table 3.1 shows the proximate composition of the flours.

Table 3.1: Proximate composition of the flours (g/100 g)

Proximates	Maize	Maize+soybean	Maize+sorghum+Soybean
Ash	0.83	5.51	5.45
Moisture	10.23	9.27	9.11
Oil	4.29	11.30	11.45
Protein	9.45	17.39	18.59
Carbohydrate[1]	75.20	56.53	55.45
Energy (Kj)[2]	1578.247	1662.638	1669.458

[1]Calculated by the difference method (FAO, 2003) where % carbohydrates= 100-(% fat+% moisture+% ash (minerals) + % protein)
[2]Calcualted by multiplying with Atwater's factor (FAO, 2003) where energy (Kj) = (% carbohydrates×16.736) + (% protein×16.736)+ (% oil×37.656)

3.7.3 Preparation of the porridge

Preparation of the porridges was done according to Onoja *et al.,* (2014) standard recipe for preparation of gruel. One hundred grams of flours (from both composites and the control), 100 ml of cold water (to make paste) and 500 ml of water (to cook the slurry) were used. Water was brought to boil; paste was made from the composite flours. The paste was then added to the boiling water, and the slurry allowed cooking for about 10 minutes under medium heat, stirring occasionally until cooked. The porridge was left to cool at room temperature to serving state of 40^0C. Three cooks were trained on how to cook the porridge.

3.8 Administration of the porridge

Randomization of children into trial groups was done. The feeding program included all children in the ECD classes. However, for the purpose of this study, only the children who were monitored consistently were used. Each class was assigned a formulation of the porridge. Children fed on sorghum-maize-soybean blends and those fed on maize-soybean porridge constituted the treatment groups; while those who were fed on maize flour porridge were the control group.

The children were to receive the porridges as per the groups in which they were randomly allocated for a period of six (6) months at school. Each child received trial or control porridge with an estimated 300 ml of the porridge per cup at every 10 o'clock in the morning, for five days in a week (Monday to Friday). At the 6^{th} month, the feeding were terminated, and the groups were followed up and monitored for another three (3) months to measure changes in nutritional status. In the follow up, weight, MUAC and height measurements were taken.

3.9 Inclusion criteria

1. Children whose parents/guardians gave consent for their children to participate in the study

3.10 Exclusion criteria

1. Children who were excluded are those whose parents, caregivers or guardians did not consent for their children to be enrolled in the study
2. Children who were below 3 years or above 5 years of age

3.11 Selection and training of research assistants

Three research assistants were recruited in the study. The research assistants were conveniently selected from the B Sc. University Food Science and Nutrition third year students from University of Eldoret. The researcher trained these research assistants for three days on the objectives of the research and the data collection procedures. They were taken through the questionnaire, by reading through each question to ensure familiarization and the clarity of the responses. In case there were questions, clarifications were made. They were also trained on taking anthropometric using the actual measurement tools which were used for the study.

3.12 Reliability of data collection instruments

Pre-testing of the questionnaires was done on 10% of the children, who were randomly selected from Lwandas primary school. The pilot testing was done on children with similar characteristics as the study children. This pre-testing allowed for modifications on the questionnaires by correcting mistakes made during construction of the instrument and inclusion of the foods that may have been missed out. It also allowed for elimination of foods that may not be applicable in the community. Ambiguous questions were corrected to ensure clarity and to elicit the required information therefore enhancing reliability.

3.13 Study variables

The dependent variables in the study are: child nutritional status

The independent variables are: household income, household size, caregiver level of education

3.14 Data collection procedures

Structured questionnaires were used to obtain data on socio-economic and demographic characteristics of the households of the children who participated in this study, food consumption patterns and diet diversity. The caregivers of the target child responded to the interview questions. The questionnaire was administered in school.

The questionnaire was made up of three sections. The first section sought to collect data on the socio-economic characteristics of the childrens' households. The second section collected data on the food consumption patterns of the children using a quantitative food frequency questionnaire and a 24 hour food recall. The third section collected data on anthropometric measurements of the children.

3.14.1 Assessment of the nutritional status of the children

Three main anthropometric measurements were taken: Weight, Height and MUAC. The anthropometric measurements were carried out on the index child by the researcher and the research assistants using the standard anthropometric equipment and procedures as described by de Onis *et al*., (2004). The measurements were done at school.

3.14.2 Height measurement

Height measurement was taken using a portable microtoise to the nearest 0.1 cm. It was stretched to its full length, with careful positioning of the red mark showing where the measurement starts and hooked on a wall using a nail. The child was asked to remove their shoes and stand on a flat cemented surface below the macrotoise with the head positioned such that the Frankfurt plane were horizontal; the knees were straight, buttocks, heels, shoulder blades and back of the head touching the wall and arms hanging loosely at the side with the palms facing the thighs. The macrotoise was gently lowered until it touché the crown of the head. The measurements were taken at the eye level, off the red mark on the macrotoise.

3.14.3 Weight measurement

Body weight was taken using a SECA weighing scale (Vogel and Halke Hamburg, Model 7141014009, Germany, 2008) to the nearest 0. 1 kg. The weighing scale was placed on a flat cemented surface. It was calibrated using a known weight (in this case 1 kg of sugar) as recommended by (KNBS & Ministry of Public Health and Sanitation (MoPHS), 2008). Calibration was done on every visit before the measurements were made. The child was asked to remove heavy clothing and shoes, and asked to step at the centre of the scale facing straight ahead, arms at the side, looking relaxed but still. The reading was read from the weighing scale.

3.14.4 Mid Upper-Arm Circumference (MUAC)

The measurement of MUAC was taken using a non-stretchable arm circumference tape to the nearest 0.1 cm. It was measured on the posterior aspect of the left arm on the midpoint between the acromion process of the shoulder and the olecranon process of the elbow. The arm was relaxed and hanging down side the body. A MUAC tape was wrapped gently but firmly around the arm, the measurement were read from the window of the tape without pinching the arm or leaving the tape loose.

Each of the anthropometric measurements were taken three (3) times and the average value used for the analysis. If the mother or caregiver was unable to recall the date of birth of the child, reference was made to a birth certificates, clinic cards, baptism cards, school records, calendar of events or by recall by the caregiver.

Height and weight measurements were used to compute HAZ, WAZ and WHZ scores accordingly to determine the extent of stunting, underweight and wasting respectively. Children with HAZ, WAZ and WHZ values <-2SD of the reference population were considered malnourished. Those < -3SD of the reference population were considered severely malnourished.

3.14.5 Assessment of nutritional adequacy

An individual dietary diversity questionnaire recommended by FAO (Kennedy *et al.*, 2011) was adopted and modified for this study. The recall included foods from 16 food groups which include Cereals; Vitamin A rich vegetables and tubers; White roots and tubers; Dark green leafy vegetables; Other vegetables; Vitamin A rich fruits; Other fruits; Organ meat; Flesh meat; Eggs; Fish; Pulses/Legumes, nuts and seeds; Milk and milk products; Oils and fats; Sweets and sugar and condiments and spices.

Questions were directed to the parent, but the target child was also present during the interview to assist in indicating foods eaten outside home. Subjects were asked to mention all the foods and beverages eaten during the preceding 24 hours (from the time they woke up the previous day up to the time they woke up again on the day of the interview). The researcher obtained a range of household utensils: glasses, spoons, cups and plates were used to estimate the amounts of food and beverages. Utensils were used as visual aids to ensure accuracy in the estimation of the portion sizes. Ingredients used in the food preparation and the method of preparation were sought. Seasonal fruits and vegetables were purchased and used in the estimation of portion sizes. The administration of the questionnaire was done in school, after convening a meeting with the parents.

Dietary diversity scores were calculated based on the consumption of the food groups based on the recall, using FAO (2015) classification of dietary diversity.

3.15 Data Analysis

Completed questionnaires were checked for accuracy and completeness in recording of the responses after each day of the interview. Socio-demographics of the caregivers were entered and analyzed using SPSS Version 21 (2007). Data for household diet diversity and food frequency questionnaire were entered into Nutri-survey nutrition assessment programme (2007) for quantitative calculations and amounts were converted to gram equivalents. Data on anthropometric measurements were analyzed using ENA for SMART. Data generated was then exported to SPSS for cross analysis with other variables.

Descriptive statistics such as frequencies and percentages for discrete data (non-continuous) and the mean values for continuous data were computed. Spearman correlation was used to establish the relationship between household demographic characteristics. ANOVA was used to determine significant differences between the of the different porridge formulations on nutritional status on of the children at baseline, the 6th month and the 9th month. A p value of < 0.05 was considered statistically significant.

3.16 Ethical review and informed consent

Permission to carry out the research was granted by the National Commission for Science Technology and Innovation (NACOSTI) (Permit number: NACOSTI/P/16/44801/15644 (Appendix 7). Written consent was granted from the parents of the children (Appendix 1). Verbal consent was obtained from the children. Permission was obtained from the school administration before carrying out the survey and the feeding program in the school. While collecting data, research assistants observed professional ethics through their mode of dressing and language. The subjects were assured of confidentiality through anonymity by the use of codes in the questionnaires instead of the names of the parents or the children.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-demographic characteristics of the caregivers

More than half of the respondents (56%)were be between 15-35 years old (Table 4.1). More than half of the caregivers (56%) had primary level of education, whereas those who had achieved university or college education were only 9%. This could be due to the cultural practice where girls in the area are married early; most of the women are married at the age of 12-16 years (KNBS & SID, 2013). This is the time that most of these women are finishing off their primary school. The results found in this study concur with those of Walingo and Ekesa (2013) who found that in Matungu, Butere-Mumias in Western Kenya, that most of the mothers had spent an average of 6.12 years in school. According to a report by the Kenya National Bureau of Statistics (KNBS) and Society for International Development (SID) Bungoma County have 61% of residents with only a primary level of education (KNBS & SID, 2013).

Table 4.1: Socio-demographic characteristics of the caregivers (n=125)

Variable		N=125	(%) of the respondents
Care giver	Mother	111	89
	Father	4	3
	Grandparent	4	3
	Aunt/uncle	6	5
Caregiver's age	15-24	22	18
	25-35	48	38
	36-44	13	10
	45-49	33	26
	50 and above	4	3
Marital status	Single	3	2
	Married	111	89
	Widowed	8	6
	Divorced	4	3
Level of education	None	13	10
	Primary	70	56
	Secondary	31	25
	College/university	11	9
Size of the household	1-2 Children	16	13
	3 children	15	12
	4 children	56	45
	5 children	29	23
	➢ 5 children	9	7
Current occupation	Employed unskilled	46	37
	Employed skilled	13	10
	Housewife	56	45
	Farmer	6	5
	Self-employed	4	3
Size of land allocated to crops	1 acre and below	56	45
	1-5 acres	69	55
	5 acres and above	13	10
Income levels of the caregivers	Less than 1000	15	12
	1001-5000	70	56
	50001-10,000	15	12
	10,000 and above	13	10

4.2 Characteristics of the study children

A total of 125 children were sampled for the study. Most (53%) of them were 4-5 years old whereas the rest (47%) were 3 years old. Fifty five (55%) of the children were boys and the girls were 45% of the children (Table 4.2).

Table 4.2: Age and sex of the children

Variable		N	Percentage (%)
Age	**3 years**	59	47
	4-5 years	66	53
Gender	**Males**	69	55
	Females	56	45

4.2 Food consumption patterns of the children

4.2.1 Meal frequency

Results showed that only 8% of the children took one meal in a day, whereas 20% took two meals in a day. Most of the children (69%) took three meals in a day while 3% ate more than 3 meals in a day. This shows that most (97%) of the children were not fed frequently. A key indicator of whether the child is adequately fed, apart from nutrient density of the food, is the frequency with which the child is being fed (SCN, 2016). Because their stomachs are small, young children need to eat small frequent meals that are energy and nutrient dense. The results from this study concur with those of Waswa *et al.*, (2015) in Western Kenya, who found out that most caregivers did not feed their 6-59 months children frequently. The implication is that the children are likely to become under-nourished because they will not be able to eat a wide range and quantity of foods, which would add up to sufficiently meet their nutritional requirements. This therefore is a pointer that the diets of the children are not likely to meet their nutritional requirements.

Results revealed that nearly all the children (93%) ate breakfast before going to school. This is encouraging because studies have shown positive relationship between breakfast intake and concentration in class, where children who eat breakfast are more likely to be attentive than those who do not take breakfast, and therefore perform better on intelligence tests (Hoyland *et al*., 2009). On the other hand, children who skip breakfast show deficits in behavioral and memory tests (Rampersaud *et al*., 2005). There was low consumption of a morning snack among the children. This is due to the fact that the children were in school and that most of them did not carry a snack to school. Furthermore by the time of data collection, the County Early Childhood Education Policy (2014) had not been implemented where all ECD children are supposed to be provided with a mid-morning snack in school. However, low consumption of the morning snack could be due to food unavailability at the households as most of the households were of low socio-economic status. The interval at which children eat food is critical as the glycogen stores need replenishing after 4-6 hours (Pivik & Dykman, 2007). This means that most of the children who ate meals after the 6^{th} hour might have had their glycogen stores depleted. Maintaining adequate blood glucose levels in a growing child is very important as it is needed in supporting brain activities (Kosti *et al*., 2008).

This study revealed that most of the children took black tea in the morning before going to school and a few of the children took white tea. Tea contains a polyphenol, tannin, which is an important anti-nutrient factor. Anti-nutritional factors are food constituents that have a negative impact on the solubility or digestibility of required nutrients, reducing the amounts of bioavailable nutrients and available energy in foods (Hambidge *et al.*, 2008).

The effect of polyphenol compounds is complex formation with iron, zinc and calcium and precipitation of proteins, reducing their bioavailability (Gibson *et al.*, 2007). The implication is that most of the children in this study area are likely to suffer from multiple micronutrient deficiencies as most of these critical micronutrients will not be available, or will be available in minute quantities.

4.3 Children's dietary intake per food group

The most commonly consumed food groups in the area were cereals (maize, sorghum, rice and wheat) and tubers (cassava and sweet potatoes). The other commonly consumed foods included dark green vegetables and legumes. The least consumed foods were foods from animal sources such as organ meat, fish, eggs, milk and flesh meat.

Table 4.4 Dietary intake per food group

Food groups	N	Percentage
Cereals	125	100
Vitamin A rich vegetables	55	43.5
Dark green vegetables	111	89
Other vegetables	122	97
Vitamin A rich fruits	40	32
Roots and tubers	120	96
Organ meat (Iron rich meat)	16	12.5
Flesh meat (Beef, chicken)	11	8.4
Eggs	19	14.9
Fish	36	28.7
Legumes	71	67.8
Milk	26	25
Oil and fats	84	73

Source: FAO (2007)

This study showed that cereals and starchy roots and tubers were the most consumed foods and that they contributed majorly to the energy intake of the children. The most commonly consumed staples were maize, sorghum and cassava. The reason is that most of these staples are commonly grown in the area due to favorable climate (Macharia *et al*., 2012). Furthermore, according to KNBS and ICF Macro (2015), maize is the most consumed staple in rural households and a national staple food for Kenyans. Food consumption surveys in Western Kenya have documented that cereals and starchy staples were the most consumed food group (Waswa *et al*., 2015; Walingo and Ekesa, 2013; Ekesa *et al*., 2009). The second reason for high consumption is that starchy staples are less expensive in comparison to foods from other food groups. A trend analysis by Thompson & Amoroso (2009) found that in Sub-Saharan Africa, there is a shift from diets that are diverse to those that are predominantly high in carbohydrates because of declining incomes. This is further justified by the fact that starchy staple foods are cheaper compared to fruits and vegetables and animal source foods. Generally, starchy staples, roots and tubers are the most predominant in the diets of population from developing countries (Stephenson *et al.,* 2010; Gewa & Leslie, 2015). The results from this study corroborate those found in other parts of Kenya and other developing countries. In Eastern Kenya, Badake *et al*., (2014) reported high consumption of cereals, roots and tubers among children from the region. In Burundi and Democratic Republic of Congo, Ekesa (2009) and Kismul *et al.,* (2015) also reported high consumption of cereals; roots and tubers among young children.

This study revealed that most (68%) of the children did not take vitamin A rich foods according to the 24 hour food recall. Despite existing knowledge on the consequences of Vitamin A deficiency (VAD) and access to cheap fruits and vegetables in rural, resource limited areas, VAD still remains a widespread problem globally, particularly among young children (WHO, 2009). This becomes an exacerbating factor to increased prevalence of VAD considering that Western Kenya has the lowest Vitamin A Supplementation (VAS) coverage at 19.8% compared to 30.3% nationally (KNBS & ICF Macro, 2015; Grant *et al*., 2016). The reason for the low intake could be that the fruits were not in season at the time of data collection.

Individually, consumption of fruits among the children was very low. Fruits are an invaluable source of energy and micronutrients such as iron and vitamins A and C. According to Ruel *et al*., (2004), the demand for fruits increases with increase in the household income, although the proportion of the total expenditure allocated to it tends to decline. The implication is that the demand for fruits and vegetables at lower incomes is much lower probably because low income households must prioritize the fulfillment of their basic energy requirements to avoid hunger (Onyono *et al*., 2015). These study results concurs with that of Onyono *et al*., (2015) who found low fruit consumption among young children in two banana growing Divisions in Kisii County, Kenya.

The results from this study showed that most of the children ate dark green vegetables in the last 24 hours. The most commonly consumed vegetables were cowpeas (*Vigana Unguiculata*), pumpkin leaves (*Curcubita moschata*), Amaranth (*Amaranthus blitum*) and Jute mallow (*Corchoruso litorius*). Vegetables are a rich source of minerals such as iron, calcium, Vitamin C and pro-vitamin A. In addition to the energy and the nutrients they provide, vegetables bring taste, colour and variability in the diet (Michealsen *et al*., 2009). Green leafy vegetables consumed daily have been found to be a valuable source of vitamin A, even with low intake of dietary fat (Mosha *et al*., 1995). Therefore, since dark green leafy vegetables can be grown at home at a low cost, they may serve as reasonable alternatives to vitamin A rich animal source foods (Ribaya-Mercado *et al*., 2007). The iron content of most green leafy vegetables is relatively high, although the bioavailability of iron is compromised by high intake of tannins and oxalates (Kumari *et al*., 2004). Majority of the children consumed vegetables and this could be due to the reason that most households in Western Kenya grow these types of vegetables. Most food consumption surveys in Western Kenya have reported almost 100% consumption of vegetables regardless of the recall period. Studies (Waswa *et al.,* 2014; Ekesa *et al*., 2008a) have shown that most of the pre-school children from Western Kenya consume a considerable amount of vegetables.

A study in South Africa indicated a negative significant influence on consumption of vegetables with education, where per unit increase in household education, there was a 4.116 decrease in the log of leafy vegetables consumption holding all other independent variables constant (Taruvinga & Nengovhela, 2015). This could also be true in this study because most of the households were from a low socio-demographic status. Furthermore, vegetables have been seen as a cheap source of food for low income households as they can be easily procured and prepared (Ekesa *et al*., 2008b). Similar results to this have been reported by Mayekiso (2013) and Labadarios *et al*., (2011) both in South Africa. It is worth noting that vegetables intake in this study is encouraging, because consumption of green leafy vegetables improves the nutrient quality of cereal based diets as supported by Michealsen *et al*., (2009).

This study established that the major source of proteins in the diets of the children were legumes. Animal sources of proteins were rarely consumed. It is recommended that a larger portion of the protein be provided by animal sources as they are proteins of high quality and support maximum growth in children (Bwibo and Neumann, 2003). Furthermore, animal source proteins are easily digestible and they contain virtually no anti-nutrients compared to the legumes (Michelsen *et al*., 2009). However, in this study, starchy staples contributed more than half (53%) of the proteins while legumes provided 16.2%. The most important micronutrients in animal products are iron, Zinc, Calcium, Vitamin A, Riboflavin and Vitamin B_{12}. A number of studies have examined the role of animal source foods in growth, mental development, morbidity, anemia and immune function of children (Grillenberger *et al*., 2003, 2006). Positive associations have been found between intake of animal source foods and growth in weight and height, after controlling for economic factors. In Mexico, consumption of foods of animal origin was positively associated with body size in stunted children at 30 months and with growth rates from 18-30 months (Allen *et al*., 1992).

Nevertheless, even though plant proteins are considered inferior due to anti-nutrient factors such as lectins that affect the bioavailability of zinc and iron, they are often the main source of proteins for low income populations. A trend analysis on production, trade and consumption patterns of legumes in Sub-Saharan Africa by Akibode (2011) documented that legumes are a cheap source of protein and micronutrients. Legumes are also important for children because they have a considerable amount of amino acids which complements the amino acid profile of cereals particularly for communities whose diets are cereal-based (Michelsen *et al*., 2009). The results from this study concur with those of Onyono *et al*., (2015), and those of Ronoh and Were (2015).

This study showed that most of the children (73%) ate food prepared with fats and oils the previous day. Fat is an important source of energy for young children since it is energy dense. Furthermore, it is recommended that children who are moderately wasted should have increased fat intake to provide energy for catch up growth, because fats have a high energy density. Therefore a diet that is high in fat could be beneficial to children in this study area whose levels of under nutrition were high. Fat also provides a medium in which fat soluble vitamins can be transported and absorbed into the body (Mangusho *et al*., 2010).

4.4 Diet diversity of the children

According to the Food and Agriculture (FAO, 2011) Household Diet Diversity Score (HDDS) categorization, consumption of less than 3 food groups is classified as poor dietary diversity, 4-5 food groups is classified as medium dietary diversity and greater or equal are classified as high dietary diversity. The results from this study showed that majority (55.2%) of the children had low dietary diversity, 29.1% had medium dietary diversity and 15.7% had greater dietary diversity. This study revealed that most of the children's diet was not diverse. More than half (55.20%) of the children consumed food from less than 3 food groups in the last 24 hours. A few of them (15.73%) consumed diets that were diverse. This could be attributed to low socio-economic status of the respondents, and that most of them had small pieces of land allocated to food production. This can be attributed to food insecurity, in terms of accessibility and stability of food, which are key elements of food security. Lack of dietary diversity is particularly a problem among children in developing countries (Kennedy *et al.*, 2007). In Sub-Sahara African countries, diets are predominantly based on starchy foods with little or no animal products and few fresh fruits (Ochola & Masibo, 2014).

Studies have shown that dietary diversity is positively associated with overall dietary quality and micronutrient intake of young children and household food security (Steyn *et al*., 2006; Kennedy *et al.,* 2007). A high dietary diversity has also been associated with better nutritional status of children (Sawadogo *et al.,* 2006; Arimond *et al.,* 2010). This study showed that most of the children consume a lot of cereal products and low consumption of animal protein. This indicates that the pre-school children in this region are consuming inadequate and monotonous diets mainly composed of carbohydrates and little proteins. Studies have also shown that the overall nutritional quality of the diet improves with increasing number of food groups (Bukania *et al.,* 2014; Kennedy *et al.,* 2010). The implication of low diet diversity is that these children are pre-disposed to high levels of under nutrition, which is evident in this study. Moving from a less diversified diet to one containing more diverse range of food items has been shown to increase intake of energy as well as micronutrients in developing countries (Gina *et al*., 2007). These study results are similar to those reported by Lumole & Msuya (2013) in Tanzania who found that the diet diversity of the children had an average score of 3.4 food groups. Similarly, a study by Ekesa *et al*., (2008b) reported that only 3% of the pre- school children from Western Kenya consumed highly diversified (defined as > 4 food groups) foods while 45% of the children had very low diet diversity (defined as < 3 food groups). These results contradict with those of Abele *et al*., (2007) who documented that most of the households in Western Kenya consume diversified diets.

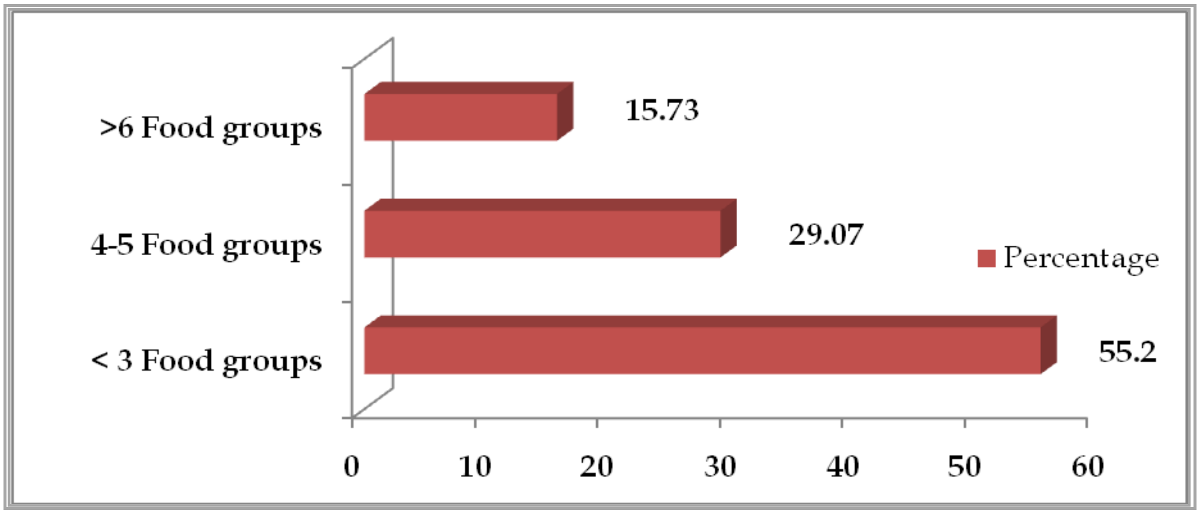


Figure 4.2: Diet diversity scores of the children

4.5 Nutritional adequacy of the children's diet

Protein Energy Under nutrition, Vitamin A, Zinc and Iron deficiencies are the most prevalent deficiencies affecting children globally. Therefore it was necessary to establish the intake of these nutrients among these children to find out if they are deficient. The results have been presented in Table 4.4 for children aged 3 years and Table 4.5 for children aged 4-5 years. The values for individual intake by the children were also compared against the different age groups' RDA values in order to determine if the daily intake of the nutrients met the recommended dietary intake for the specific age group. The findings show that most children in both age groups did not meet their RDAs for all the selected nutrients. Therefore there was need to use the Estimated Average Requirements (EAR) values to establish the percentage of the population at risk for inadequate intake. Normally, the EAR is used to assess the prevalence of inadequate nutrient intake of a population (IOM, 2000).

Table 4.4 Nutrient intake of 3 year old children

Nutrient	Mean(standard deviation) intake	Range of nutrient intake (min to max)	RDA[a]/ EER[b]	Deficient (surplus)
Proteins (g)	8 ±2.5	4.2-11.8	13	5
Iron (mg)	5.6± 1.1	3.4-6.5	7	1.4
Energy (Kcal)	854± 67	566-1002	992-1046	138-192
Vitamin A (µg)	231± 34	196-267	300	69
Zinc (mg)	1.7± 0.67	0.8-2.8	3	1.3

[a] Based on nutrient requirements for children 2-3 years old as recommended by IOM (2000)
[b]The Estimated Energy Requirement (EER) represents the average dietary energy intake that will maintain energy balance in a healthy person of a given gender, age, weight, height, and physical activity level

Table 4.5 Nutrient intake of 4-5 year old children

Nutrient	Mean± standard deviation) intake	Range of nutrient intake (min to max)	RDA[a]/ EER[b]	Deficient (surplus)
Proteins (g)	13±4.5	10.5-16.8	19	6
Iron (mg)	6.6 ± 1.1	4.4-8.9	10	3.4
Energy (Kcal)	1386 ± 87	1243-1567	1642-1742	256-356
Vitamin A (µg)	296± 34	245-384	400	104
Zinc (mg)	2.5 ± 1.8	2.3-3.9	5	2.5

[a] Based on nutrient requirements for children 4-5 years old as recommended by IOM (2000)
[b]The Estimated Energy Requirement (EER) represents the average dietary energy intake that will maintain energy balance in a healthy person of a given gender, age, weight, height, and physical activity level

4.5.1 Energy intake: The mean energy intake for children aged 3 years was 854 Kcal (Table 4.4) whereas for the 4-5 years children were 1386 Kcal (Table 4.5). The mean energy intake for the children in both age groups did not meet the EER. This shows that there was a section of the population that did not fulfill their energy requirements and therefore there was a risk for energy deficiency. For children aged 2-3 years the EER range values are 992-1046 Kcal while of the children aged 4-5 years was 1642-1742 Kcal. The ranges incorporate both genders in the groups, the lower value being for the girls and the higher value for the boys. The calorie intake did not meet the Estimated Energy Requirement (EER) as recommended by the Institute of Medicine (IOM), (2000). The reason for this could be attributed to the insufficient intake of carbohydrates, fats and proteins which are the main sources of energy. The energy density is most important for wasted children, as they require increased energy for catch-up growth (Michealsen *et al*., 2009). Furthermore, deficiency of energy increases the chances of the children developing protein energy under nutrition. These findings corroborate with those found by Ekesa *et al*., (2009) who reported that pre-school children from Western Kenya did not meet their energy requirements. A review by Bwibo and Neumann (2003) showed that the main source of energy in the diets of Kenyan children was cereals. The implication is that these children are likely to suffer from energy deficiency, which when coupled with protein deficiency leads to protein and energy under nutrition.

4.5.2 Protein intake: The mean protein intake for the 3 year old children was 8 g whereas for the 4-5 year old children were 13 g. The RDA for 3 year old children is 13 g while for 4-5 year old children is 19 g. These results show that the children did not meet their RDA and therefore a pointer that a section of the children were at risk of protein deficiency. On average, the children did not meet their protein intake. The main sources of protein in the diet were cereals and legumes. Animal source foods of proteins were rarely consumed. This could be attributed to the high cost of animal source foods. Neumann and Harris (1999) documented that when animal products are priced out of reach of many low income households, they are likely to rely more on staple grains and legumes as their protein sources. A review by Bwibo and Neumann (2003) showed that most of the Kenyan children did not meet their protein needs. Protein is needed for growth and development in young children (FAO, 2011). Even though the Luyhia community from which this study was conducted keep chicken which could have acted as a source of protein for the children, the animals are kept as a source of livelihoods and their products are rarely consumed by children as they are traded for other foods or money (Waswa *et al*., 2015). Secondly, food taboos in the community related to intake of eggs among the young children hinder consumption of eggs. The community believes that consumption of eggs by young children delays speech and more so, children don't eat the best of the animal source food as they are mostly eaten by the male heads of the household (Waswa *et al.,* 2015). A study by Oniang'o *et al*., (2003) showed that low levels of education, taboos and ignorance are the major factors that limit the consumption of ASF among African communities. This therefore is a pointer that these children are likely to suffer from protein deficiency leading to marasmus.

4.5.3 Vitamin A intake

The mean vitamin A intake for the 2 year old children was 231 µg whereas for the 4-5 year old children were 296 µg (Tables 4.4 and 4.5)Their RDA is 300 µg and 400 µg respectively. This shows that both ages did not meet their Vitamin A requirements by a deficit of 69 µg and 104 µg respectively. This is a pointer that a section of the children were at risk of Vitamin A Deficiency. This could have been due to low consumption of vitamin A rich fruits and vegetables. Similar results have been documented by Grant *et al.*, (2016) in Western Kenya where children (6-59 months) from this region were found to be vitamin A deficient, a conclusion that was drawn from low intake of Vitamin A rich foods in this age group. Others factors that could influence the adequacy of vitamin A intake include seasonality of fruits, food preparation methods and availability of money to buy fruits (Onyono *et al*., 2015). The implication is that these children are likely to suffer from Vitamin A deficiency, which pre-disposes them to night blindness. Furthermore, Vitamin A is required for the proper functioning of the epithelial surfaces and immunity, particularly in children (Mangusho *et al*., 2010). A study by Kismul *et al*., (2014) concluded that consumption of β-carotene rich foods has a protective role in the development of kwashiorkor in children below the age of 5 years in the Democratic Republic of Congo. This shows that vitamin A is an important micronutrient in the growth and development of young children. Contrary results to those reported in this study have been documented by Onyono *et al.,* (2015) among children in two banana consuming areas of Kisii County, Kenya, who found high intake of vitamin A rich fruits among 2-5 year old children.

4.5.4 Zinc intake: The mean zinc intake for 2 year old children was 1.7 mg against the RDA of 3 mg whereas the intake among the 4-5 year old children was 2.5 mg against an RDA of 5 mg (Tables 4.4 and 4.5)). This shows that the children met the nutrient requirement by half. The low zinc intake indicates that there is a high risk of the children suffering from zinc deficiency. This is because consumption of animal source foods which are rich sources of zinc was low. Even though legumes were the major source of zinc, bioavailability of zinc is low (Hambidge *et al.*, 2008). Zinc is an essential micronutrient that is involved in many regulatory, structural and catalytic processes in the body (Hambidge *et al.*, 2008). Zinc is present in almost all cells of the body, and therefore its deficiency is non-specific, affecting the immune and reproductive functions as well as growth and brain development (Gibson, 2007). Zinc is therefore a critical micronutrient in the growth and development of young children. Inadequate zinc intake in the diet has been implicated for high levels of stunting in children (Hambidge *et al.,* 2008). The high levels of stunting reported in this study could have been due to the fact that the zinc intake in the diets of the children was too low to meet the physiological requirements for growth as has been reported by Were *et al.*, (2010). A study by Ferguson *et al.,* (2015) among pre-school children (n=401) from Western and Eastern Kenya showed that the complementary foods fed to the children were low in zinc and therefore did not meet the WHO recommendations for growth and development of young children.

In general, the findings of this study on food consumption patterns and nutrient adequacy agree with those of populations found in developing countries. In developing countries, the typical diets fed to children are predominantly of starch-rich staples such as cereals (maize and rice) or tuber (cassava) with limited amounts of fruit vegetables, legumes, pulses and little or no animal source food (Michelsen *et al*., 2009; Gewa & Leslie, 2015). Such a diet is bulky, has low density of energy and nutrients and low bioavailability of minerals, and which results in impaired growth, development and a host of infections due to low immunity levels in children. Intake of diets high in anti-nutrients is most likely to have a negative effect on the growth of children because their growing velocity is high. This therefore leads to increased prevalence of under nutrition in these children which is evident in this study.

4.6 Effect of soybean fortified porridge on the Nutritional status of the children

4.6.1 Nutritional status of the children at baseline

The nutritional indices for the children at the baseline are shown in the figure 4.3. A comparison between the control and the experimental groups showed that there was no significant difference in the under nutrition levels at baseline ($p < 0.05$).

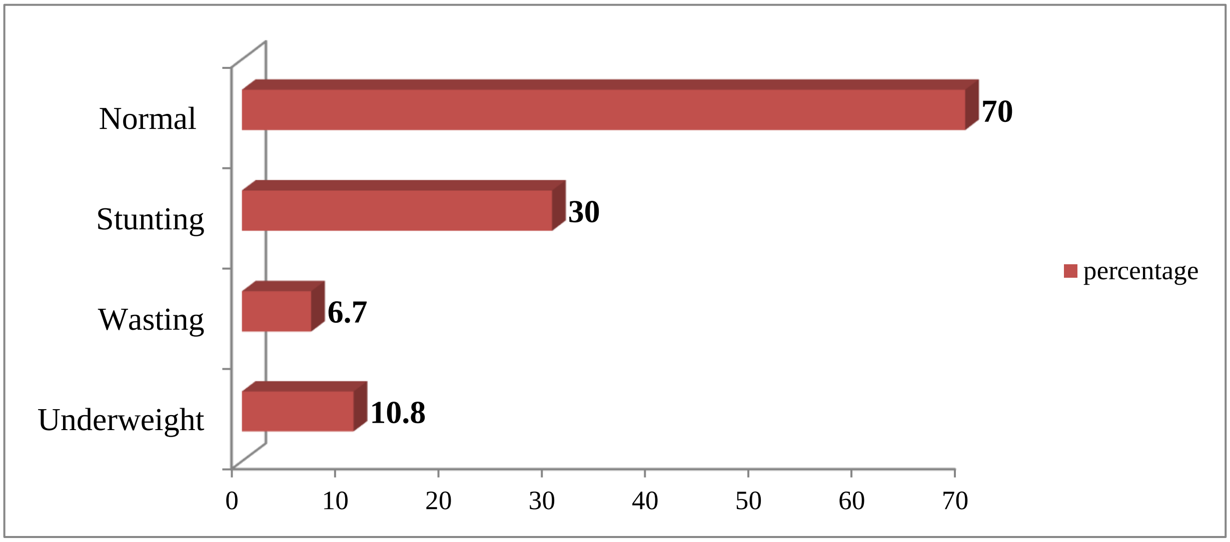


Figure 4.3: Nutritional status of the children at baseline

Seventy percent (70%) of the children were normal at baseline. According to the MUAC measurements, 75% of the children were normal at baseline, while 25% were wasted. Results further revealed that at baseline, the prevalence of underweight was 10.8%. Underweight is a consequence of acute and chronic under nutrition (UNICEF, 2013). This value is higher than that reported in the KDHS (KNBS & ICF Macro, 2015) in Western Kenya of 2.9%. However, this value is almost similar to the national value on underweight prevalence of 11% (KNBS & ICF Macro, 2015).

The prevalence of wasting in this study was 6.7%. This value is higher than national prevalence of 4% (KNBS & ICF Macro, 2015). Studies in Western Kenya have reported almost similar values. A study by Grant *et al*., (2016) reported a lower value of 5.9%. Wasting indicates deficit in tissue and fat mass compared with amount of weight expected in a child of the same height or length, and may also result from failure to gain weight or actual weight loss (UNICEF/WHO/World Bank, 2015). The high percentage of wasting observed in the study area might have been due to failure to receive adequate nutrition of due to recent episodes of illnesses causing weight loss.

The prevalence of stunting was 30%. The prevalence of under nutrition reported in this study area was high. Stunting is a result of prolonged inadequate intake of food as well as diseases making young children to have a low height for age (SCN, 2015). Stunting is associated with low cognitive development and increased morbidity in children under 5 years old (Dewey and Begum, 2011). The prevalence of stunting in the area is almost similar to that reported in Western Kenya in the Kenya Demographic Health Survey (KDHS) at 24.4% (KNBS and ICF Macro, 2015) and Waswa *et al*., (2015) at 29.4%. The study by Walingo and Ekesa (2013) in Western Kenya reported a lower value of 12% among children aged 12-60 months (n=164). A study in Western Kenya among 2-5 years old children in cassava consuming households concluded that this was the age when most of the children become stunted due to inadequate consumption of proteins in their diet (Stephenson *et al*., 2010). Similar results (24.8%) have been reported by Grant *et al.*, (2016) in Bungoma and Busia counties in Western Kenya among pre-school children (n=1816). However, this value is higher than the national prevalence of 26% (KNBS and ICF Macro, 2015). The prevalence of stunting at this age group suggests that under-nutrition starts at very early age and therefore appropriate nutritional efforts need to be focused at an early age. It can also suggest that most of the households in the area are perennially food insecure and therefore the diets fed to the children might be inadequate to meet their physiological needs for growth.

Generally, in this study, the prevalence of stunting is higher compared to the other two nutrition indices. According to literature, most studies have reported high levels of stunting compared to underweight and wasting in Kenya and other developing countries. It is possible that during infancy and the first year of life the children grew normally up to the age of 12 months due to universal breastfeeding habit. Thereafter, improper complementary foods and high prevalence of infections could have resulted in growth retardation and subsequent increase in the levels of under nutrition. Children within the age bracket of 24-59 months are highly affected because they are actively growing, and if their diet is inadequate to meet their physiological needs, they end up malnourished (UNICEF, 2013b). Reports from other developing countries have identified a similar trend in children between those ages of 36-59 months (KNBS & ICF Macro, 2015). It is worth noting that the critical period of growth retardation coincides with the weaning period implying that there is inadequacy either in the quality or the quantity in the diets of these children. Classical childhood illnesses such as pneumonia, diarrhea, malaria and heavy infestation with helminthes is likely to exacerbate the problem of under-nutrition in children (Laura *et al*., 2006).

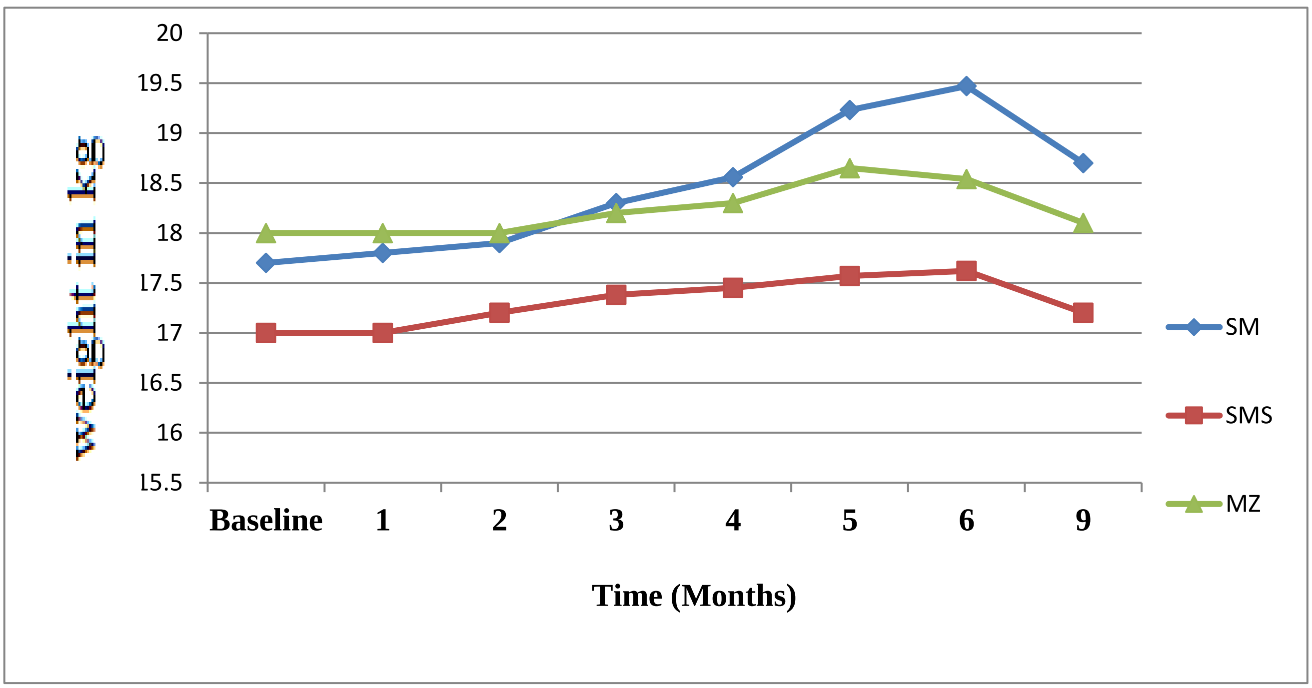
4.6.2 Prevalence of underweight between baseline and 9 months

The prevalence of underweight in the experimental groups was 10.4% and 11.0% at the baseline for SM and SMS respectively. In the control group, the prevalence of underweight at baseline was 10.9% and this value decreased to 10.4% at the end of the feeding trial (Table 4.6).

Table 4.6 Prevalence of underweight between baseline, 6th and 9th months

Underweight	**Before intervention (Baseline)**			**6th month**		**9th month**	
Experimental groups	**SM group**	**SMS group**	**MZ group**	**SM group**	**SMS group**	**SM group**	**SMS group**
<-2SD to -3SD (Moderate)	9.5	9.7	10.1	5.4	5.8	9.6	8.6
< 3 SD (Severe)	0.9	1.4	0.8	0	0	0.3	0.6

SM=soybean+maize, SMS= sorghum+maize+soybean , MZ= maize only



SM=soybean+maize, SMS= sorghum+maize+soybean, MZ=maize only

Figure 4.4: The trends in the weight changes in the children during the feeding trial

This study found that there was an increase in the weight of the children in the experimental group after feeding them with the soybean fortified porridges (Fig 4.4). The children who were fed on SM showed modest weight increase at each month when the measurements were taken. The highest value was recorded at the 6th month for the MS group. The children fed on the sorghum-maize-soy (SMS) mixture showed that that there was slowed increase in the weight gain of the children particularly at the beginning of the intervention. The children who were fed on the control porridge made from maize only showed slowed and stagnant weight throughout the study.

This study showed that there was significant increase in the weight of the children fed on the experimental porridges ($p<0.05$). On the other hand, children who were fed on the maize only porridge showed increased levels of underweight. However, children who were fed on the SMS porridge showed that the rate of weight gain was low as compared to those that were fed on the SM even though the protein content of the latter porridge was higher. This could be attributed to the high anti-nutrient content in the SMS blend. Nutrient absorption from complementary foods of children may be limited by anti-nutrient factors such as phytic acid which is high in sorghum (Bisimwa *et al.,* 2012). Phytic acid is a potent inhibitor of iron, zinc and calcium, which are key nutrients that are needed for growth and development of young children. Young children are also likely to be more sensitive to the effect of anti-nutrients, for example high levels of phytate, which impairs the absorption of several growth-limiting minerals, such as zinc (Michaelsen *et al.,* 2009). For example, zinc is essential to growth, syntheses and maintenance of lean body mass in children (Michealsen *et al.,* 2009). Through its role in the metalloenzymes, zinc plays a major role in vital processes of growth such as nucleic acid synthesis, protein digestion and synthesis

(Rolfes & Whitney, 2014). Food analysis of soy-maize-sorghum based Ready to Use Complementary Food (RUCF) used by Bisimwa *et al.,* (2012) showed a high phytic acid content and a high phytic acid: iron molar ratio from the ingredients used. A study by Akomo *et al.,* (2016) showed that the phytic acid mineral molar ratios observed for raw and extruded sorghum-maize-soybean products were higher than those preferred for adequate mineral absorption young children. Evidence has shown that removal of phytic acid from the food matrix using microbial phytase is associated with improved weight for Age (underweight) and decreased deficiencies of iron and zinc in young children (Akomo *et al.,* 2016; Troesch *et al.,* 2011). Furthermore, a study in Malawi found no effect on zinc status of supplementary food fed to young children with a peanut/soy spread and this was attributed to the high levels of phytic acid in the spread (Lin *et al.*, 2008). The same might have been the case in this study where the growth of the children might have been affected by the low bioavailability of these minerals in the SMS which are essential for growth. This may be further augmented by the fact that these children were fed on diets high in phytates and tannins. Consumption of foods that have a high bioavailability of zinc, and zinc supplementation has been associated with positive effect on linear growth in children (Hambidge *et al*., 2008). Similar studies have shown that feeding of children with soybean fortified supplementary foods improves the weight of the children as well as reducing the levels of wasting an underweight in the study children (Were *et al.,* 2010; Kamau *et al*., 2008; Niyibuturonsa *et al.,* 2014).

4.6.3 Prevalence of wasting between baseline and 9 months

The prevalence of wasting among children in the experimental group was at 5.8% and 6.1% for CSB and the SMS groups respectively at baseline (table 4.7). After the feeding trial, these values decreased to 3.9% and 4.8% respectively for the SM and the SMS group respectively. On the other hand, the control group had a prevalence of 6.1% at baseline, and this value decreased to 4.8% by the end of the 6th month. The value then increased to 5.8% at the end of the 9th month when children had been withdrawn from the feeding trial. The changes in the wasting levels before and after the feeding trial were significant in both groups ($p<0.05$). This study found out that there was a significant reduction in the prevalence of underweight and wasting at the end of the feeding trial for children in the experimental group. The reduction in the prevalence in the under nutrition indices could be attributed to the increase in the quantity of lysine, an essential amino acid, in the diets of the children. Mutual complementation of cereals with legumes (Soybean) leads to a product with high amino acid profile. This is with reference to improvement in the content of the indispensable amino acid, lysine. A study by Kamau *et al*., (2014) established that fortification of maize with soybean significantly improved the lysine content. Similar results were documented by Kure and Wyasu (2013). Lysine is responsible for improved growth in young children as it is a major amino acid required in the process of cell division (Serrem *et al*., 2011). A study by Vivek (2008) showed that feeding of children with high quality protein maize (HQPM) with improved lysine content improved the growth patterns of young children compared to the conventional maize which was low in lysine. This therefore shows that increase in the lysine content in the soybean fortified porridges could have led to the improvement in the nutritional status of the children. A study by Serrem *et al.*, (2011) showed that the improvement in the lysine content of soybean fortified biscuits was adequate to meet the nutrient needs of children 2 years and 3-10 year old children.

On the other hand, the control group didn't show any significant changes in the nutritional status. In fact, the prevalence of under nutrition increased. Consumption of food products made from maize flour, for example porridge has been implicated for etiology of under nutrition particularly among young children. A review by Solomon (2005) showed that frequent consumption of *Koko*, a Ghanaian food prepared from maize flour, was implicated for protein and energy under nutrition in children. A study by Kismul *et al.*, (2014) revealed that frequent consumption of diets based on maize and cassava was positively correlated with the development of kwashiorkor among young children in the Democratic Republic of Congo. This can be attributed to the low nutritional value of maize. The protein quality of maize is poor, being low in lysine and tryptophan, which are the indispensable amino acids for growth of young children (Shiriki *et al.*, 2015). This could therefore be the reason for the increased levels of under nutrition, particularly underweight among the control group. The study by Kamau *et al*., (2014) showed that feeding of experimental rats with a diet from maize only neither led to significant weight gain or loss. This shows that there was stagnation in growth, and this might have been the case in this study. Furthermore, porridge prepared from maize has low energy density and is bulky.

The second reason for the improvement in the nutritional status of the children could be due to improved protein quality in the soybean fortified porridge. Complementation of cereals and legumes increase the protein quality of the flour blend. Kamau *et al*., (2014) showed that fortification of maize meal flour with soybean flour led to a significant improvement in the PDCAAS value from 53% in maize flour to 70% in the soybean fortified flour. Similar results were reported by Serrem *et al*., (2011) and Shiriki *et al*., (2015) in sorghum and maize respectively. PDCAAS is a WHO endorsed method for assessing the protein quality of a food. Foods with a PDCAAS of over 70% are recommended for ensuring growth in young children (Michealsen *et al*., 2009). From the PDCASS value of the soybean fortified flours, it can be inferred that the porridge was able to support improvement in the nutritional status of the children.

Furthermore, the porridge supplemented the energy intakes of the children. The soybean fortified porridges provided 395 Kcal/100 g to the diets of the children. Since the children were fed on approximately 100 g of the flour, the contribution of the soybean fortified porridges was 355.5 Kcal, which bridged the deficiency of energy requirements of the children as shown in Table 4.5 and 4.6. Furthermore, the flour that was used was full fat and therefore this contributed to the increased energy content considering that fats are energy dense. Energy density is one of the important determinants of the nutritional adequacy of diets fed to children (SCN, 2015). Energy is required by children for proper growth and development, and deficiency in energy intake has been implicated for poor growth in children (FAO, 2011). Foods supplements that have been shown to have energy content of more than 1.0 g/100 g has been shown to reduce the prevalence of wasting and underweight in malnourished children (Michealsen *et al.,* 2009). This could have been the reason for improved nutritional status of children.

The changes in the underweight and wasting in the experimental groups could be due to the reason that these nutrition indices are as a result of sudden change in the nutritional intake of the children and other factors such as episodes of sickness such as diarrhoea. Therefore, increasing the nutritional adequacy of the children by the soybean fortified porridges led to the reduction in the prevalence of underweight and wasting. These nutritional indices have been shown to reduce as a result of an intervention and therefore have been used to measure the success of intervention programs (UNICEF/WHO/World Bank, 2015).

Table 4.7 Prevalence of wasting between baseline and 9 months

(Wasting	**Before intervention (Baseline)**						
				6th month		**9th month**	
Experimental groups	**SM group**	**SMS group**	**MZ group**	**SM group**	**SMS group**	**SM group**	**SMS group**
<-2SD to -3SD (Moderate)	4.6	5.9	5.9	3.4	4.6	3.9	4.8
< 3 SD (Severe)	1.2	0.2	0.2	0.4	0	0	0

SM=soybean+maize, SMS= sorghum+maize+soybean, MZ=maize only

The results show that there in the CSB group, there was significant reduction in the prevalence of wasting, underweight and stunting. In the SMS group, there was a significant reduction in the prevalence of underweight and wasting only.

Table 4.8 Nutritional status of the children by Z scores at baseline and 9th month

Porridge type	Nutrition index	Baseline		6th month		9th month	
		Mean ± SE	F value	Mean ± SE	F value	Mean ± SE	F value
SM	**WAZ (Underweight)**	-0.757 ± 0.075	F=1.862 df=2.169 P=0.175	0.076 ± 0.09	F= 2.90 df= 1.867 p=0.256	0.134 ±0.07	0.267± 0.02 df= 1.456
	WHZ (Wasting)	-0.349 ±0.071	0. 234± 0.016	0.234 ±.0453	F=3.23 df= 1.867 ***P< 0.05**	0.378±0.002	F= 6.45 df= 1.456 ***P<0.002**
	MUAC	13.5± 1.32	F= 0.0967 df= 2.169	13.9	F=1.45 df= 1.867 ***p= 0.043**	14.5	F=3.120 df= 1.456 ***P<0.002**
SMS	**WAZ (Underweight)**	-0.674 ±0.983	F=2.560 df= 2.169 p=0.345	0.156± 0.057	F=1.890 df= 1.867 ***P<0.05**	1.345± 0.02	F=1.345 df=1.365 ***P<0.001**
	WHZ (Wasting)	-0.237 ±0.067	F=1.987 df= 2.169 p=0.289	1.89± 0.002	F=2.78 df= 1.867 ***p=0.045**	2.476± 0.023	F= 3.423 ± 0.067 ***P=0.045**
	MUAC	12.3±1. 45	F= 2.46 df= 2.169 p=0.384	13.0	F=2.890 df= 1.867 ***p=0.05**	13.52	F= 2.89± 0.056 **P< 0.03**

SM=soybean+maize, SMS= sorghum+maize+soybean, *p<0.05 significant

This study showed that fortification of commonly consumed cereal, maize and sorghum, with soybean improved the nutrient adequacy of the diet, which in turn led to improved nutritional status of the children. Utilization of high protein legumes such as soybean can be one of the sustainable ways of reducing the prevalence of under nutrition in developing countries. This is with reference to climate change, where the production costs of animal source foods is expected to increase (Anuonye, 2011). This therefore means that most of the low income rural population will be faced with the brunt of protein deficiency as they will not be able to afford animal source foods. There is need to look for alternative sources of high quality protein and legumes can fit in as they are a cheaper source of proteins and they do well in the tropical climate where levels of under nutrition are projected to be high (Anuonye, 2011). To further augment this, evidence has shown that households which consume soybeans have better long term nutritional status as compared to households that doesn't consume them (Sanginga *et al*., 1999, Ojiako *et al*., 2009).

4.7 Relationship between socio-demographic factors and nutritional status of the children

Maternal level of education was a determining factor for occurrence of stunting in the children, where those parents who had no education at all or who had a primary level of education, their children were likely to be stunted compared to those who had secondary, college or university education. Table 4.10 summarizes the relationship between socio-demographic characteristics and the nutritional status of the children.

Table 4.9 Correlation coefficients of selected socio-economic and demographic factors and nutritional status of the children

Variable	WAZ	HAZ	WHZ
	r	r	r
Household size	0.612	-0.410*	-0.400*
Educational level of the parent	0.346	0.047	0.828*
Household income	-0.562	0.036*	0.042*
Size of the cultivated land	0.611	0.013	-0.013
Age of the child	-0.544	-0.270	0.573

*correlation significant at 0.05 level of confidence (2 tailed) WAZ = Weight-for-Age Z-score, HAZ= Height-for-Age Z-Score, WHZ= Weight-for-Height Z-Score

Findings from this study indicate that maternal level of education plays a significant role in determining stunting in children. Studies confirm that mothers who are better educated understand and, generally, act more responsively to the nutrition of their children, seek disease prevention and treatment, and maintain sanitary living conditions (Panjsheri, 2007; Bwalya, 2013). Maternal education generally has an inverse relationship with stunting levels and has consistently shown to be critical for child health, nutrition and survival (Alemayehu *et al*., 2014; Bwalya, 2013). Educated women are likely to be more aware of nutrition, hygiene and health care; and they can easily introduce new feeding practices which can improve the nutritional status of children (Ajao *et al*., 2010; Sumonkati and Islam, 2008). They tend to be better able to use health-care facilities, interact effectively with health-care providers, comply with treatment recommendations, and keep their living environment clean (Engle *et al.,* 1997). Similarly, it is also one of the most important resources that enable women to provide appropriate care for their children, which is an important determinant of children's growth and development (Engle *et al.,* 1997). Women's status is defined as women's power relative to that of men in the households, communities, and nations in which they live (Smith *et al*., 2003). Compared to their higher status counterparts, women with low status especially in rural areas tend to have weaker control over household resources; tighter constraints on their time; more restricted access to information and health services; and poorer mental health, self-confidence, and self-esteem (Torheim *et al.*, 2010). All of these factors are closely tied to the woman's nutritional status and the quality of care received and in turn children's weights and the quality of care provided to the children (Menon *et al*., 2009.). This finding makes a good case for the use of educational empowerment and capacity building of women as a means of promoting food and nutritional status of children in particular and household members in general.

These results revealed that there was an inverse relationship between household size and nutritional status of the children. This means that as the number of children increase the dependency ratio increases. This can be attributed to the fact that as the number of dependants increase, there will be reduction in the food quality and quantity available for consumption in the rural poor households. Similar results to this have been found by Ojiako *et al*., (2009). Households commonly respond to conditions of limited resources and food insufficiency by adopting various methods of coping or fall back strategies (FAO, 2015), which have negative impact on household members' nutritional status.

The current study used the UNICEF conceptual framework to examine the determinants of under nutrition among children. With respect to the UNICEF framework, this study showed that maternal education, household size and household income had a relationship with the nutritional status of the children. In the framework, these are the underlying causes for determining the occurrence of under nutrition in children (Fig. 1). This shows that these three variables should form an intervention that could help combat the levels of under nutrition in the study area. For example, for the low education of the mothers influencing the nutritional status of the children, strategies to improve the nutrition education level of the mothers can be put in place. Improving the maternal nutrition education level has been shown to lead to an improvement in the nutritional status of the children (Were *et al*., 2010; Waswa *et al.*, 2015).

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From this study the following conclusions can be drawn:

1. Most of the households in the study area are of low socio-economic and demographic status. Most attained primary level of education and earn less than 1 dollar a day.
2. There was nutrient inadequacy in the diet consumed by the study children. This is attested by inadequacy in key macronutrients (protein) and micronutrients (Vitamin A, Iron and Zinc), and low diet diversity of children
3. Soybean fortified porridges significantly improved the nutritional status (significant reduction in wasting and underweight) of 3-5 year old children attending Mateka Primary school, Bungoma County
4. Maternal level of education, household size, household income and maternal age have a significant relationship with the nutritional status of the children

5.2 Recommendations

1. **Recommendation for policy:** Policies on fortification of commonly consumed staples in Western Kenya with soybeans to improve the nutritional adequacy of the diets of the children should be made. This is to augment the efforts of the County Early Childhood Education Bill that advocates for feeding of pre-school children with nutritionally adequate foods.
2. **Recommendation for practice:** As one of the ways of reducing the prevalence of under nutrition among pre-school children in Western Kenya, awareness of the

nutritional benefits of soybean should be raised to increase its adoption and therefore consumption in the households. This can be done though nutrition education programs in the study area.

3. **Recommendation for further research:** There is need for more research to document the extent of micronutrient under nutrition among the children in the study area**.**

REFERENCES

Abele S, Twine E, Legg C, 2007. *Food Security in Eastern Africa and the Great Lakes Region. Dar es Salaam, Tanzania*. International Institute of Tropical Agriculture. Final report submitted to USAID on October 15th 2007.

Ajao, K.O., Ojofeitimi, E.O., Adebayo, A.A., Fatusi, A.O. and Afolabi, O.T. (2010). Influence of Family Size, Household Food Security Status, and Child Care Practices on the Nutritional Status of Under-five Children in Ile-Ife, Nigeria. *African Journal of Reproductive Health.* Vol. 14 (4) 123-132.

Akhtar, S. and Ashgar, A. (2011). *Mineral Fortification of Whole Wheat Flour: An Overview*. Flour and Breads and their Fortification in Health and Disease Prevention. Pp. 263–271.

Akibode, C. S. and Maredia, M. (2011). *Global and regional trends in production, trade and consumption of food legume crops. Report Submitted to CGIAR Special Panel on Impact Assessment*. Accessed on 4th October, 2015 from http://impact.cgiar.org/sites/default/files/images/Legumetrendsv2.pdf

Akibode, C. S. (2011). *Trends in the production, trade, and consumption of food-legume crops in Sub-Saharan Africa*. Unpublished thesis.

Akomo, P. O., Egli, I., Okoth, M.W., Bahwere, P., Cercamondi, C. I., Zeder, C., Njage, P. M. K. and Owino, V. O. (2016). Estimated Iron and Zinc Bioavailability in Soybean-Maize-Sorghum Ready to Use Foods: Effect of Soy Protein Concentrate and Added

Phytase. *Journal of Food Processing and Technology*. 7: 556. doi:10.4172/2157-7110.1000556

Alemayehu, M., Tinsae, F., Haileslassie, K., Seid, O., Gebremedhin, G. and Yebyo, H. (2014). Nutritional Status and Associated Factors among Under-five Children, Tigray, Northern Ethiopia. *International Journal of Nutrition and Food Sciences.* Vol. 3 (6) 579-586.

Aliyar, R., Gelli, A. and Hamdani, S. H. (2015). A review of nutritional guidelines and menu composition for school feeding programs in 12 countries. *Frontiers in Public Health*. Vol 3 (148): 1-13

Allen, L. H., Backstrand, J.R., Stanek, E. J, Pelto, G. H., Chavez, A., Molina, E., Castillo, J. B. and Mata, A. (1992). The interactive effects of dietary quality on the growth and attained size of young Mexican children. *American Journal of Clinical Nutrition*. 56:353–64.

Amankwah, E. A., Barimah, J., Nuamah, A. K. M., Oldham, J. H. and Nnaji, C. O. (2009). Formulation of weaning food from fermented maize, rice, soybean and fishmeal. *Pakistan Journal of Nutrition*. 8(11): 1747-1752

Amankwah, E. A., Firempong, C. K., Barimah, J. and Ahima, J. K. (2010). Some anthropometric, biochemical and haematogical studies of rats fed on different composite diets prepared from maize, groundnut and soybean. *Asian Journal of Clinical Nutrition*. 2(4): 200-207

Anuonye, J.C. (2011). *Soybean Utilization and Fortification of Indegenous Foods in Times of Climate Changes.* INTECH Open Access Publisher.

Appor, L.Y and Krekling, S (2005). Maternal nutritional knowledge and child nutritional status in the Volta region of Ghana. *Maternal and Child Nutrition*.Vol 1 (2): 100-110

Arimond, M., Wiesmann, D., Becquey, E., Carriquiry, A., Daniels, M., Deitchler, M., Fanou-Fogny, N., Kennedy, G., Martin-Prevel, Y. and Torheim, L. E. (2010). Simple food group diversity indicators predict micronutrient adequacy of women's diets in 5 diverse, resource-poor settings. *Journal of Nutrition* 140 (11): 2079-2093.

Aubery, F. (2012). The detrimental effect of under nutrition on school achievement: Evidence from two districts of Madagascar. Centre for Education Research and Development. Vol 2 (3): 102-115

Badake, Q. D., Maina, I., Mboganie, M.A., Muchemi, G., Kihoro, E.M. and Chelimo, E. (2014). Nutritional status of children under five years and associated factors in Mbeere South District, Kenya. *African Crop Science Journal*. Vol. 22 (2). Supp. 4: 799-806.

Bisimwa, G. Owino, V. O., Bahwere, P., Dramax, M., Donned, P., Dibari, F. and Collins, S. (2012). Randomized controlled trial of the effectiveness of a soybean-maize-sorghum-based ready-to-use complementary food paste on infant growth in South Kivu, Democratic Republic of Congo. *American Journal of Clinical Nutrition.* 95: 1157-64

Black, Robert E, Cesar G Victora, Susan P Walker, Zulfiqar A Bhutta, Parul Christian, Mercedes de Onis, Majid Ezzati, Sally Grantham-McGregor, Joanne Katz, Reynaldo Martorell, Ricardo Uauy, the Maternal and Child Nutrition Study Group. (2013). Maternal and child under nutrition and overweight in low-income and middle-income countries. *Lancet* Vol 382, No. 9890, p 427–451.

Bukania, Z.N., Mwangi, M., Karanja, R.M., Mutisya, R., Kombe, Y.. Kaduka, L.U. and Johns, T. (2014). Food Insecurity and Not Dietary Diversity Is a Predictor of Nutrition Status in Children within Semiarid Agro-ecological Zones in Eastern Kenya. *Journal of Nutrition and Metabolism*. Volume14(3): 1-9.

Bundy, D., Burbano, C., Grosh, M., Gelli, A.Jukes,M., &Drake, L. (2009). *Rethinking School Feeding -Social Safety Nets, Child Development and the Education Sector, Directions in Development, Human Development*, The World Bank, Washington D.C., 2009.

Bwalya, B., B. (2013). *Influence of Maternal Characteristics on under-five Nutritional Status in Zambia.* Master of .Arts in Population Studies Thesis, Department of Population Studies, The University of Zambia. Pp. 1-132.

Bwibo, N.O. and Neumann, C.G. (2003). The need for animal source foods by Kenyan children. *Journal of Nutrition* 133: 3936S-40S.

Castaneda, C., Dolnikowski, G.G., Dallal, G.E., Evans, W.J. andCrim, M.C. (1995). Protein turnover and energy metabolism of elderly women fed a low-protein diet. *American Journal of Clinical Nutrition.* 62, 40-48.

Carba, D. B., Tan, V. L. and Adir, L. S (2009). Early childhood length-Age is associated with work status of Filipino young adults. *Economics and Human Biology*. Vol 7 (1): 7-17.

Chianu, J., Vanlauwe, N., Mahasi, B., Katungi, J.M., Akech E., Mairura C., Chianu, F.S. Justina, N. and Sanginga, N. (2008). *Soybean situation and outlook analysis*. Case of Kenya. pp.1- 62.

Christina, A. (2011). Diet diversity is associated with nutrient intakes and nutritional status of children in Ghana. *Asia journal of medical sciences.* Vol. 2(3): 105-109.

de Lara, C. B and Emilie, S. (2011). *Managing the transition towards National school feeding Programs: Preliminary insights from Partners' support in Countries: A discussion paper*. World Food Program. P.p 1-18

de Onis M, Onyango A. W, Van den Broeck, J., Chumlea WC, Martorell R. (2004). Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. *Food Nutr Bull*. 25(1 Suppl):S27–S36.

DeLange, C. J., (2010). *Factors contributing to under nutrition in children 0-60 months admitted to hospital in the Northern Cape*. Unpublished thesis. University of Pretoria.

Dewey, K. G., and Begum, K. (2011). Long-term consequences of stunting in early life. *Maternal and Child Nutrition*, 7(Suppl. 3), 5-18.

Ekesa BN, Blomme G, Garming H. (2011). Dietary diversity and nutritional status of preschool children from MUSA-Dependent households in Gitega (Burundi) and Butembo (democratic Republic of Congo). *African J Food Agri Nutr Dev* (AJFAND). Vol. 11: 4896-4911.

Ekesa, B. N., Walingo, M.K. and Abukutsa-Onyango, M.O. (2009). Accessibility to and consumption of indigenous vegetables and fruits of rural households in Matungu division, Western Kenya. *African Journal of Food, Agriculture, Nutrition and Development.* Vol. 9 (8): 1725:1738.

Ekesa, B. N., Walingo, M.K. and Onyango, M. O. (2008a). Role of Agricultural Biodiversity on Dietary Intake and Nutritional Status of Preschool children in Matungu Division, Western Kenya. *African Journal of Food Science*. Vol. 2(4):026–32.

Ekesa, B.N., Walingo, M.K. and Abukutsa-Onyango, M.O. (2008b). Influence of agricultural biodiversity on dietary diversity of preschool children in Matungu Division, Westrern Kenya. *African Journal of Food, Agriculture, Nutrition and Development,* Vol. 8(4): 391-404.

Engle, P., Menon, P. J., Garrett, J. and Slack, A. (1997). Urbanization and caregiving: A framework for analysis and examples from Southern and Eastern Africa. *Environment and Urbanization* 9 (2): 253-270.

Ernst, J., Ettyang, G., Neumann, C., Nyakindo, W., Siika, A. and Yiannoutsos, C. (2008). *Introduction to the HIV Nutrition Project (HNP): Increasing Animal Source Foods (ASF) in diets of HIV-infected Kenyan Women and Their Children*. Global Livestock CRSP: Research brief 08-01-HNP. Retrieved on 4th October, 2015 from http://glcrsp.ucdavis.edu

Eshun, G. (2009). *Baseline data on the nutrient content and physicochemical properties of selected varieties of soybean, groundnut and rice for the development of nutritious, energy-dense diets.* Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Espejo, F. (2009). *Home-grown School Feeding: A Framework to Link School Feeding with Local Agricultural Production.* Rome: World Food Program.

FAO (2011). *Protein digestibility and absorption: Effects of fibre and the extent of individual variation*. Retrieved on 23rd July , 2016 from www.fao.org

FAO (2012). FAOSTAT. Accessed on 26th May, 2016 from http://faostat.fao.org/site/567/default.asp#ancor

FAO (2015). *The state of food insecurity in the world*. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/docrep/013/i11683e/i1683e.pdf . Accessed 15th June, 2016.

FAO/WHO (2014). Rome Declaration on Nutrition. Second International Conference on Nutrition, Document ICN2 2104/2. Rome., Italy. Accessed on 5th October, 2015 from http://www.fao.org/3/a-mm215e.pdf

Ferguson, E., Chege, P., Kimiywe, J., Wiesmann, D. and Hotz, C. (2015). Zinc, iron and calcium are major limiting nutrients in the complementary diets of rural children. *Maternal and Child Nutrition*. Suppl. 3 (II): 6-20.

Food and Agriculture Organization of the United Nations (2015). *"The State of Food Insecurity in the World 2015. Strengthening the enabling environment for food security and nutrition."* Rome: FAO. Accessed on 2nd November, 2016 from http://www.fao.org/3/a4ef2d16-70a7-460a-a9ac-2a65a533269a/i4646e.pdfAccessed September 2016.

Food and Agriculture Organization of the United Nations (FAO) (2007). *Guidelines for measuring household and individual dietary diversity*. Version 3, Rome, Italy.

Food and Agriculture Organization of the United Nations. (2003). *Food energy - Methods of analysis and conversion factors*. Food and Agriculture organization Nutrition paper 77.

Gewa, C. A. and Leslie, T. F. (2015). Distribution and determinants of young child feeding practices in the East African region: demographic health survey data analysis from 2008-2011. *Journal of Health Population and Nutrition.* Vol. 3 (14): 1-16

Ghatge, N. S. (2013). Impact of soyaladoo feeding on biochemical analysis of malnourished pre-school children. *Research Journal of Family, Community and Consumer Sciences*. Vol. 1 (2): 6-9

Gibson, R. S., Manger, M. S., Krittaphol, W., Pongcharoen, T., Gowachirapant, S., Bailey, K. B. and Winichagoon, P. (2011). Does zinc deficiency play a role in stunting among primary school children in NE Thailand? *Br J Nutr*. ;97(1):167-75

Gina, L.K., Maria, R.P. and Chiara, S. (2007). Dietary diversity score is a useful indicator of micronutrient intake in non-breast-feeding Filipino children. *Journal of Nutrition.* 137:472-477.

Government of Kenya (2014). *The County Early Childhood Education Bill 2014*. Kenya Gazette Supplement No. 108. Retrieved on 24th March, 2015 from http%3A%2F%2Fkenyalaw.org%2Fkl%2Ffileadmin%2Fpdfdownloads%2Fbills%2F2014%2FCountyEarlyChildhoodEducationBill2014.pdfandusg=AFQjCNG1c0lA-heDenKFB4dOJ2BV-XaXUQandsig2=1XEHMyhGfDz28UKcHXA6UQ

Grant, F., Cole, D., Kirimi, S., Levin, C., Garret, D., Kariuki, S., Ouedarugo, H., Loechi, C. *et al*., (2016). Prevalence of Vitamin A deficiency among infants participating in the Mama Sasha proof of concept project in Western Kenya.

Grillenberger, M., Neumann, C. G., Murphy, S. P, Bwibo, N. O, van't Veer P, Hautvast, J. G. A. J. and West, C. E. (2003). Food supplements have a positive impact on weight gain and the addition of animal source foods increases lean body mass of Kenyan school children. *Journaal of Nutrition*. Vol. 133 (5):3957S–64S.

Grillenberger, M., Neumann, C. G., Murphy, SP, Bwibo N. O, Weiss, R. E., Jiang, L. H., Hautvast, J.G. and West, C. E. (2006). Intake of micronutrients high in animal-source foods is associated with better growth in rural Kenyan school children. *British Journal of Nutrition*. 95:379–90.

Hambidge, K.M., Miller, L.V., Westcott, J.E. and Krebs, N.F. (2008).Dietary reference intakes for zinc may require adjustment for phytate intake based upon model predictions. *Journal of Nutrition* ;138:2363–6.

Hoffman, J.R. and Falvo, M.J. (2004). Protein – which is best? *Journal of Sports Science and Medicine.*Vol. 3, pp 18-130

Hoyland, A., Dye, L. and Lawton, C. (2009). A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. *Nutr Res Rev.* Vol. 22: 220-224.

Institute of Medicine (IOM), (2000). *Dietary Reference Intakes: Application in Dietary Assessment*. National Academy Press, Washington, DC, pp. 73-105.

International Food Policy Research Institute. (2016). *Global Nutrition Report 2016: From Promise to Impact: Ending Under nutrition by 2030.* Washington, DC. Accessed on 2nd November, 2016 from http://data.unicef.org/wp-content/uploads/2016/06/130565-1.pdf

Jason, J., Archibald, L. K., Nwanyanwu, O. C., Sowell, A. L., Buchanan, I., Larned, J., Bell, M., Kazembe, N. P., Dobbie, H. and Jarvis, W. R. (2002). Vitamin A Levels and Immunity in Humans. *Clinical and Diagnostic Laboratory Immunology*. Vol. 9(3): 616–621.

Kalaluka, E. (2011). Supporting small holder market participation through Zambian Home grown school feeding program.

Kamau, E. H., Serrem, A. C. and Wamunga, W.F. (2014). *Nutrient composition, Efficacy and Consumer acceptability of soy fortified complementary foods from Western Kenya.* Department of Family and Consumer Science, University of Eldoret.

Kamau, J., Ohiokpehai, O., Mbithe, D., Kimiywe, J., Oteba, L., Were, G., andKing'olla, B. (2008). *Effect of soybean (Glycine max) Supplementation on nutritional status of school children aged 6-9 years from HIV affected households in Suba District, Kenya*. MSc thesis. Kenyatta University.

Kearney, J. (2008). *School feeding programs and products*. Accessed on 3rd March, 2017 from https://2Fdigiresearch.vut.ac.za

Kennedy, G. L., Pedro, M. R., Seghieri, C., Nantel, G., and Brouwer, I. (2007) Dietary Diversity Score is a useful indicator of micronutrient intake in non-breastfeeding Filipino children. *The Journal of Nutrition*, 137, 472-477.

Kennedy, G., Ballard, Tand Marieclaude, D. (2011). *Guidelines for Measuring Household and Individual Dietary Diversity*. FAO, Rome:Italy.

Kennedy, G., Fanou–Fogny, N., Seghieri, C., Arimond, M., Koreissi, Y., Dossa, R., Kok, F. J. and Brouwer, I. D. (2010). Food groups associated with composite measure of probability of adequate intake of 11 micronutrients in the diets of women in urban Mali. *Journal of Nutrition* 140: 2070-2078.

Kenya Kids Can Organization (2017). *Feeding program*. Accessed on 3rd March, 2017 from http://kenyakidscan.org/feeding-program/

Kenya National Bureau of Statistics (KNBS) and ICF Macro. (2015). *Kenya Demographic and Health Survey 2014-2015*. Calverton, Maryland: KFNBS and ICF Macro.

Kenya National Bureau of Statistics (KNBS) and Ministry of Public Health and Sanitation (MoPHS) (2008). *Guidelines for Nutritional assessments in Kenya.* Ministry State Planning and National Development and Vision 2030 and Ministry of Public Health and Sanitation. 1st Edition. Nairobi, Kenya.

Kenya Open Data (2015). *Bungoma County profile*. Accessed on 23rd June, 2015 from http://kenyaopendata2015/focusonbungomacounty

Khanam RHS, Nghiem T, Rahman MM (2011). The impact of childhood under nutrition on schooling: Evidence from Bangladesh. *Journal of Biosocial Sciences* 43 (4): 437-451

Kinabo, J., Mnkeni, A. P. and Nyaruhucha, C. N. M. (2006). Feeding frequency and nutrient content of foods commonly consumed in the Iringa and Morogoro regions in Tanzania. *International Journal of Food Science and Nutrition* 57: 9–17.

Kinyuru, J. N. et al., (2012). Identification of traditional foods with public Health potential for complementary feeding in Western Kenya. *Journal of Food Research.*Vol 1 (12): 148-158.

Kismul, H., Broeck, J.V.and Lunde, T.M. (2014). Diet and kwashiorkor: a prospective study from rural DR Congo. *Peer J* 2:e350; DOI 10.7717/peerj.350

KNBS and SID (2013). *Exploring Kenya's inequality. Pulling apart or pooling together. Focus on Bungoma County*. Nairobi, Kenya.

Kolapo, A. L. (2011). *Soybean: Africa's potential Cinderella Food Crop*. Ibadan: Nigeria.

Kosti, R.I., Panagiotakos, D., Zampelas, A., Mihas, C., Alevizos, A., Leonard, C., Tountas, Y. and Mariolis, A. (2008). The association between consumption of breakfast cereals and BMI in schoolchildren aged 12–17 years: the VYRONAS study. *Public Health Nutr. Vol* 5 (11):1015–1021.

Kumari, M., Gupta, S., Lakshmi, A.J., and Prakash, J. (2004). Iron bioavailability in green leafy vegetables cooked in different utensils. *Food Chem* 86:217–22.

Kure, O. A. and Wyasu, G. (2013). Influence of natural fermentation, malt addition and soya fortification on the sensory and physic-chemical characteristics of Ibyer-sorghum gruel. *Advances in Applied Science Research.* Vol 4 (1): 345-349.

Labadarios, D., Steyn, N., Maunder, E., Gericke, G., Swart, R., Huskinson, J., Dannhauser, A., Voster, H. H., Nesamvuni, A. E. and Nel, J. H. (2005). The National Food Consumption Survey (NFCS), South Africa, *Public Health Nutrition* 8(5): 533-543.

Laura, E. C., Stephanie, A., Richard, J., Rivera, A., Philip, M. and Black, E. (2006). *Stunting, wasting and micronutrient deficiency disorders.*World Bank. Geneva, Switzerland 150pp.

Lawson, Ty M. (2012). *Impact of School Feeding Programs on Educational, Nutritional, and Agricultural Development Goals. Michigan State University.*

Le Thuc, D. (2009). *The effects of Early Age Stunting on cognitive achievement among children in Vietnam.* Young Lives working paper number 45, Young Lives: UK

Lin, C.A., Manary, M.J., Maleta, K., Briend, A. and Ashorn, P. (2008). An energy-dense complementary food is associated with a modest increase in weight gain when compared with a fortified porridge in Malawian children aged 6-18 months. *J Nutr*. 138:593–8.

Lumole, S. Z. and Msuya, J. (2013). *Household dietary diversity and nutritional status of children and women of reproductive age in Madizini township and its Hinterland villages*. Msc thesis, Sokoine University of Agriculture

M’Kaibi, F.K., Steyn, N., Ochola, S and Du Plessis (2015). Effects of agricultural biodiversity and seasonal rain on diet dietary adequacy and household food security in rural areas of Kenya. *BMC Public Health* 15:422

Macharia, I., Orrr, A. and Schipmann, C. (2012). Cereal consumption pattern in Kenya. International Crops Research Institute for the Arid and Semi-arid Tropics (ICRISAT). Nairobi. Pp. 1-35.

Maleta, K., Kuittinen, J. and Duggan, M.B. (2004). Supplementary feeding of underweight, stunted Malawian children with ready-to-use food. *J Pediatr Gastroenterol Nutr* 38, 143–145.

Mangusho, G. (2010). Effect of Vitamin A-mineral supplementation on serum retinol and overall nutritional status of school children aged 6-10 years in Wakiso District, Uganda: a randomized controlled trial. Msc thesis, Makerere University.

Masibo, P. K. (2013). Effects of Initial Nutritional Status on the Responses to a School Feeding Programme among School Children Aged 6 to 13 Years in the Millennium Villages Project, Siaya, Kenya. Stellenbosch, Stellenbosch University, 2013. Retrieved on 3rd October, 2015 from http://scholar.sun.ac.za/handle/10019.1/85693

Mayekiso, A. (2013). *Perceptions and attitudes of rural communities towards indigenous leafy vegetables at Nyadeni Location in Libode, Eastern Cape Province, South Africa*. Unpublished Hons Dissertation, University of Fort Hare: South Africa.

Menon, P., Ruel, M. T. and Morris, S. (2009). Socio-economic differentials in child stunting are considerably larger in urban than rural areas: Analysis of 10 DHS data sets. *Food and Nutrition Bulletin* 21 (3): 282-289.

Michaelsen, K. F., Floppe, C., Root, N., Kaestel, P., Stougard, M., Laurtzen, L., Molgard, C., Girma, T. and Friis, H. (2009).Choice of food ingredient for moderately malnourished children 6 month to 5 years of age. University of Copenhagen, Denmark. *Journal of Food and Nutrition* 30 (3): 1-62

Moura, F., Palmer, A., Finkelstein, J., Haas, J., Murray-Kolb, L.,Wenger, M., Birol, E., Boy, E., and Pena-Rosas, J. (2014). Are biofortified staple food crops improving vitamin A and iron status in women and children? New evidence from efficacy trials.*Advances in Nutrition*.Vol (5): 568–570

Mugenda, O.M. and Mugenda, A. G. (2003). *Research methods. Quantitative and qualitative Approaches.* Nairobi: Acts Press.

Neumann, C. and Harris, D.M. (1999). *Contribution of animal source foods in improving diet quality for children in the developing world*. The World Bank Washington, D.C.

Niyibituronsa, M., Kyallo, F., Mugo and Gaidashova, S. (2014). Improving the nutritional status of malnourished children using soybean products in Rwanda. *African Journal of Food, Agriculture and Development.*Vol.14 (4). Kigali: African scholarly Science communication trust.

Niyibituronsa, M., Kyallo, F., Mugo, C. and Gaidashova, S. (2015). Intrahousehold allocation, household headship and nutrition of under-fives: A study of Western Kenya. African *Journal of Food, Agriculture, Nutrition and Development*. 15(1):9744-9761.

Ochola, S. and Masibo, P.K (2014).Dietary intake of school children and adolescents in developing countries. *Annals of Nutrient Metabolism* 64 (suppl): 24-40

Odunayo, I.S. and Oyewole, O.A. (2006). Risk Factors for Under nutrition among Rural Nigerian Children. *Asia Pacific Journal of Clinical Nutrition* .Vol 15 (14) 491-495.

Ohiokpehai, O., Mbithe, D. D and Kamau, J. (2009a). Serum zinc levels of school children on a corn-soy blend feeding trial in primary schools in Suba district, Kenya. *Journal of Applied Sciences*. Vol. 2 (3): 112-117

Ojiako, A.I., Mayong, V.M. and Ikpi, A. (2010). Determinants of nutritional status of pre-school children from rural households in Kaduna and Kano States, Nigeria. *Pakistan Journal of Nutrition.* Vol 8 (9): 1497-1505.

Oniang'o, R. K., Mutuku, J.M. and Malaba, S.J. (2003). Contemporary African food habits and their nutritional and health implications. *Asia Pacific Journal of Clinical Nutrition.* Vol. 12 (3): 231-236.

Onoja, U.S. and Obizoba, I. C. (2009). Nutrient composition and organoleptic attributes of gruel based on fermented cereal, legume, tuber and root flour. *Journal of Tropical Agriculture Food and Environment*. Ex 8: 162-168

Onoja, U.S., Akubor, P.I., Gernar, D.I., and Chinmma, E.C. (2014). Evaluation of complementary food formulated from local staples and fortified with calcium, iron and zinc. *Journal of Nutrition and Food Science*.Vol 4(6): 1-6

Onyono, K.E., Serrrem, C.A and Serem, C. (2015). *Food consumption patterns and nutritional status of children living in Banana producing areas in Kisii.* Msc thesis, Department of Family and Consumer Sciences, University of Eldoret.

Oyunga, A.M., Omondi, O. D. and Grant, E. K. F. (2016). Awareness in the context of prevalence of Vitamin A Deficiency among households in Western Kenya using a cross-sectional survey. *Journal of Food and Nutrition.* Vol. (4) 3: 55-64. doi: 10.11648/j.jfns.20160403.13

Panjsheri, S.B.S. (2007). *Child Health: Mothers Knows Best; the Association between Child Under nutrition and Maternal Education in Nepal*. Master of Public Policy. Thesis, Georgetown University, Graduate School of Arts and Sciences. Pp. 34-40.

Phuka, J C., Thakwalakwa, C., Maleta, K., Cheung, Y.B., Briend, A., Manary, M.J., and Ashorn, P. (2009). Post intervention growth of Malawian children who received 12-month dietary complementation with a lipid-based nutrient supplement or maize–soy flour. *American Journal of Clinical Nutrition.* 89: 382–390.

Pivik, R. and Dykman, R. (2007). Events-related variations in alpha band activity during an attentional task in pre-adolescents. Effects of morning nutrition. *Journal of Clinical Neurophysiology*. 118: 615-632.

Plahar, W. A., Okezie, B. and Annan, N. (2003a). Nutritional quality and storage stability of extruded weaning foods based on peanut, maize and soybean.*PlantFoodsHum.Nutr*., 58(3): 1-16.

Plahar, W. A., Okezie, B. and Gyato, C. (2003b). Development of a high protein weaning food by extrusion cooking using peanuts, maize and soybeans.*PlantFoodsHum.Nutr*. 58(3): 1-12.

Rampersaud, G. C., Pereira, M., Girard, B., Adams, J. and Metzl, J. (2005). Breakfast habits, nutritional status, body weight and academic performance in children and adolescents. *J Am Diet Assoc.* Vol (12) 105: 743-760

Ribaya-Mercado, J. D., Maramag, C. C., Tengco, L.W., Dolnikowski, G. G., Blumberg, J.B. and Solon, F. S. (2007). Carotene-rich plant foods ingested with minimal dietary fat enhance the total-body vitamin A pool size in Filipino schoolchildren as assessed by sTable-isotope-dilution methodology. *American Journal of Clinical Nutrition* 85:1041–9.

Rolfes, S. R., Pinna, K. and Whitney, E. (2008). *Understanding normal and clinical nutrition*. Cengage Learning, 200 First Stamford Plc, 4th Fl, Stamford, CT 06902. Hardcover book, 1,120 pp, $321, ISBN: 978-1-285-45876-2.

Ronoh, A. K. and Were, G. M. (2015). Diet Diversity of complementary foods. A case study of Mulot Division, Narok County. *African Journal of Education Science and Technology*. Vol 2 (2) : 1-12.

Ruel, M. T., Minot, N and Smith, L. (2004). *Patterns and determinants of fruit and vegetables consumption in sub- Saharan Africa. Background paper for the Joint FAO/WHO workshop, Kobe, Japan*

Sanchez, A. (2009). *Early Nutrition and Cognitive development in Pre-school children in Peru.* Young Lives working paper number 57. Young Lives: UK

Sanginga, P.C., Adesina, A.A. Manyong, V.M. Otite, O. and. Dashiell, K.E. (1999). *Social Impact of Soybean in Nigeria's Southern Guinea Savanna.* International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria.

Sarma, G.S., Wijesinghe, N.G. and Sivananthawerl, T. (2013). The effects of nutritional status on education performance of primary school children in the plantation sector in Nuwara Eliya Educational Zone. *Tropical Agricultural Research.* Vol (24) 3: 203-214.

Sawadogo, P. S., Martin-Prevel, Y., Savy, M., Kameli, Y., Traissac, P. and Traore, A.S. (2006). An infant and child feeding index is associated with the nutritional status of 6-23month-old children in rural Burkina Faso. *Journal of Nutrition* 136: 656–663.

Schlaudecker, E. P., Steinhoff, M. C. and Moore, S.R. (2011). Interactions of diarrhea, pneumonia, and under nutrition in childhood: recent evidence from developing countries. *Curr Opin Infect Dis*.;24:496–502.

Semproli S, Canducci E, Ricci E, Gualdi-Russo E (2011).Nutrient intake in 5–17-year-old African boys and girls in a rural district of Kenya.*NutrHosp*; 26: 765–774.

Serrem, C.A., de Kock, H.L., Oelofse, A. and Taylor, J.R.N. (2011).*Soy fortified sorghum biscuits for supplementary feeding of school-age children*. Department of Food Science, University of Pretoria.

Shiriki, D., Igyor, M.A. and Gernah, D.I. (2015). Nutritional evaluation of complementary food formulations from Maize, Soybean and Peanut Fortified with *Moringa oleifera* Leaf Powder. *Food and Nutrition Sciences*, Vol. **6**: 494-500.

Siekmann, J. H., Allen, L. H., Bwibo, N. O., Demment, M. W., Murphy, S. P. and Neumann, C. G. (2003). Kenyan school children have multiple micronutrient deficiencies, but increased plasma vitamin B-12 is the only detectable micronutrient response to meat or milk supplementation. *J Nutr* ;133:3972S–80S.

Signh, P., Kumar, R., Sabapathy, S. N. and Bawa, A. S. (2008). Functional and Edible uses of soy protein products. *Comprehensive Review in Food Science and Safety.* Vol.7 (2): 14-28.

Smith, L. C., Ramakrishan, U., Ndiaye, A., Hadad, L. and Martorell, R. (2003). The importance of women's status for child nutrition in developing countries. Washington, DC: *International Food Policy Research Institute* 47pp.

Solomon, M. (2005). Nutritive Value of Three Potential Complementary Foods Based on Cereals and Legumes. *The African Journal of Food, Agriculture, Nutrition and Development* (*AJFAND*), **5**, 1-14.

Standing committee on Nutrition (2016). *An assessment of the situation regarding the principle of "ensuring that no one is left behind" at the global level: The United Nations System Standing Committee on Nutrition.* Accessed on 2nd February, 2016 from https://sustainabledevelopment.un.org/index.php?page=viewandtype=30022andnr=120andmenu=3170

Stephenson, K., Amthor, R., Mallowa, S., Nungo, R., Maziya-Dixon, B., Gichuki, S., Mbanaso, A. and Manary, M. (2010). Consuming cassava as a staple food places children 2-5 years old at risk of inadequate protein intake, an observational study in Kenya and Nigeria. *Nutrition Journal* 9:9

Steyn, N.P., Nel, J. H., Nantel, G., Kennedy, G. and Labadarios, D. (2006). Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutrition Vol.* 9 (5): 644-650.

Sumonkati, D.M.Z. and Islam, M.A. (2008). Predictors of Child Chronic Under nutrition in Bangladesh*; Proc Pakistan Acad. Sci*. 45 (3) 137-155.

Swick, R. (2007). *Selecting soy protein for animal feed.* 15th annual ASA-IM South East Asian feed technology and nutrition workshop. ASA-IM, Singapore. Pp 1-11.

Taruvinga, A. and Nengovhela, R. (2015). *Consumers' perceptions and consumption dynamics of African leafy vegetables (ALV's): Evidence from Feni Communal Area, Eastern Cape Province, South Africa*. 5th International Conference on Biomedical Engineering and Technology. Vol 81 (16), IACSIT Press: Singapore.

Thompson, B. and Amoroso, L. (2009). *Combating Micronutrient Deficiencies: Food-based Approaches*. Rome: FAO.

Torheim, L. E., Ferguson, E., Penrose, K. and Arimond, M. (2010). Women in resource-poor settings are at risk of inadequate intakes of multiple micronutrients. *Journal of Nutrition* 140:2051–8.

Troesch, B., van Stuijvenberg, M.E., Smuts, C.M., Kruger, H.S., Biebinger, R., Hurrell, R.F., Baumgartner, J. and Zimmermann, M. B. (2011). A micronutrient powder with low doses of highly absorbable iron and zinc reduces iron and zinc deficiency and improves weight-for-age Z-scores in South African children. *J Nutr*. 141:237–42.

Tucker, K. L. (2001). Eat variety of healthful foods: old advice with new support. *Nutrition Reviews* 59:156–158.

UNICEF (1990). UNICEF (United Nations Children's Fund) (1990). *Strategy for Improved Nutrition of Children and Women in Developing Countries.* NewYork.

UNICEF (2009b).*Tracking progress on child and maternal nutrition: A survival and development priority*. New York: USA.

UNICEF (2013a). *The right ingredients: the need to invest in child nutrition*, United Kingdom.

UNICEF (2013b). *Improving child Nutrition: The achievable imperative for global progress.* Accessed on 10th June, 2016 from www.unicef.org/publications/index.html

UNICEF. (2009a). *CHILDINFO*: *Monitoring the Situation of Children and Women.* United Nations Children's Fund.

UNICEF/WHO/ The World Bank. (2014). *"Summary of key facts about the 2013 joint under nutrition estimates."* Accessed on 2nd November, 2016 from http://www.who.int/entity/nutgrowthdb/summary_jme_2013.pdf?ua=1

UNICEF/WHO/World Bank (2015). *Levels and trends in child under nutrition. UNICEF-WHO-World Bank group joint child under nutrition estimates. Key findings of the 2015 edition*. Retrieved on 6th August, 2016 from http://unnicef-under nutritionestimates.org

United Sates Development Agency (USDA) Foreign Agricultural Service. (2009). *Assessment of Local Production for School Feeding in Kenya. Office of Capacity Building and Development*

USAID, (2006). *Understanding nutrition data and the causes of under nutrition in Kenya*. A special report by the Famine Early Warning Systems Network (FEWSNET). USAID.

Vivek, B.S., Krivanek, A.F., Palacios-Rojas, N., Twumasi-Afriyie, S., and Diallo. A.O. (2008). *Breeding Quality Protein Maize (QPM): protocols for developing QPM cultivars*. Mexico, CIMMYT.

Walingo, M.K. and Ekesa, B.N. (2013). Nutrient intake, morbidity and Nutritional status of pre-school children are influenced by agricultural and diet diversity in Western Kenya. *Pakistan Journal of Nutrition* 12(9): 854-859

Walingo, M.K. and Kidake, F. M. (2013).The influence of household procurement strategies on food intake and nutritional status of pre-school children in rural Western Kenya.*Sustainable Agriculture Research*. Vol. 2 No 2 109-16

Waswa, M., Keding, B.G., Irmgard, J., Johannes, H. and Michael, B.K. (2015). *Nutritional status, dietary diversity and morbidity among infants and children aged 6-23 months in rural western Kenya*. Retrieved on 15th July 2016 from http://www.bioversity.org

Were, G. M., Ohiokpehai, O., Okeyo-Owuor, J.B., Mbagaya, G.M., Kimiywe, J., Mbithe, D. and Okello, M. M. (2010). Soybean (*Glycine max*) complementation and the zinc status of HIV and AIDS affected children in Suba District, Kenya. *AJFAND*. Vol. 10 (3): 2187-2202

WHO (2009). *Global prevalence of vitamin A deficiency in populations at risk 1995-2005: WHO global database on vitamin A deficiency. Geneva, World Health Organization*. Accessed on 8th April, 2016 from http://www.who.int/vmnis/vitamina/prevalence/en/

WHO (2015). *Iodine Deficiency Disorders*. Accessed on 5th October, 2015 from http://www.who.int/nutrition/topics/idd/en/

World Bank (2013). *Education overview*. Accessed on 3rd March, 2017 from http://www.worldbank.org/en/topic/education/overview

World Food Program (2005). *State of school feeding worldwide*. Accessed on 3rd March, 2017 from Fhttps://www.google.documents.wfp.org%2Fstellent%2Fgroups%2Fpublic%2documents%2Fcommunications%2Fwfp257481.pdf

World Food Program (2017). *School Meals*. Accessed on 3rd March, 2017 from http://www1.wfp.org/school-meals

World Hunger Education Service (2015). *World Hunger and Poverty Facts and Statistics*. Accessed on 8th August, 2016 from http://www.worldhunger.org/articles/Learn/world%20hunger%20facts%202002.htm

World Hunger Education Services (2016). 2016 World Hunger and Poverty Facts and Statistics. Accessed 2nd November, 2016 from http://www.worldhunger.org/

Zimmermann, M. and Anderson, M. (2012). Assessment of iodine nutrition in populations: past, present, and future. *Nutrition Reviews*. Vol 70 (10): 553-570

APPENDICES

APPENDIX 1: LETTER OF INTRODUCTION

Hello. My name is Ronoh Amos, and I am a student at the University of Eldoret. I am conducting a study on effect of soybean fortified porridges on the nutritional status of children 3-5 years old in Mateka aprimary School, Bungoma County.

My research assistants and I will ask you questions about your household demographics and the recall of the child's diet in the last 24 hours. We will also measure the weight, height and the mid upper arm circumference. The questionnaire will take around 40-45 minutes to complete. Whatever information will be kept strictly confidential and will not be shown to any other persons.

Participation in this study is voluntary and you can choose not to answer any individual question or all of the questions.

Researcher: **Ronoh Amos**

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Informed consent

Study procedures

In this study, my three research assistants and I will ask dietary, demographic and dietary, demographic and socio-economic questions that you will be required to answer as correctly as possible. The questionnaire will take between 30-45 minutes to complete. They will then have their weight, height andmid upper arm circumference measured every month for the 9 months the study is going to run.

Risks

What are the risks involved in participating in the study?

There are no serious risks involved. During the process of taking weight, height and MUAC care will be taken to ensure that the child will not feel any discomfort.

Benefits

Are there benefits to the child for participating in the study?

During this study there are no direct benefits for the child participating in the study. However, the child is going to receive the porridge for 6 months then terminated after which measurements will be made on the 9^{th} month. The findings from this study will contribute to knowledge to help in formulation of policies to improve the nutritional status of pre-school children in this region and other parts of the country.

Ethical issues and confidentiality

Whatever information you shall provide will be kept strictly confidential and will not be shown to any other persons. Participation in this study is voluntary and you can choose not to answer any individual questions or all of the questions or consent for your child to participate in the study.

Ask the participant if they have any questions, then address them before they sign the consent form.

Letter of consent

By signing below, I ……………………………………………… a resident of ………………………………. location, Bungoma County, agree to take part in this study and also consent my child to take part in this study. I hereby declare that:

- I have been informed about the research and I have understood the benefits and the risks involved.

- I have had the chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is voluntary and I have not been pressured to take part in it.
- I may choose to leave the study at any time and that I will not be penalized or prejudiced in any way. I have been assured of confidentiality on any information that will be given.

……………………………….. Date ……………………

Signature of respondent

………………………………………….. Date

……………………………….

Signature of investigator

…………………………………………….. Date …………………………

Signature of Witness

APPENDIX 2: QUESTIONNAIRE

<u>SECTION A</u>: DEMOGRAPHIC INFORMATION

Tick where appropriate

1. What is your marital status?
   (i) Married [ ]
   (ii) Single [ ]
2. What is your level of education?
   (i) None [ ]
   (ii) Primary [ ]
   (iii) Secondary [ ]
   (iv) College [ ]
   (v) University [ ]
3. What is your current occupation?
   (i) Student [ ]
   (ii) Employed unskilled [ ]
   (iii) Employed skilled [ ]
   (iv) Professional [ ]
   (v) Self employed [ ]
   (vi) Farmer [ ]
   (vii) House wife [ ]
   (viii) Casual laborer [ ]
4. What is your household monthly income?
   (i) Less than 1,000 [ ]
   (ii) 1,001 - 5,000 [ ]
   (iii) 5001 - 10,000 [ ]
   (iv) 10,001 and above [ ]
   (v) Don’t know
5. Do you cultivate any land? Yes [ ] No [ ].

   If yes, how much land is allocated for food crop?
   (i) 1 acre and below [ ]

(ii) 1 to 5 acres [ ]

(iii) 5 acres and above [ ]

SECTION B: INFORMATION ON THE CHILD'S FEEDING PRACTICES

1. Are you the mother of the child? (Please state relationship)?

    (i) Yes [ ]

    (ii) No [ ]

    (iii) Other [ ]

    If other, specify/ remark…………………………………………………………

2. Are you responsible for the child's feeding?

    (i) Yes [ ]

    (ii) No [ ]

    (iii) Only responsible for preparing food [ ]

    (i) Other (specify)………………………………….

SECTION 3: HOUSEHOLD DIET DIVERSITY QUESTONNAIRE

Please describe the foods (meals and snacks) that you ate yesterday during the day and night, whether at home or outside the home. Start with the first food eaten in the morning.

	Food group	Examples	**Last 7 days 1=Yes 2=No**
1	Cereals	bread, biscuits, cookies or any other foods made from millet, sorghum, maize, spaghetti, pasta, rice, wheat, ugali, porridge or pastes or other locally available grains	
2	Vitamin A rich vegetables and Tubers	pumpkin, carrots, yellow fleshed sweet potatoes	
3	White tubers and roots	white potatoes, white yams, cassava, green bananas	
4	Dark green leafy vegetables	Sukuma wiki, spinach, cabbages ,cassava leaves, pumpkin leaves, cowpeas leaves ,indigenous green vegetables	
5	Other vegetables	Tomato, onion, eggplant, green pepper,	
6	Vitamin A rich fruits	ripe mangoes, paw paw	
7	Other fruits	passion fruit, banana, mkwaju, oranges, Avocado	
8	Organ meat (iron rich)	liver, kidney, heart or other organ meats	
9	Flesh meats	beef, pork, lamb, goat, rabbit, wild game, chicken, duck, doves or other birds	
10	Eggs	Eggs	
11	Fish	Nile perch, tilapia, omena, fresh or dried fish,	
12	Legumes, nuts and seeds	beans, ndengu, green grams, cowpeas, dried peas, lentils, groundnuts, simsim	

13	Milk and milk products	milk, cheese, yogurt, mala or other milk products	
14	Oils and fats	oil, fats or butter added to food or used for cooking	
15	Sweets	sugar, honey, sweetened soda or sugary foods such as chocolates, sweets or candies	
16	Spices, condiments, Beverages	Spices (black pepper, salt), coffee, tea, alcoholic beverages, Roiko, curry powder	

SECTION 4: FOOD FREQUENCY QUESTIONNAIRE

Instructions to research assistants:

CIRCLE THE CHOSEN ANSWER AND FILL IN THE AMOUNT AND TIMES EATEN IN THE APPROPRIATE COLUMNS.

I will ask you about the types and amounts of food the child has been eating during the last six months. Please tell me if the child ate the food, how much the child eats and how often the child eats.

STARCH

Food	Description	Amount	Times eaten				Amount /day
			Per day	Per week	Per month	Never	
Porridge	Maize meal						
	Sorghum						
	Mixed flour (specify the ingredients)						
	Enriched with sugar, milk, margarine, mixed flour						
Ugali	Maize meal						
	Sorghum						
	Millet						
	Mixed flour (specify the ingredients)						
Bread	Whole bread						
	White bread						
Rice							
Pasta							
Other starches	Boiled cassava						
	Floured cassava products						
	Sweet potatoes						
	Green banana						

PROTEINS

Food	Description	Amount	Times eaten				Amount /day
			Per day	Per week	Per month	Never	
Protein	Cow’s milk						
	Commercial milk						
	Others						

Pulses	Beans						
	Cowpeas						
	Ndengu						
	Soybeans						
	Groundnuts						
Eggs	Boiled						
	Fried						
	Others						
Fish	Tilapia						
	Omena						
	Mbuta						
Chicken/Duck	Boiled with skin						
	Boiled without skin						
	Chicken heads						
	Chicken offals						
	Other methods of preparation						
Beef	Roasted						
	Stewed						
	Dried and boiled						
	Other methods of preparation						
Offals	Liver/kidney						
	Tripe						
Other meats	Specify………………… …						

VEGETABLES

Food	Description	Amount	Times eaten				Amt/day
			Per day	Per week	Per month	Never	
Dark green vegetable	Spinach						
	Likhubi						
	Lisebebe (Pumpkin leaves)						
	Tsimboka (Amaranth leaves)						
	Lisutsa						
	Nderema						
	Mrere						
	Miroo						
	Sukumawiki						
	Tsisaka Others						
Cabbage							
Orange/yellow vegetable	Carrots						
	Tomatoes						
	Liondo						
Others specify							

FRUITS

Food	Description	Amount	Times eaten				Amount /day
			Per day	Per week	Per month	Never	
Fruits	Guavas						
	Oranges						
	Bananas						
	Mangoes						
	Pawpaw						
	Pineapples						
	Loquats						
	Others Specify…………						

APPENDIX 3: ANTHROPOMETRIC MEASUREMENTS RECORDING FORM

a) Take the following measurements of the child fed porridge for the given months

Month		1st	2nd	3rd	4th	5th	6th	9th
MUAC (mm)	1st							
	2nd							
	3rd							
	Average							
Weight (Kgs)	1st							
	2nd							
	3rd							
	Average							
Height (cm)	1st							
	2nd							
	3rd							
	Average							

APPENDIX 4: MAP OF THE STUDY AREA

(Source: Maphill.com)

APPENDIX 7: RESEARCH PERMIT

NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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Ref. No. **NACOSTI/P/17/44801/15644**

Date: **17th March, 2017**

Ronoh Kipkemoi Amos
University of Eldoret
P.O. Box 1125-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on **"*Evaluation of the effect of soybean fortified porridges on the nutritional status of school children 3-5 years in Mateka Primary School, Bungoma County,*"** I am pleased to inform you that you have been authorized to undertake research in **Bungoma County** for the period ending **16th March, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Bungoma County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Bungoma County.

The County Director of Education
Bungoma County.

Plate 1: Researcher Taking Anthropometric Measurements (Source : Author, 2016)

Plate 2: Children Drinking The Porridge (Source: Author, 2016)