DEVELOPMENT AND ACCEPTABILITY EVALUATION OF MILLET-SESAME-SOY COMPOSITE AS A COMPLEMENTARY FOOD IN ACHOLI SUB-REGION OF UGANDA

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DECLARATION

I, Prossy Nassanga (14/U/2797/MFN), do declare that the work presented in this dissertation is my own and has not been submitted for academic award in any University.

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APPROVAL

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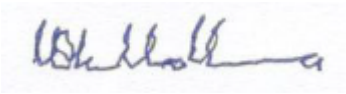
Signature: 

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DEDICATION

I dedicate this work to my parents, husband and siblings.

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ACRONYMS

ACF:	Action Against Hunger
ACTED:	Agency for Technical Cooperation and Development
ANOVA:	Analysis of Variance
AOAC**:**	Association of Official Analytical Chemists
C.F:	Complementary Feeding
EBF:	Exclusive Breast Feeding
FAO:	Food and Agriculture Organization of the United Nations
FGDs:	Focused Group Discussions
GAM:	Global Acute Malnutrition
IFAD:	International Fund for Agricultural Development
KAP:	Knowledge, Attitude, Practices
MFN:	Master of Science in Food Security and Community Nutrition
MSSC:	Millet- sesame- Soy Composite
Mo:	Month (s)
MOWT:	Ministry of Works and Transport
PAHO:	Pan American Health Organization
SPSS:	Statistical Package for Social Scientists
UACE:	Uganda Advanced Certificate of Education
UBOS:	Uganda Bureau of Statistics
UGX:	Uganda Shillings
UNICEF:	United Nations Children's Fund
WFP:	World Food Program of the United Nations

WHO: World Health Organization

ABSTRACT

Complementary feeding still remains a challenge to many rural mothers in Uganda and Africa at large. This is mainly because of: (i) inappropriate complementary feeding practices by caregivers who lack adequate nutritional knowledge and good attitude towards complementary feeding; and (ii) commercial complementary food formulae available on the market are too expensive and not easily accessible to poor people in developing countries who live mainly in rural areas. The use of locally available food resources to produce locally-adapted formulae has been suggested as a potential option for complementary feeding in rural areas. Therefore this study: (i) assessed the knowledge, attitude and practices of caregivers of 6-23 months old children in Acholi Sub-region of Uganda using household survey and focus group discussions; and (ii) experimented the feasibility of the option of producing locally adapted formulae using millet, sesame and soy, food resources locally available in the area. Various combinations of millet, sesame and soy were compounded to produce complementary food formulae corresponding to energy content of 200, 300 and 550 Kcal meant for breast fed children in the age category 6-8, 9-11, and 12-23 months, respectively and processed into flour under rural conditions. The flour formulae were reconstituted into porridge and evaluated for sensory attributes and acceptability among mothers and caregivers of children 6-23 months old to enable them select the most preferred formula for each energy category. The results showed that a high proportion of caregivers had good knowledge (88%) and attitude (90.1%) towards complementary feeding. However, only a half (50%) practiced what they knew. In relation to socio-demographic factors, education status of the household head and sex of the child significantly predicted caregiver knowledge on complementary feeding ($P \leq 0.05$). Education status of the household head also predicted caregiver attitude towards complementary feeding ($P \leq 0.05$). However no socio-demographic factors predicted complementary feeding practices among caregivers. Based on the results of overall

acceptability evaluation, the community selected 92 % millet-0.8% sesame-7.2% soy, 75 % millet-10% sesame-15% soy, and 12.1% millet-10% sesame-77.9% soy composite, as the most preferred formula for children aged 6-8, 9-11 and 12-23 months, respectively. Laboratory analyses showed that the selected formulae had energy and nutrient density within the recommended levels for complementary food formulae. Interestingly, mothers and caregivers who participated in the study expressed willingness to start using the formulae with immediate effect. However, training is still required to extend the technology to the wider community in the sub-region. The results of this study demonstrate that use of locally available food resources to develop complementary formulae is indeed a feasible option for management of child undernutrition in rural areas.

Key words: Complementary feeding; 6-23 months old children; Millet-sesame-soy composite; Acholi sub-region

CHAPTER ONE

INTRODUCTION

1.1 Background

Child undernutrition remains one of the main public health problems in developing countries (Semahegn *et al*.,2014; Müller & Krawinkel, 2005). It is one of the most common causes of morbidity and mortality among children in these countries (Amsalu & Tigabu, 2008). Globally, 165 million children are stunted and undernutrition is reported to be responsible for approximately 3·1 million deaths in those younger than 5 years annually (Bhutta *et al*., 2013). Globally, undernutrition is concentrated in developing countries. This is because the prevalence of undernutrition worldwide (11.3%) is comparable to the level (13.5%) in the developing countries (FAO, IFAD &WFP, 2014). In Uganda, the prevalence of undernutrition is 25.7% which is more than double the global prevalence of 11.3% (FAO, IFAD, & WFP, 2014).

It is documented that more than 1/3 of under-five mortality is due to undernutrition related to inadequate complementary feeding (Mesfin *et al*., 2015; Daelmans *et al*., 2013). This is largely attributed to inappropriate complementary feeding practices by caregivers who in most cases lack adequate nutrition knowledge and information (Shi & Zhang, 2011; Khanal *et al*., 2013). The Uganda Bureau of Statistics (UBOS, 2011) highlights that only 44% of children 6 to 23 months met the minimum meal frequency whereas only 11% met the minimum dietary diversity. In Acholi sub-region (Northern-Uganda), undernutrition amongst children is reported to peak between the age of 6-17 months (WFP, 2012). This has been attributed largely to inappropriate complementary feeding practices as evidenced by results of a previous study which showed that in Uganda only half of women initiated complementary feeding at six months (Mokori & Orikushaba, 2012).

Because infants and young children especially in developing countries are at an increased risk of undernutrition from six months of age onwards, complementary feeding becomes very essential (Rao *et al*., 2011; Muhimbula & Issa-Zacharia, 2010; Memon *et al*., 2010). The susceptibility of young children (6-59 months) to undernutrition becomes apparent if complementary foods are of low nutrient density and bioavailability. In practice soft foods and liquids should be given to the child alongside breast milk (Hasnain *et al*., 2013; Marriott *et al*., 2011; WHO, 2010b; WHO, 2008). However, if complementary feeding is not carried out properly, it can lead to problems such as diarrhoea, growth retardation (leading to kwashiorkor), marasmus and immunodeficiency marked by recurrent and persistent infections which in some situations can be fatal (Rao *et al*., 2011). The common inappropriate complementary feeding practices include introducing foods too early or too late, offering a limited diversity of foods, providing children with food for limited number of times and providing an inadequate quantity of food (Mokori & Orikushaba, 2012).

In Acholi sub-region, a number of food types are used as complementary foods depending on their availability. A study conducted in Pader and Kitgum districts revealed that millet, sorghum and maize meal were consumed by infants as energy source whereas cowpea leaf sauce, simsim and groundnut paste were provided as protein source (Acheng, 2014). Another study conducted in the same districts showed that cereals, water and dry tea were the most common foods offered to the children (Mokori *et al*., 2013). Data on dietary diversity score recorded from the same study revealed that most of the children consumed an average of three food groups per day. The mean number of times that the children consumed food was 2.2 times per day. This means that complementary feeding practices are still poor and that foods offered to children are inadequate in terms of nutrients as most of them are cereal based.

Opportunity to improve complementary feeding in Acholi sub-region exists as the region produces a lot of cereals and legumes. These can be used to develop quality and affordable complementary foods. Cereals and legumes when used together bring about complementation in terms of pooling necessary nutrients required for child nutrition. Generally, cereals are low in the amino acid lysine whereas legumes are low in the amino acids methionine and cysteine, but are high in lysine (Nour *et al*., 2014). Therefore, combination of legumes and cereals improves and compensates the protein deficiency of both (Thapliyal & Singh, 2015; Nour *et al*., 2014). For example, millet is a good source of energy and contains high amounts of methionine and cysteine but is limited in lysine and tryptophan (Amadou *et al*., 2013). Sesame is a good source of complex carbohydrates, minerals and is rich in energy due to the high fat content (Embaby, 2011). Soy is a good source of proteins (Yin, Fatufe, & Blachier, 2011) but is deficient in amino acid methionine (Oluwamukomi & Adeyemi, 2013). Blending millet, sesame and soy allows for mutual complementation in terms of nutrients resulting into a product that provides adequate amount of energy and protein for child growth. The product if successful in Acholi Sub-region is likely to be used in other areas where millet, sesame and soy are produced especially in the greater northern and eastern parts of the country.

1.2 Problem statement

In Acholi sub-region of Uganda, as a result of the long protracted conflict, people lived for over a decade in internally displaced peoples' camps (Saile *et al*., 2013). Upon their return to the villages (in the period spanning 2006-2010), people started life afresh (Mokori *et al*., 2013). This situation was anticipated to compromise the dietary intake and health care of children especially those younger than two years of age and this situation exacerbated acute undernutrition problems in the sub-region (Mokori & Orikushaba, 2012). However, much as this was anticipated, since peoples' return to their ancestral villages, there is no well documented information on nutritional knowledge, attitudes and practices among caregivers

of children to provide a bench mark for sustained nutritional intervention in the sub-region. On the other hand, there is a wide array of standardized complementary foods available commercially in Uganda. However, these commercial products are too expensive and inaccessible by families in the sub-region, a majority of whom live in rural areas. The sub-region produces a lot of different foods that can be used to develop low cost food complementary formulae. [Most of the studies conducted in the Sub-region focused on understanding changes in complementary feeding practices (Mokori *et al*., 2013), challenges to complementary feeding practices (Acheng, 2014) and food and nutrition security situation in the area (WFP, 2012).] However, nutritious and locally-adopted formulae based on local foods available in the sub-region are largely unavailable. Millet, soybean and sesame are widely grown and consumed in the sub-region. They are nutritious food resources when blended can result in simple complementary food formulae that can easily be integrated in household nutrition practices for preventative management of child undernutrition. The success of innovations such as the locally-adopted complementary food formulae considered in this study depends on acceptability by the community (Grace *et al*., 2010; Leroy *et al*., 2007). However it is still unknown whether complementary food formulae based on millet, sesame and soy will be accepted by the community in Acholi sub-region.

1.3 Objectives of the study

1.3.1 General objective

To examine the feasibility of using locally available food resources to develop complementary food formulae for children 6-23 months old using millet, sesame and soy in Acholi sub-region of Uganda

1.3.2 Specific objectives

i. To establish the level of nutritional knowledge, nature of attitude and complementary feeding practices among caregivers of children 6-23 months old

ii. To design and produce under rural conditions millet-sesame-soy composite formulae as a complementary food for children 6-23 months old

iii. To determine the acceptability of millet-sesame-soy composite complementary food formulae by caregivers of children 6-23 months old

1.3.3 Research questions

i. What is the distribution of knowledge, attitude and practices of the caregivers of children 6-23 months old in Acholi sub-region of Uganda?

ii. What combinations of millet, sesame and soy results in composites suitable for complementary feeding of children 6-23 months old in Acholi Sub-region of Uganda?

iii. What composite formulae are acceptable to caregivers of children 6-23 months old?

1.4 Conceptual framework

The conceptual framework guiding this study is presented in Figure 1. The framework illustrates a multifarious interplay of factors that determine the nutritional status of the child. These factors are dietary and environmental in nature but collectively contribute to the risks of undernutrition in children (de Onis *et al*., 1993). The framework shows that land is very vital in fighting the burden of undernutrition amongst children. This is because land can be used to increase food availability through production (Titus & Adetokunbo, 2007). Other resources like finances are vital in accessing health services and other foods that are not produced at home. This ensures that the nutrient needs of the child are met and diseases that would reduce nutrient intake hence compromising the nutritional status of the child are also

treated. Financial resources enable people to access nutritional knowledge through attending nutritional trainings, buying reading materials among others. This in turn influences the feeding practices of the caregiver (Porterfield & McBride, 2007).

Access to nutritional knowledge results into appropriate feeding practices which are predictors of good nutritional status of the children (Sethi *et al*., 2003). Lack of these resources translates into food insecurity which consequently leads to undenutrition.

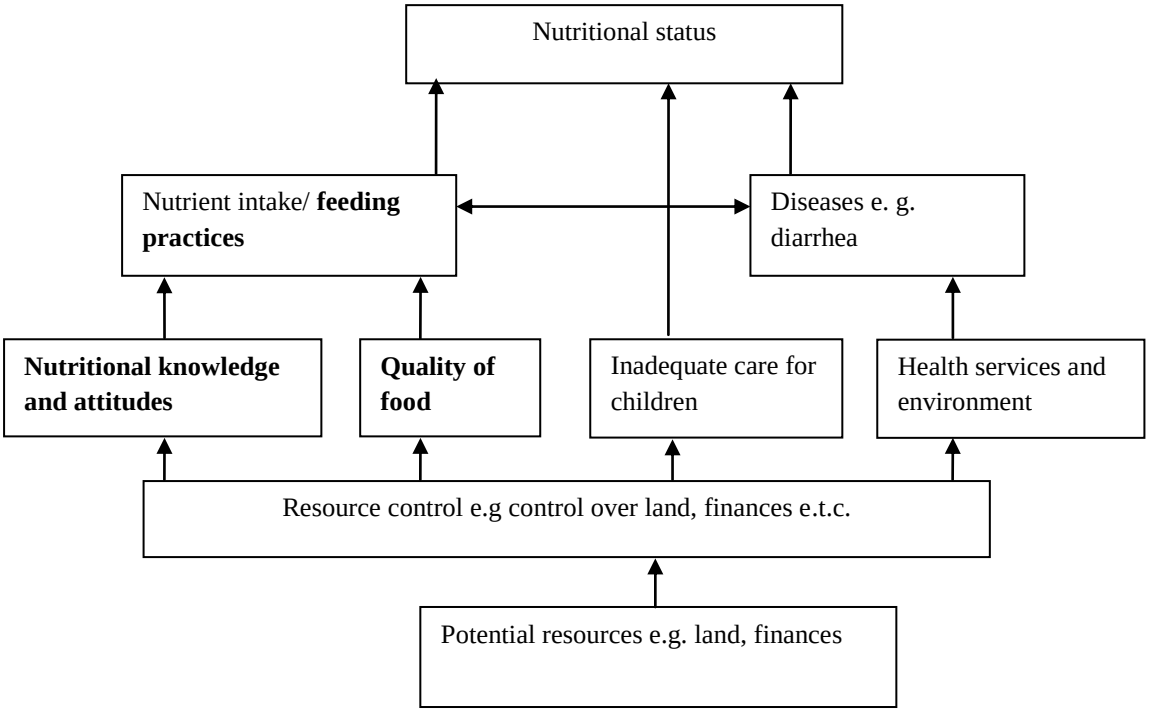

Figure 1: Conceptual framework for child undernutrition

Adapted with modification from Gross *et al.* (2000).

On the other hand, the framework implicitly shows that presence of resources alone is not sufficient. The caregivers need to have control over these resources in order to fully exploit the resources to their benefit. Lack of control over these resources results into inability to access health services and a healthy environment, inability to access nutritional knowledge, inadequate care for children and also affects the quality of food provided to the children. The quality of food provided to the child determines the nutrient intake of the child which at the

end determines the child's nutritional status (Cooke & Papadaki, 2014). Lack of nutritional knowledge, poor attitudes towards importance of nutrition combined with poor quality of food results into insufficient nutrient intake which translates into undernutrition (Turyashemererwa, 2009).

The framework further illustrates that lack of control over resources limits opportunity for adequate care for children and ability to access health services which results into incidences of diseases such as diarrhoea, respiratory infections among others. Consequently this results into an undernourished child. These diseases are responsible for most nutrition-related health problems in children in developing countries (Gross *et al.*, 2000). Inadequate nutrient intake and diseases are inextricably linked with each being the cause and an effect of the other. Inadequate nutrient intake weakens the body due to a poor immune system which increases the susceptibility to diseases. On the other hand, diseases lead to loss of appetite hence resulting into inadequate nutrient intake further resulting into a weakened immune system. The elements in the conceptual framework being addressed in the study are highlighted in bold.

1.5 Justification

This study contributes to efforts aimed at demonstrating that locally available food resources can be used to develop nutritious food products to address undernutrition in 6-23 months old children in rural areas in developing countries. Additionally, it contributes to efforts geared at increasing access to affordable complementary foods for preventative management of undernutrition among 6-23 months old children in rural areas in developing countries.

CHAPTER TWO

LITERATURE REVIEW

2.1 Complementary feeding

The United Nations Children's Fund (UNICEF) recommends that infants should be exclusively breastfed for the first six months of life to achieve optimal growth, development and health. This should be followed by giving them safe and nutritionally adequate complementary foods while breastfeeding continues for up to two years of age or beyond (UNICEF, 2012). The foods should be adequate, prepared and given in a safe manner in sufficient quantity and appropriate texture (WHO, 2002). Complementary feeding refers to the process of introducing soft foods to the infants in addition to breast milk or infant formula (Hasnain *et al*., 2013; WHO/PAHO, 2004). This is done to enable them meet their evolving nutritional needs since this stage is associated with major changes in both macronutrient and micronutrient intake (Agostoni *et al*., 2008).

Complementary foods should be given from 6 months of age because the infant is developmentally ready for other foods. Failure to introduce complementary foods after 6 months of age leads to faltering of an infant's growth (WHO, 2010b; WHO/PAHO, 2004). Complementary foods offered before 6 months of age tend to displace breast milk and do not confer any growth advantage over exclusive breastfeeding (Dewey & Brown, 2003). Displacement of breast milk means that the child misses out on the advantages offered by breast milk, e.g., strengthening the immune system (Ike, 2013).

Dietary diversity is important in complementary feeding and is a measure of nutrient adequacy of the diet. To ensure dietary diversity, it is recommended that a child should consume foods from at least four out of the seven recognised food groups (WHO, 2010b;

WHO, 2008). The food consistency and variety should also be increased gradually as the infant gets older. This should adapt to the infant's requirements and abilities (WHO/PAHO, 2004). Infants can eat pureed, mashed and semi-solid foods beginning at six months, mashed/finely chopped foods between 9-11 months whereas at 12 months they are able to eat the same types of foods as consumed by the rest of the family (Hasnain *et al*., 2013). It is also recommended that breast feeding children of 6-8 and 9-23 months should be fed on complementary foods for 2-3 times and 3-4 times a day, respectively (WHO/PAHO, 2004).

2.2 The impact of nutrition at early childhood on human and economic development

The impacts of nutrition on health throughout the course of human life are very profound and are inextricably linked to cognitive and social development and more so in early childhood (Black *et al*., 2013). Adequate nutrition during infancy and early childhood is therefore essential to ensure the growth, health, and development of children to their full potential (Motee *et al*., 2013). For this reason an appropriate diet is critical in ensuring the growth and development of children especially in the first two years of life (Rao *et al*., 2011).

The first few years of a child's life are particularly important because vital development occurs in all domains. For example brain development takes place and begins prenatally and continually through school age. This begins with the formation of brain cells, followed by cell migration and differentiation, and finally the development of synapses to enable cells to communicate with one another. These events build on one another and take place at different times (Lenroot & Giedd, 2006). A number of nutrients are essential for such vital processes. For example, retinol (Vitamin A) and zinc deficiencies result in deaths while iodine and iron deficiencies combined with stunting deter children from reaching their developmental potential (Zimmermann, 2011; Black *et al*., 2013). These examples indicate the vital role that nutrition plays in the health of an individual most especially at infancy.

The consequences of undernutrition to the child are both short and long term (Black *et al*., 2008). The short term consequences are mortality due to infectious diseases, morbidity and disability (Martorell, 1999). Long term consequences include short stature in adulthood, reduced intellectual ability, economic productivity, reproductive performance and increased risk of contracting non-communicable diseases such as metabolic and cardiovascular disease in adulthood. In effect therefore, the detrimental effects of undernutrition spanning from conception through the second birthday of the child and the negative effects of this early damage on productivity, health, brain development, intelligence and educability are now known to be irreversible (World Bank, 2006). The resultant effects of the above are reduced human capital, shorter adult height/short stature, less schooling and reduced economic productivity (Hoddinott *et al*., 2008).

2.3 Factors that affect the outcomes of complementary feeding

2.3.1 Nutritional quality and safety of complementary foods

The nutritional quality and safety of complementary foods determine the outcomes of complementary feeding. Complementary foods of poor nutrient quality may falter the child's growth and when they are contaminated cause diseases that can compromise the nutritional status of the child leading to undernutrition (Muhimbula & Issa-zacharia, 2010). The risk becomes even worse especially in developing countries where complementary feeding practices are inadequate (Bhandari *et al*., 2004).

Complementary foods in developing countries are majorly porridges based on staple foods including cereals and root crops (Lassi *et al*., 2013; Kulwa *et al*., 2006). These foods vary from one area to another and also depend on the locally available resources (Wondafrash *et al*., 2012). They are however, poor in terms of nutrients quality (Gibson *et al*., 1998). In Uganda complementary foods avaliable in rural areas include traditional medicine, water,

juice, cereal, dry tea, sugar, syrup, green cooking bananas (matooke), cereal porridges and cow milk. Most of these foods are less energy dense and poor in nutrients of public health importance (Kikafunda *et al*., 2003; Mokori et al., 2013). Considering that complementary foods in developing countries are expected to provide approximately 200, 300 and 550 kcal per day for children aged 6-8, 9-11 and 12-23 months of age, respectively (WHO/PAHO, 2004; Dewey & Adu-afarwuah, 2008). It becomes very apparent that cereal and starchy based foods provided to infants and children indicated above do not meet recommendations for complementary feeding. Therefore, a concerted effort is needed to design and promote complementary food formulae tailored to the circumstances of rural areas.

2.3.2 Socio-demographic factors

Several studies have established socio-demographic factors that influence complementary feeding. These include education status of the parents (Hasnain *et al*., 2013; Rao *et al*., 2011; Motee *et al*., 2013; Khanal *et al*., 2013), occupation of the mothers (Nair *et al*., 2014; Hasnain *et al*., 2013; Liu *et al*., 2013), type of family (Hasnain *et al*., 2013), socio-economic status of the household, birth order, place of delivery and maternal education (Victor, *et al*., 2014; Rao *et al*., 2011; Taddele *et al.*, 2014), nutritional education of the mothers (Sethi *et al*. 2003), sex of the child (Semahegn *et al*., 2014) and maternal age (Khanal *et al*., 2013; Liu *et al*., 2013). These factors are generally known to be significant predictors of complementary feeding, however, specific differences also exist. For instance in Mauritius, complementary feeding was influenced by type of delivery, parity, alcohol consumption, education, occupation and area of residence (Motee *et al*., 2013), whereas in China, Liu *et al*. (2013) reported that having grandparents, residing within the same province, illness and gestational age as the major predicting factors. Considering the afore stated disparity, it becomes apparent that socio-demographic factors that affect complementary feeding in Acholi sub-

region cannot be inferred from information available for other geographic areas, and should therefore be identified empirically.

2.3.3 Nutritional knowledge, attitude and practices

Nutritional knowledge, attitude and practices (KAP) play an important role in the growth and development of the child. Appropriate infant feeding practices lead to greater gain in weight and length of children during infancy (Saha *et al*., 2008). Infants and young children need assistance that is appropriate for their age and developmental needs to ensure that they consume adequate amounts of complementary food (WHO, 2002). This requires attention to foods as well as the behaviours of caregivers with respect to complementary feeding.

It is well documented that inadequate knowledge of caregivers translates into inappropriate feeding practices (Memon *et al.*, 2010; Shi & Zhang, 2011; Sethi *et al*., 2003) which in turn lead to undernutrition, increased mortality and morbidity (Hazir *et al.*, 2012). Poor knowledge about appropriate foods and feeding practices is indeed a greater determinant of undernutrition than lack of food (Turyashemererwa, 2009; World Bank, 2006). Kumar *et al*. (2015) in their study showed that the feeding practices are a combination of perceptions and knowledge of caregivers.

Azizi *et al*. (2011) found a positive and significant correlation between the nutrition attitude and practice of college students. However, some studies have also reported a negative relationship between nutritional knowledge and dietary practices. Alade *et al*. (2013) in their study conducted in Nigeria noted poor exclusive feeding practices amongst mothers despite their high level of knowledge. A research conducted in eastern Uganda (Bukusuba *et al*., 2010) indicated that a very high percentage of the study group understood that consumption of balanced diet (99.3%), fruits and vegetables (99.3%) and special diets (63.1%) was necessary for good health but only 21.8% of the participants consumed three or more meals

per day. This shows that good nutrition knowledge and attitude do not necessarily lead to good dietary practices. The implication is that nutritional knowledge and attitude attained should be followed up to ensure translation into good dietary practices.

Considering that the relationship between knowledge, attitude and practices is not general as illustrated with findings of Azizi *et al*. (2011) and Bukusuba *et al*. (2010), it implies that information from a given community cannot be applied to another community. Since information on knowledge, attitude and practices of caregivers on complementary feeding in Acholi sub-region is insufficient, the nutritional knowledge, attitude and practices need to be established.

2.3.4 Relationship between socio-demographic factors and nutrition knowledge, attitude and practices

Socio-demographic factors influence nutritional KAP of households in different ways. Several studies have shown that households with good socio-economic status are associated with consumption of diversified diets (Abdollahi *et al*., 2014; Rao *et al*., 2011) compared to those with poor socio-economic status. Socio-economic power also determines whether a mother attends antenatal care and/or delivers from a health facility that enables her attend training on good complementary feeding practices (Khanal *et al*., 2013; Rao *et al*., 2011).

The sex of the child in some societies determines the care, practices and the level of knowledge that a mother may seek to better the nutritional status of her child. In societies where a boy child is a priority, care givers tend to have good nutrition knowledge and complementary feeding practices than in case when they have a girl child (Semahegn *et al*., 2014; Noni, 2009). In addition, the age of the mother determines the feeding practices. In Nepal, it was observed that children of older mothers (>35 years) received the recommended dietary diversity compared to children of young mothers (Khanal *et al*., 2013).

Several studies have demonstrated that educated mothers have good complementary feeding practices as compared to the uneducated mothers (Mekbib *et al*., 2014; Motee *et al*., 2013; Khanal *et al*., 2013; Rao *et al*., 2011). Nutritional training of mothers also improves their knowledge and practices. Mothers who receive nutritional training have better complementary feeding practices as compared to those who do not receive any nutritional training (Negash *et al*., 2014). Notably, in household where the fathers are educated, the caregivers are associated with good complementary feeding practices (Semahegn *et al*., 2014; Khanal *et al*., 2013). Hasnain *et al*., (2013) reported that households of educated parents exercised appropriate feeding practices as compared to the uneducated parents. This is because education is associated with employability and access to knowledge and other basic requirements. Thus, in household where fathers were employed, appropriate feeding practices were observed (Semahegn *et al.,* 2014; Hasnain *et al*., 2013).

However, in the case of the mothers, employment affects feeding practices in several directions. While in Pakistan employed mothers exercised appropriate feeding practices (Hasnain *et al*., 2013), in Ethiopia (Taddele *et al.,* 2014) and Australia (Cooklin *et al*., 2008), maternal employment contributed to premature cessation of exclusive breast feeding. Additionally in Malaysia, most unemployed mothers observed timely introduction of complementary foods unlike their employed counterparts (Shuhaimi & Muniandy, 2012).

The place of residence affects the ease of access to information and other services like trainings which in turn affect complementary feeding. Usually urban resident enjoy a comparative advantage over their rural counterparts in terms of accessing services. In Ethiopia, urban residents initiated complementary feeding timely than rural residents (Semahegn *et al*., 2014). The variation of socio-demographic factors among communities and geographical locations (Nair *et al*., 2014; Liu *et al*., 2013; Hasnain *et al*., 2013), make the

association between KAP and socio-demographic factors observed in other societies not to be relevant to the situation in the Acholi sub-region. Therefore this needs to be established.

2.4 Innovations in complementary feeding for rural communities

Different strategies have been applied to address complementary feeding problems in rural communities. These include; education about complementary foods, provision of complementary foods/products offering extra energy provision of food combined with nutrition education to mothers, fortification of local foods with micronutrients and improving the energy density and/or nutrient bioavailability of complementary foods through use of simple technologies (Dewey & Adu-afarwuah, 2008). The use of available traditional and indigenous plant and animal foods to prepare complementary foods that are hygienically and nutritionally adequate has been recommended as a sustainable way to reduce undernutrition in infants and young children in rural communities in developing countries (Kunyanga *et al*., 2011; WHO, 2008).

In several developing countries, use of local foods in complementary feeding has attracted a lot of attention because the local formulations have proven to be highly nutritious and are comparable to commercially formulated complementary foods (Fathelrahman *et al*., 2015). Besides, when these foods are subjected to sensory evaluation they are highly acceptable amongst the communities, and affordable by the local people most of whom live in rural areas. In Ethiopia, a weaning food based on sorghum, pigeon pea, soybean, skimmed milk and sucrose was developed (Addis *et al*., 2013) whereas in Bangladesh the complementary food was based on rice, sugar, skimmed milk and butter (Satter *et al*., 2013). In Southern Sudan, a complementary food formula was based on wheat flour supplemented with defatted sesame flour (Fathelrahman *et al*., 2015) whereas in Tanzania, Martin *et al*. (2010) developed complementary foods based on bananas, soy beans and chicken peas. In western Kenya, grain

amaranth, maize, soy oil and sugar supplemented with and without edible termites and *dagaa* (silver fish) were used to develop complementary foods (Konyole *et al*., 2012). The formulated complementary foods were nutritious, highly acceptable and had no adverse effects on the participants (mothers and their infants). In another study, four food formulae were developed based on finger millet, amaranth grains, pigeon pea, field beans, ground nuts, pumpkin, sweet potato, amaranth leaves, pumpkin leaves and small dried fish (*Rastrineobola argentea*) (Kunyanga *et al*., 2011).

All the above innovations from different developing countries demonstrate the feasibility of using locally available food stuffs in the community and offering rural families the alternatives to manage complementary feeding. However, it is very apparent that the various formulae were developed using food resources specific to this location. Therefore, these formulae cannot be applied in other locations where the food resources used to produce the formulae are lacking. In addition, previous studies have shown that communities are likely to accept what is known to them compared to what is considered to be foreign (Wustenhagena *et al*., 2007). Thus the need to develop and evaluate in Acholi sub-region complementary food formulae based on local food resources available in the area.

2.5 Nutritional characteristics and health benefits of millet, sesame and soy

Millets are small-seeded grains with different varieties such as pearl millet (*Pennisetum glaucum*), finger millet (*Eleusine coracana*), *kodo millet* (*Paspalum setaceum*), proso millet (*Penicum miliaceum*), foxtail millet (*Setaria italic*), little millet (*Panicum sumatrense*), and barnyard millet (*Echinochloa utilis*) (Saleh *et al*., 2013). Millet is a good source of energy, protein, fatty acids, minerals such as calcium and iron, vitamins such as thiamin, riboflavin and niacin, dietary fiber and fatty acids (Thapliyal & Singh, 2015). Nutrients like calcium prevent bone and teeth disorder while iron prevents anemia (Anderson, 1996; Lozoff *et al*.,

2003). It also contains fatty acids such as oleic acid, palmitic acid, linoleic acid and linolenic acid. These play an important role in visual and cognitive development throughout childhood (Osendarp, 2011; Innis, 2007). The dietary fiber and polyphenols in finger millet offer numerous health benefits such as antidiabetic, antioxidant, hypocholesterolaemic, antimicrobial effects and protection from diet related chronic diseases (Devi *et al*., 2011; Banerjee *et al*., 2012). Millet protein contains high quantity of essential amino acids methionine and cysteine (Amadou *et al.*, 2013). These nutritional qualities make millet, a potential ingredient for inclusion in complementary food formulae. However millet contains anti nutritional factors such as trypsin inhibitor, hemagglutinin, cyanogenic glycosides, alkaloids saponins, phytates, phenols, tannins and enzyme inhibitors that can significantly lower nutrient availability (Chandrasekara & Shahidi, 2011). The antinutritional factors can be inactivated by techniques such as roasting and malting (Kumar *et al*., 2016; Ndidi *et al*., 2014; Maidala *et al*., 2013; Gibson *et al*., 2006).

Sesame (*Sesamum indicum L*.) is one of the oldest cultivated plants in the world. It is roughly 45% by weight oil as compared to only 20% of seed weight for soybeans, and 25% protein and is a good source of essential amino acids and minerals (Chayjan, 2010). Sesame seeds are good sources of proteins, complex carbohydrates, minerals (calcium, phosphorus) and are a good source of energy due to the high fat contents (Tunde-Akintunde *et al*., 2012). Sesame seeds contain certain bioactive compounds (isoflovones and sesamin) that are believed to play a role in reducing the risk of the development of chronic diseases such as cancer, diabetes, and coronary heart diseases (Embaby, 2011). In addition, sesame has numerous useful compounds such as mono and polyunsaturated fatty acids, dietary fiber, phytochemicals, antioxidants, phytosterol, and lignans (Asghar *et al*., 2014). These nutritional properties make sesame a good ingredient for application in the development of complementary food composites. On the other hand, sesame also contain antinutritional

factors like tannins, trypsin inhibitors, phytic acid and lectin, which can potentially reduce the nutrient utilization from sesame by humans (Soetan & Oyewole, 2009). The antinutritional factors can be inactivated by techniques such as roasting and malting (Kumar *et al*., 2016; Ndidi *et al*., 2014; Maidala *et al*., 2013; Gibson *et al*., 2006).

Soybean (*Glycine max*) seeds are an important and economical source of protein and other micronutrients. Soy is a complete protein and soy-foods are rich in vitamins (A, D, E, K), phosphorus (Yin *et al*., 2011) and is 20% by weight oil (Chayjan, 2010). These nutritional characteristics also make soy a potential ingredient for formulating complementary food. However, soy beans contain antinutritional factors such as protease inhibitors, phytic acid, allergens, lectins, saponins and antivitamins that affect protein and mineral bioavailability (Akande *et al*., 2010; Ghavidel & Prakash, 2007; Sandberg, 2002). These antinutritional factors can be eliminated by methods such as roasting and malting (Kumar *et al*., 2016; Ndidi *et al*., 2014; Maidala *et al*., 2013).

2.6 Sensory characteristics that affect acceptability of complementary foods

The sensory qualities of a complementary food formulation correspond to the food preferences of mothers and their infants (Konyole *et al*., 2012). This means that sensory quality established through use of organoleptic properties is of great importance when determining the acceptability of a food. The organoleptic properties include taste, colour/appearance, flavour/aroma, mouth feel and consistency. These properties have been used in a number of studies to determine the acceptability of foods (Muhihi *et al*., 2013; Kunyanga *et al*., 2012; Muhimbula *et al*., 2011; Young *et al*., 2010).

The taste of the food is an important parameter because much as the food may be nutritious and appealing but without good taste it will be rejected or unaccepted. For instance, complementary food formulae based on soybean, banana and cowpea were developed in

Tanzania. Results of sensory evaluation revealed that formulations with large amounts of cowpea were more appealing in terms of appearance than those with high level of soybean. In addition, samples which had fermented soybean were not liked due to the beany flavour and the smell that resulted from fermentation process while samples with untreated and fermented soybean were also not liked due to the poor taste (Martin *et al*., 2010). This demonstrates the importance of considering organoleptic properties (colour, smell and taste) of a food in determining the formulation. By inference it cannot be predicted what proportion of millet, sesame and soy will result in a composite formulae that meet nutritional requirements for complementary feeding and organoleptically acceptable to caregivers in Acholi Sub-region of Uganda.

CHAPTER THREE

METHODOLOGY

3.1 Assessment of knowledge, attitude and practices

3.1.1 Study design

A cross sectional study design that made use of in-depth household interviews and focus group discussions was applied. The in-depth interviews were used to collect quantitative data while the focus group discussions were used to collect qualitative data.

3.1.2 Study area and study population

The study was conducted in Nwoya ($02^0$38'N $32^0$00'E) and Amuru ($02^0$50'N $33^0$05'E) districts. The districts were selected because they had the highest rates of undernutrition in Acholi sub-region (WFP, 2012). Nwoya district is composed of 5 sub-counties, 25 parishes and 63 villages while Amuru district comprises of 6 sub-counties, 32 parishes and 67 villages. Amuru district has a total area of 3626Km^2 and is bordered by Adjumani district to the north, South Sudan and Lamwo district to the northeast, Gulu district to the east, Nwoya district to the south, Nebbi district to the southwest and Arua to the west. Nwoya district covers a total area of 4736Km^2 and is bordered by Amuru district to the north, Gulu district to the northeast, Oyam district to the east, Kiryandongo district to the southeast, Buliisa district to the southwest and Nebbi district to the west.

The study population comprised of caregivers of children aged 6-23 months old. In the context of this study, a caregiver is the mother of the child or another person who takes care of the child in absence of the mother. The inclusion criteria were that the caregiver should have been resident in Amuru and Nwoya for at least 6 months and willing to participate in the study.

3.1.3 Sample size and sampling framework

The number of participants (n) that participated in the study was calculated using a standard formula according to Kasiulevičius *et al.*, (2006). The formula is presented in equation 1.

$$Sample\ size(n) = \frac{Z^2 P(1-P)}{e^2} \quad (1)$$

Where, n is required sample size, Z is confidence level at 95% (standard value = 1.96), p is prevalence of Global Acute Malnutrition amongst children 6-17 months in Acholi sub region reported to be 7.4% (WFP, 2012) and e is margin of error at 5%. The calculated sample size was 128. However, assuming an attrition rate of 20%, the sample size was adjusted upwards by the same percentage leading to the final sample size of 154 participants. To locate the study participants, a multi-stage sampling framework was applied. First, for each district, 2 sub-counties were randomly selected. Secondly, for each sub-county, 3 parishes were randomly selected.

Table 1: The sub-counties, parishes and villages where the study was conducted

District	Sub-Counties	Parishes	Villages
Amuru	Pabbo	Pabbo Kal	Kal Centre, Oguru
		Parubanga	Abera,Pericu
		Gaya	Paomo, Pukwany
	Lamogi	Lacor	Lwalakwar, Pukure
		Guruguru	Amora,Otici
		Pagoro	Coorom, Kal
Nwoya	Kochgoma	Kal	Kal A1, Kal A2
		Agonga	Agonga A, Agonga B
		Lii	Pakiya, Bungu
	Alero	Alero Kal	Kal Atoocon, Kal Okura
		Paibwor	Nwoya, Lulyango
		Panyabono	Lalar, Oyenya

Thirdly for each parish, 2 villages were randomly selected. From the selected villages, participants were then purposively selected. The matrix showing the sub-counties, parishes and villages where the study was conducted is presented in Table 1.

3.1.4 Study instruments

Knowledge, attitude and practices (KAP) were assessed using a standard questionnaire adapted with modification from WHO, (2010a) and FAO, (2014). The questionnaire also had a provision for collection of data on socio-demographic and economic characteristics of the households. With regard to knowledge, the questions provided for correct and wrong answers while for practice the caregivers were asked to tell what they did. Questions used for measuring attitude were on a 3 point likert scale (0=disagree, 1=neither agree nor disagree, 2=agree) (Anand & Puri, 2013). The attitude section had both positive and negatively framed questions. A focus group discussion (FGD) guide was used to obtain the community's perspective on complementary feeding and also to generate information to supplement that obtained from household interviews.

The instruments were pretested among caregivers of children in the nutrition ward at Gulu Regional Referral Hospital in Gulu municipality, Gulu district. This was done to ensure accuracy, clarity and consistency in interpretation of questions. After pretesting, the responses were analysed to check for validity and ambiguous questions were rephrased. Another round of pre-test exercise was conducted among communities in Agwee village, Laroo Division, Gulu district, to check for reliability of the household questionnaire. In this exercise, the Test-Retest method was used to test the consistency of the questionnaire in producing the same results. To achieve this, ten caregivers were interviewed two times (with a span of one week between the interviews) using the same questionnaire.

3.1.5 Data collection

Data was collected using research assistants who had previous exposure to nutrition surveys and fluent in English and the local language (Luo/Acholi). The assistants were conversant with the instruments since they had participated in the pretesting exercise described in section

3.1.4. The assistants were trained only to interpret questions to the study participants but not to assist them in giving answers. Focus group discussions (FGDs) were conducted prior to household interviews. Each FGD constituted of 6-10 members and a total of 10 FGDs were conducted. These numbers of FGDs are above the minimum number of six that has been reported to ensure saturation of information (Guest *et al*., 2006; Mclafferty, 2004). To ensure originality of information, households that participated in the FGDs were not selected for household interviews. The household interviews lasted between 40 to 55 minutes. During the interviews with the caregivers other members of the household were not allowed to participate to avoid influencing the caregiver. In addition, a caregiver already interviewed was not allowed to interact with a caregiver to be interviewed subsequently.

3.1.6 Data analysis

Data from FGDs was transcribed, coded and common themes established and analysed using qualitative content analysis method (Cho & Lee, 2014). With regard to knowledge and practices, every correct answer took on a score of 1 while the wrong answer and where the respondent did not know a score of 0 was awarded. In case of attitude, reverse scoring was done for negatively-framed statements. This meant that a score of 0 was given to 'agree' and 2 to 'disagree' (Anand & Puri, 2013). Scores on knowledge, attitude and practice for each respondent were calculated by summing up the scores attained on each question and the overall score ranked as good or poor. Knowledge, attitude and practice scores were ranked as poor if the overall score fell below 55%, 57.1% and 62.5%, respectively according to Ul Haq *et al*. (2012). Data on socio-demographic characteristics and KAP were summarized using descriptive statistics (frequency, percentages, mean and standard deviation). Out of the calculated sample size of 154 respondents, data from 2 of them was dropped due to inconsistencies and non-response to key questions. Pearson correlation was performed to establish the association between complementary feeding attributes of knowledge, attitudes

and practices. Binary logistic regression was performed to establish the predictors of good KAP. Independent sample t-test was conducted to compare the mean difference in KAP among caregivers between the two districts. Statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 20.

3.2 Development and acceptability evaluation of millet-sesame-soy composite formulae

3.2.1 Materials

The experimental materials consisting of millet, sesame and soy were purchased from local markets in Amuru and Nwoya districts in Northern Uganda. Samples were collected from 20 different market stalls (10 in Amuru and 10 in Nwoya). Thorough mixing of the contents in the holding containers was undertaken at the market place to ensure homogeneity and representativeness of the samples. The samples were put in separate polythene bags, sealed and transported to the Faculty of Agriculture and Environment Laboratory at Gulu University and stored at room temperature (25 ^{0}C) till used.

3.2.2 Design and production of the composite formulae

Millet, sesame and soy samples were individually cleaned by winnowing and sorting out extraneous materials. Millet and sesame were washed with water at room temperature (25 ^{0}C) to remove soil particles and dried under sunshine. This was then followed by roasting of the different ingredients separately in an open sauce pan under local conditions in the village (Figure 2). Experienced rural women were used to determine the readiness of the roasted materials. Following roasting, the samples were allowed to cool under room temperature (25 ^{0}C) in readiness for subsequent processes.

Figure 2 : Caregivers participate in preparation of composite ingredients

Different proportions of the roasted millet, sesame, and soy used to make each formula were established using Microsoft Excel and Harvest Plus Food Composition Table (Hotz *et al*., 2012) to match energy content of 200 kcal, 300 kcal and 550 kcal expected to come from a complementary food for children 6-8, 9-11 and 12-23 months respectively, in developing countries (WHO/PAHO, 2004 & Dewey and Adu-Afarwuah, 2008).

The different proportions of the ingredients for making each formula were then weighed and mixed together. The different mixtures were then milled into fine flour using the AMEC mill, (20HP, China) with a sieve diameter of 0.5mm. Matrix of the ratios of millet-sesame- soy for the three energy categories is presented in Table 2.

Table 2: Composition of millet-sesame-soy composite formulae designed

Ingredients	Formulation identity	Mixing ratios (%)
	200Kcal	
Millet , sesame and soy	F11	91.8% millet +0.7% sesame+ 7.5%soy
,,	F12	92.2% millet +0.9% sesame+ 6.9%soy
,,	F13	92% millet +0.8% sesame+ 7.2%soy
	300Kcal	
Millet , sesame and soy,,	F21	75% millet +10% sesame+ 15%soy
,,	F22	65%millet +5% sesame+30%soy
,,	F23	71% millet +8% sesame+ 21%soy
	550Kcal	
Millet , sesame and soy,,	F31	12.1% millet +10% sesame+ 77.9%soy
,,	F32	16.1% millet +11.9% sesame+ 72%soy
,,	F33	18.1% millet +12.9%sesame+ 69%soy

Each composite flour sample was made in triplicate

3.2.3 Sensory evaluation and selection of community-preferred composite formulae

Using a group of local women, porridge samples from each formula per energy category were produced to a consistency level agreed to by the women as representative of what they would give to their children. Porridge samples were subjected to sensory evaluation using 30 adult panelists (caregivers of children) drawn from within the local community as reported previously by Martin *et al*. (2010) and Wamono *et al*. (2011). The use of adult panelists instead of children was necessary because of their ability to evaluate objectively the sensory characteristics of the formulations. The panelists were different from women that participated in preparation of samples. The panelists were asked to express their degree of liking on a 5 - point hedonic scale with ratings ranging from 5 (like very much) to 1 (dislike very much) as previously applied in other studies (Fathelrahman *et al*., 2015; Konyole *et al*., 2012). The porridge samples were evaluated for taste, aroma, colour, texture, mouth feel, and overall acceptability. Clean and boiled drinking water at room temperature (25^0C) was given to each panelist for mouth rinsing before and after every sample tasting to eliminate carry over effects (Emmanuel-ikpeme *et al*., 2012). The products that were most liked were selected for laboratory analysis of nutritional composition.

3.2.4 Analysis of nutritional composition of community-preferred composite formulae

Proximate and mineral contents of community-preferred composite flour formulae were analyzed in the laboratory of Food Technology and Nutrition at Makerere University. Analyses were performed for gross energy, crude protein, ash, fat, crude fibre, total carbohydrates, moisture, phosphorus, calcium, iron, zinc and magnesium. Crude protein was determined using the micro Kjeldahl method as described by Magomya *et al*. (2014). Moisture, crude fat, crude fibre, ash and carbohydrate contents were determined according to AOAC (1990). Energy was determined using a bomb calorimetric method according to FAO (2011). Calcium was determined using the flame photometric method as previously described by Harworth and Cleaver (1961) while phosphorus, iron, magnesium and zinc were determined using the atomic absorption spectrophotometric method according to AOAC (1990).

3.2.5 Data analysis

Scores on each sensory attribute and overall acceptability were aggregated for each composite formula for each energy category. One way Analysis of Variance (ANOVA) was used to test whether difference existed in aggregate scores for each sensory attribute and overall acceptability between composite flour formulae within each energy category. The means were separated using the Turkey's method at 5% level of significance. SPSS was used for statistical analysis

3.3 Ethical consideration

Ethical approval was sought from the Gulu University Research Ethics Committee (GUREC/02/07/2016). Permission to carryout research in the two districts was obtained from the Chief Administrative Officers of the respective district (see appendices 3.1 and 3.2). At

the village level, permission from the Local Council leaders was also obtained. At the house hold level, respondents had to consent by signing the consent form (see appendices 1.1 & 2.1). Respondents were guaranteed confidentiality and informed that the information provided was only used for research purposes.

CHAPTER FOUR

RESULTS

4.1 Socio-demographic characteristics of the respondents

Data on socio-demographic characteristics of the study respondents is presented in Table 3.

Table 3: **Socio-demographic characteristics of the respondents**

Variables	N	%	Variables	N	%
Caregiver's age			**Main source of family income**		
<18 years	5	3.3	Formal employment	16	10.5
18-35 years	132	86.8	Casual labor	14	9.2
36 -45	15	9.9	Small scale business	26	17.1
Residential area			Sale of Agriculture produce	78	51.3
Rural	102	67.1	Small scale business & sale of agricultural produces	18	11.9
Urban	50	32.9	**Education level of the household head**		
Marital status			No formal education	15	9.9
Single	12	7.9	Primary	65	42.8
Married	128	84.2	Secondary	50	32.8
Separated	11	7.2	Tertiary	22	14.5
Widowed	1	0.7	**Education level of the caregiver**		
Sex of the child			No formal education	18	11.8
Male	80	52.6	Primary	102	67.1
Female	72	47.4	Secondary	25	16.5
Source of child's birth			Tertiary	7	4.6
Hospital	136	89.5	**Decision on expenditure of family income**		
Home	16	10.5	Husband	105	69.1
Sex of the household head			Wife	26	17.1
Male	132	86.8	Husband & wife	11	7.2
Female	20	13.2	Mother in-law	5	3.3
Occupation of the household head			Father in-law	4	2.6
Not employed	13	8.6	Grand parents	1	0.7
Formal employment	20	13.2	**Decision on the food cooked in the household**		
Small scale trading	19	12.5	Husband	16	10.5
Casual labor	17	11.2	Wife	125	82.2
Farmer	83	54.6	Mother in-law	6	3.9
Occupation of the caregiver			Family	5	3.3
Not employed/ Housewife	17	11.2			
Formal employment	5	3.3			
Small scale trading	26	17.1			
Casual labor	9	5.9			
Farmer	94	61.8			
Others	1	7			

Results indicated that majority of the caregivers (87%) were between the age of 18 and 35 years. Respondents (67%) resided in rural areas whereas 84% were married. The number of

male children in the households sampled was higher than the number of females by 5% and the mean age of the children was 13.8 months. 89.5% of the infants were born from a health facility. Majority of the households (86.7%) sampled were male headed. Half of the household heads were involved in farming as the main occupation. Similarly, more than half (61.8%) of the caregivers were involved in farming as the main occupation. Sale of agricultural produce was the main source of income to half of households where the respondents resided. Besides, households spent a monthly average of UGX 10, 493 on food. The largest proportion of household heads (90.1%) and caregivers (88.2%) had obtained formal education. More than half of the men (69.1%) made decisions on how family income was spent in the household. In most households, women (82.2%) decided on the type of food to be cooked.

4.2 Complementary feeding situation in the community

Information on complementary feeding situation in the community generated from focus group discussions is presented in Table 4. There were contradicting views with regard to adequacy of complementary feeding in the community, initiation of complementary feeding at the recommended time and the recommended feeding frequency. Some respondents argued that complementary feeding practices in the community were adequate while others disagreed. It was reported that a number of local foods were used by the community in complementary feeding. When asked about awareness of commercial complementary foods, only a few of the community members were aware. The community cited packaged soya, soya mixed with mukene, biscuits, soda among others as typical examples of commercial complementary foods known to them. However, the community reported that these foods were expensive for them and that they needed a local complementary food formula.

Table 4: Community perspective on complementary feeding situation obtained from focused group discussions

Aspects of complementary feeding discussed	Community views/ perspective
Adequacy of complementary feeding	It is adequate because mothers follow advice from the hospital; there are gaps due to lack of feeds; adequacy depends on individual mothers. Some mothers may have complications with their health and so do not follow the recommended practices.
Initiation of complementary feeding at 6 months	-Varies from mother to mother although majority of the mothers do while others start early (3 or 4 months) due to different health complications such as inadequate breast milk and/or swollen breasts /breast engorgement.
Feeding at the recommended meal frequency (2-3 and 3-4 times for 6-8 and 9-23 months old children respectively)	-Some mothers do while others do not. Most mothers do not because of a lot of work/responsibilities at home. Feeding children is challenging in the community due to the effect of the drought which affected crop yields.
Foods commonly given to children 6-23 months	-Porridge from millet or maize flour, pasted green vegetable e.g pasted cowpea leaves (*boo)* and spider plant (*akeyo*), bean soup, silver fish (*mukene*), eggs plant, cabbage, Sweet potato, irish potato, millet bread, soups obtained from the family's food, eggs (in a few families), Salt water pasted with groundnuts or simsim paste.
Awareness about complementary foods on the market.	-Some people are aware but the majority are not.
Examples of commercial complementary foods known to the community	-Packed soya, Soya mixed with silver fish and millet, maize flour mixed with soya, packed milk, millet mixed with silver fish (*mukene*) (Glucose and Corn flakes, biscuits, soda, juice.
Affordability of commercial complementary formulae	Not affordable
Existence of locally adapted complementary food formulae	Not available.
Community wish to have a locally adapted formulae	The community wishes to have a training on formulating nutritious complementary foods using locally available food resources.
Source of information on complementary feeding	Hospitals, friends, women groups, grandmothers, mothers in-law, Village health teams, relatives, radios, natural born instinct and Non -Governmental Organizations.
Benefit and adequacy of the information	It has helped them to keep their children in a healthy state free of diseases and also prevent some of the nutrition related diseases however its inadequate
Other aspects of complementary feeding that the community would like to receive information about.	Formulation and preparation of nutritious infant foods, hygiene, estimation of the right quantity for infant feeding, education about advantages of good nutrition and the recommended meal frequency.
Perception about the effect of inappropriate complementary feeding on the nutritional status of children	Inappropriate complementary feeding is bad because some children in the community who are poorly fed are very weak and malnourished.
Challenges experienced by mothers in the community with regards to CF.	Lack of money to buy nutritious foods for their children, pain in the breasts, swollen breasts (breast engogement), changing their children's diet is expensive. Actually some families feed on the same dish for over a week, drought which affected the yields of different crops, HIV/ AIDS and limited diversity of food to feed the children.
Suggestions to improve complementary feeding	Increase accessibility to complementary foods, trainings on formulation of nutritious foods from the locally available food resources, need for a local formula for formulating infant feeds and training on aspects of sanitation, nutrition and agriculture.

Despite the existence of many sources of information on complementary feeding which were reported as being beneficial, the community needed more information especially on formulation of nutritious complementary foods, advantages of good nutrition among other aspects. The community also observed that inappropriate complementary feeding negatively affected the nutritional status of their children as poorly fed children were malnourished and weak. A number of challenges which affect complementary feeding were reported and these concentrated around poverty, food insecurity and health complications such as swollen breasts for mothers and HIV/AIDS. However, when asked about how the complementary feeding situation in the community can be improved, the community proposed introducing a local complementary food formula, increasing the accessibility of the commercial complementary foods especially to the local markets such that people who can afford can have access to them.

4.3 Knowledge, attitude and practices on complementary feeding among caregivers

The proportion of knowledge, attitude and practice on complementary feeding among caregivers is presented in figure 3.

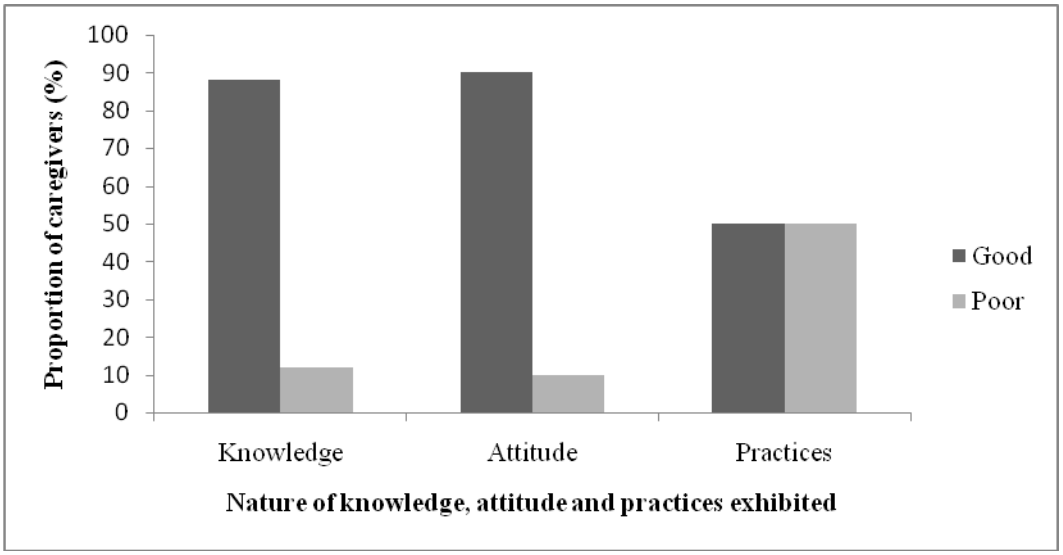

Figure 3*:* Distribution of knowledge, attitude and practices on complementary feeding among caregivers (n=152)

With regard to knowledge and attitude, the proportion of caregivers who had good nutrition knowledge and positive attitude towards complementary feeding was above 80%. For the case of practices, the proportion of caregivers with good practices on complementary feeding was equal to those with poor practices. However, when data was segregated by district, no significant differences (P>0.05) were observed among caregivers with respect to mean complementary feeding knowledge, attitude and practices (Table 5).

Table 5 : Knowledge, attitude and practices on complementary feeding amongst caregivers segregated by district

	Nwoya	Amuru	P-value
Knowledge	76.61±15.20	70.21±14.78	0.970
Attitude	78.53±13.70	84.88±15.39	0.387
Practices	65.26±20.49	75.0±19.63	0.857

Values are means± standard deviations

Correlations between knowledge, attitude and practices on complementary feeding were very weak (Table 6).

Table 6: Pearson's correlation between Nutritional KAP attributes

	Nutritional knowledge	Nutritional attitude	Nutritional practices
Nutritional knowledge	1		
Nutritional attitude	0.099	1	
Nutritional practices	0.008	0.036	1

Values are correlation coefficients

Data on specific aspects used to test knowledge on complementary feeding is provided in Table 7. The proportion of caregivers with correct responses was higher (above 60%) than those with wrong responses for all aspects tested with the exception of the aspect testing the importance of including animal foods in a child's diet.

Table 7: Distribution of knowledge on specific aspects of complementary feeding

Aspect of knowledge on complementary feeding tested	Proportion of caregivers that gave correct answers	
	(n)	**(%)**
Importance of early breast feeding	92	60.5
How often to breast feed	130	85.5
Breast feeding duration	129	84.9
Age of introduction of complementary food	131	86.2
Nature of a complementary food	138	90.8
Reasons for introducing complementary foods at 6 months	116	76.3
Risks of late complementary feeding	101	66.4
Risks of early complementary feeding	106	69.7
Minimum meal frequency for 6-8 Months children	121	79.6
Minimum meal frequency for 9-11 Months children	122	80.3
Minimum meal frequency for non breast feeding children	100	65.8
Minimum dietary diversity	109	71.7
Importance of including animal foods in a child's diet	56	36.8
Exclusive breast feeding	111	73

Distribution of caregivers' adherence to recommended complementary feeding practices is presented in Table 8. More than 60% of the respondent adhered to the recommended practices. However, ensuring dietary diversity was poorly adhered to as only half of the respondents could meet this requirement.

Table 8: Distribution of caregivers' adherence to recommended complementary feeding practices

Recommended complementary feeding practices	**Proportion of caregivers that adhere**	
	(n)	**(%)**
Continued breast feeding along with complementary foods	137	90.1
Nature of food/food consistency for 6-8, 9-11 & 12-23 months old children	107	70.4
Minimum meal frequency for 6-8Mo, 9-11Mo and non-breast fed children	110	72.4
Introduction of complementary foods at 6 months	99	65.1
Ensuring dietary diversity	80	52.6

Data on specific aspects of complementary feeding used to test attitude is provided in Table 9. Generally, the caregivers' attitude towards complementary feeding was good and above 70% with the exception that more than half of the caregivers (53.3%) who perceived breastfeeding for 2 or more years as embarrassing.

Table 9: Distribution of responses on questions used to test attitude

Specific aspects of complementary feeding	Proportion of caregivers who;					
	Disagree		Neither agree nor disagree		Agree	
	n	%	n	%	n	%
It is important to breast feed a child within one hour after birth	16	10.5	0	0	136	89.5
It is important to breast feed a child on demand	23	15.1	1	0.7	128	84.2
I do not find breast feeding for 2 or more years embarrassing[R]	84	53.3	2	1.3	66	43.4
It is good to give a child of less than 2 years other foods other than breast milk[R]	32	21.1	2	1.3	118	77.6
I am so mindful about the quality of food that I give to my baby (texture, nutritional composition)	13	8.6	1	0.7	138	90.8
I think introducing food late could affect my child	22	14.5	3	2.0	127	83.6
I am disturbed when I introduce complementary food to a child of less than 6 months[R]	27	17.8	2	1.3	123	80.9
It is important for my child to consume different types of foods	15	9.9	1	0.7	136	89.5
It is helpful to include animal foods in the child's diet	11	7.2	3	2.0	138	90.8

[R]means that the question was reverse coded

4.4 Association between socio-demographic factors and Knowledge, attitude and practices on complementary feeding

Results of binary logistic regression analysis on the effect of socio-demographic factors on knowledge, attitude and practices regarding complementary feeding are presented in Table 10. Only educational status of the household head and the sex of the child were significant predictors of knowledge on complementary feeding (P=0.009 & 0.005 respectively). The relationship is presented in equation 2.

$$Y = -21.309 - 2.870X_1 + 2.764X_2 \quad (2)$$

Where; Y represents good knowledge on complementary feeding, X_1 is the educational status of the household head and X_2 is the sex of the child. With regard to attitude, educational status of the household head was the only significant predictor (P=0.011) (Table 10). The prediction is presented in equation 3.

$$Y = -11.675 - 3.199X_1 \quad (3)$$

Where; Y represents good attitude towards complementary feeding and X_1 is the educational status of the household head. However, none of the socio-demographic factors significantly predicted good complementary feeding practices (P>0.05).

Table 10: Socio-demographic predictors of good knowledge, attitude and practices on complementary feeding among caregivers

Socio-demographic characteristics	Knowledge		Attitude		Practices	
	B	P-value	β	P-value	B	P-value
Sex of the household head	1.181	0.496	16.519	0.998	0.618	0.561
Age of the caregiver	0.082	0.311	-0.108	0.107	0.029	0.422
Marital status	-1.597	0.315	16.097	0.998	-0.363	0.711
Employment status of the household head	18.418	0.999	0.333	0.839	-0.821	0.345
Employment status of the caregiver	-0.244	0.867	-1.401	0.273	0.295	0.700
Education status of the household head	-2.870	**0.009**	-3.199	**0.011**	-0.896	0.188
Education status of the caregiver	0.402	0.736	1.305	0.257	-0.251	0.679
Size of the household	0.228	0.156	-0.014	0.942	0.027	0.750
Monthly expenditure on food	0.000	0.935	0.000	0.687	0.000	0.523
Residence of the caregiver	0.524	0.522	0.721	0.447	-0.652	0.109
Sex of the child	2.764	**0.005**	-0.607	0.439	-0.083	0.816
Age of the child	0.048	0.506	-0.146	0.067	-0.066	0.076
Birthplace of the child	-1.224	0.194	0.655	0.566	-0.653	0.287
Attainment of nutritional training	0.328	0.643	1.369	0.135	-0.634	0.097

β: regression coefficients

4.5 Sensory scores and selection of community-preferred composite formulae

Caregivers' scores on the extent of liking the various millet-sesame-soy complementary food formulae, segregated by energy requirements (200Kcal meant for 6-8 months, 300Kcal meant for 9-11 months and 550Kcal meant for 12-23 months old children) are presented in Table 11.

In the case of the 200 Kcal composite, the degree of liking of the mouth feel, thickness and appearance was the same for F12 composite (92.2% millet +0.9% sesame+ 6.9% soy) and F13 composite (92% millet + 0.8% sesame + 7.2% soy) but higher than for the F11 composite (91.8% millet +0.7% sesame+ 7.5% soy). For 300Kcal composite formula, the degree of liking of all sensory attributes was the same for F21(75% millet +10% sesame+ 15%soy) composite and F22 composite (65% millet +5% sesame+ 30% soy) but higher than for F23 composite (71% millet +8% sesame+ 21%soy) except for aroma. In the category of 550Kcal (for children 12-23 months old), the degree of liking of the sensory attributes was

the same for F31 (12.1% millet +10% sesame+ 77.9% soy) and F32 (16.1% millet +11.9% sesame+ 72% soy) but significantly higher than F33 composite (18.1% millet +12.9% sesame+ 69%soy). Based on overall acceptability evaluation, the community preferred F13, F21 and F31 for energy categories 200, 300 and 550 Kcal, respectively.

Table 11: Mean scores on sensory attributes of porridge made from millet-sesame-soy composites

	Taste	Mouth feel	Aroma	Thickness	Appearance	Overall acceptability
			200Kcal			
F11	3.00±1.34^{a}	2.50±1.22^{a}	2.07±1.17^{a}	2.67±1.35^{a}	1.97±1.25^{a}	2.37±1.45^{a}
F12	3.67±1.03^{b}	4.00±1.05^{b}	3.87±1.04^{b}	3.83±1.09^{b}	4.07±1.08^{b}	3.77±1.19^{b}
F13	4.73±0.64^{c}	4.43±0.73^{b}	4.77±0.43^{c}	4.47±0.51^{b}	4.67±0.48^{b}	4.77±0.43^{c}
			300Kcal			
F21	4.33±0.94^{b}	4.40±0.81^{b}	4.03±0.89^{b}	4.23±1.10^{b}	4.07±1.11^{b}	4.80±0.38^{c}
F22	3.87±1.33^{b}	3.90±1.16^{b}	3.73±1.44^{ab}	3.83±1.44^{b}	4.00±1.29^{b}	3.83±1.53^{b}
F23	3.00±1.68^{a}	2.93±1.60^{a}	3.07±1.57^{a}	2.60±1.35^{a}	3.07±1.46^{a}	2.30±1.58^{a}
			550Kcal			
F31	4.23±1.19^{b}	3.93±1.33^{b}	4.13±1.20^{b}	4.27±1.05^{b}	4.27±1.13^{b}	4.83±0.38^{b}
F32	3.73±1.17^{ab}	3.90±1.30^{b}	3.97±1.13^{b}	3.87±1.14^{b}	4.07±0.98^{b}	3.67±1.35^{a}
F33	3.07±1.44^{a}	2.60±1.38^{a}	2.90±1.54^{a}	3.00±1.64^{a}	2.83±1.58^{a}	3.03±1.65^{a}

Values show mean ± S.D (n=30) of scores for each sensory attribute based on a 5-point hedonic scale (ranging from 1- dislike very much, to 5-like very much). Means in the same column with different superscripts are significantly different ($p \leq 0.05$). F11: 91.8 %millet-0.7% sesame-7.5% soy; F12: 92.2 % millet-0.9% sesame-6.9%soy; F13: 92% millet- 0.8% sesame-7.2%sesame; F21: 75% millet-10 %sesame-15%soy; F22: 65% millet-5 % sesame-30% soy; F23: 71% millet-8% sesame-21%soy; F31: 12.1% millet-10% sesame-77.9%soy; F32: 16.1% millet-11.9% sesame-72% soy; F33: 18.1% millet; 12.9 % sesame-69 % soy.

4.6 Nutritional composition of community-preferred composite formulae

Nutritional composition of the community-preferred composite formulae is presented in Table 12. Based on the dry matter weight of the selected formulae, serving 58, 65 and 121g per day of F13, F21 and 31 would be required to meet energy intake of 200, 300 and 550 Kcal for children 6-8, 9-11 and 12-23 months, respectively.

Table 12 : Nutritional composition of the community-preferred composite formulae

Properties	F13	F21	F31
Carbohydrate (%)	79.85±3.4	63.40±0.28	29.57±0.41
Moisture (%)	6.59±0.11	6.17±0.21	5.24±0.16
Crude fat (%)	2.64±0.02	8.62±0.24	18.52±0.40
Dietary fibre (%)	10.63±0.61	11.00±0.95	17.15±1.55
Ash (%)	3.01±0.13	3.44±0.14	4.92±0.16
Crude protein (%)	10.25±0.18	13.18±0.48	31.27±0.36
Energy (Kcal)/100g	345.23±1.21	462.81±2.53	454.28±1.93
Phosphorus mg/100g	393.20±9.9	419.27±19.1	577.10±9.5
Iron mg/100g	86.63±0.35	100.50±1.71	107.33±4.41
Zinc mg/100g	1.57±0.15	1.67±0.06	4.17±0.15
Magnesium mg/100g	86.27±0.49	91.70±1.61	121.40±1.97
Calcium mg/100g	642.43±20.1	797.90±39.9	990.30±39.6

Data shows means±SD of triplicate determination. F13: 92% millet- 0.8% sesame-7.2% soy; F21: 95% millet-10 %sesame-15%soy; F31: 12.1% millet-10% sesame-77.9% soy.

CHAPTER FIVE

DISCUSSION

5.1 Knowledge, attitude and practices of caregivers on complementary feeding

It is generally expected that people should apply nutritional knowledge and attitude appropriately in different aspects of nutritional practices/food habits (Rezaee *et al*., 2012). Interestingly, the findings from this study show that whereas a high proportion of caregivers had good knowledge and attitude regarding complementary feeding, most of them had poor practices (Figure 3). This is not surprising as already illustrated in previous studies, where nutrition knowledge among study population from various localities was reported to be high but only a small proportion practiced what they knew (Das & Mukherjee, 2014; Salarkia *et al*., 2014; Anand & Puri, 2013; Hasnain *et al*., 2013). The low proportion of caregivers who adhered to recommended complementary feeding practices can be explained by the low educational level of the respondents and household heads (Table 3). Most of the caregivers (67.1%) had attained only primary education. Education affects employability potential (Wambugu, 2011). People who are unemployed find it difficult to afford some of the basic necessities and requirements for their children. Other than the factors above, poverty and food insecurity are among the other problems that can worsen the situation. According to the World Food Program report on the nutritional situation in Acholi sub-region (WFP, 2012), the districts of Amuru and Nwoya were reported to have had high undernutrition rates, which was attributed to the high poverty rates in the area. Poverty has been reported in many areas as a hindrance to complementary feeding. Victor *et al.* (2014) attested to this in a report which showed that poor economic status was one of the main risk factors for inappropriate complementary feeding practices in Tanzania. A cross sectional study on socio-economic determinants of household's food security and dietary diversity among women in rural

Bangladesh showed that wealth was a key determinant of food security and dietary diversity (Harris-fry *et al*., 2015)

Lack of significant difference in the good knowledge, attitudes and practices between the two districts could be due to the fact that the districts have similar socio-economic, geographical and political conditions (MOWT, 2012; ACTED, 2012). Weak correlation between nutritional knowledge, attitude and practices observed in this study deviate from findings of other studies which demonstrated a strong correlation between nutritional knowledge, attitude and practices (Masuku & Lan, 2014; Azizi, *et al*., 2011). The low proportion of caregivers knowledgeable on importance of including animal foods in the child's diet (Table 7) could be attributed to the low level of education among most of the caregivers (Table 3). This could possibly also be due to poor economic status of the households (WFP, 2012) which makes them not to attach relevance or value in knowing what they cannot afford.

Table 8 shows that only a small proportion of caregivers adhered to recommended dietary diversity. This could be attributed to poor crop yields which translated into food insecurity and poverty reported by the community during FGD exercise (Table 4). This finding is not unique to this study. It has also been reported in Iran (Hasan-ghomi *et al*., 2015). The dependence of Food and Nutrition Security on agriculture has long been recognized (Titus & Adetokunbo, 2007). Classically, food and nutrition security can be met through market and or own production pathways (Baiphethi & Jacobs, 2009). However, as demonstrated in this study, own production pathway is very critical in rural settings. Thus crop failure as reported by the community during FGD (Table 4) is a critical factor that requires attention at both policy and household practice levels. Table 4 also shows that many of the food types used as complementary food were plant based and rarely of animal origin while commercial complementary food formulae were not affordable. This finding justifies the merit for development of the composite as articulated under subsection 2.3.1.

5.2 Relationship between socio-demographic factors and knowledge, attitude and practices on complementary feeding

Different socio-demographic factors were tested to identify those that can predict good knowledge, attitude and practices on complementary feeding among caregivers (Tables 10). Caregivers' good knowledge on complementary feeding increased 2.764 times when the caregiver had a boy child compared to when he or she had a girl child. However, this is not astonishing since in many developing countries especially in rural settings, the boy child is always more treasured as compared to the girl child especially in areas of resource allocation (Mehtabul & Geeta, 2011; Dercon & Singh, 2011). These findings are comparable to findings in Ethiopia where mothers who had baby boys timely initiated complementary feeding than those who had baby girls (Semahegn *et al.*, 2014).

Furthermore, this study revealed that, as the educational status of the household head increased, the caregivers' knowledge and attitude towards complementary feeding decreased by 2.870 and 3.199, respectively. This is because education is associated with employability which has effects on the time of interaction between the educated household heads and the caregivers (Wambugu, 2011). It is expected that since educated household heads get employed easily thus spend most of their time at their work places hence compromising their ability to share their knowledge with the caregivers. This leads to caregivers' negative attitude in the long run. This may not be the case for the uneducated household heads who spend a lot more time with the caregivers and are likely to share what they know with the caregivers.

While several studies have identified maternal education as a predictor of good complementary feeding practices (Kumar *et al*., 2015; Tessema *et al*., 2013; Adnan & Muniandy, 2012; Olwedo *et al*., 2008), this wasn't the case in the current study. The findings

were, however, comparable to those in Mauritius, where Mottee *et al*. (2013) observed that the level of education did not have any influence on breastfeeding duration. Other studies have also shown that maternal employment is a determinant of complementary feeding (Ogunba, 2015; Taddele *et al*., 2014) but this was neither the case in the current study. Interestingly, none of the factors investigated as determinants of good complementary feeding practices significantly influenced it (P> 0.05). The findings from this study therefore confirm the need for location specific understanding of the effect of socio-demographic factors on complementary feeding as articulated under subsection 2.3.2 of this dissertation.

5.3 Nutritional composition and acceptability of millet-sesame-soy composite formulae

The use of locally available food resources in complementary feeding has been recommended to avert undernutrition in rural areas (WHO, 2008). This is because they are readily available, accessible and affordable to the local people. The formulation of complementary food composites from local foods as is the case in this study has been demonstrated in similar studies conducted elsewhere (Fathelrahman *et al*., 2015; Satter *et al*., 2013; Konyole *et al*., 2012). Much as this is a feasible and viable option, such innovations are bound to fail if they are not accepted by the local people. Usually communities tend to adopt what is known to them. Acceptability usually depends on socio-cultural factors and individual characteristics (Grace *et al*., 2010; Leroy *et al*., 2007) as well as sensory attributes of the food item in question (Young *et al*., 2010). Acceptability evaluation of the various millet-sesame-soy composite based on sensory attributes (taste, mouth feel, aroma, thickness, appearance) and the overall acceptability, resulted in community preference and selection of 92% millet-12.8% sesame-7.2% soy (F13), 95% millet-10 %sesame-15%soy (F21) and 12.1% millet-10% sesame-77.9% soy (F31) composite for children 6-8, 9-11 and 12-23 months, respectively.

The preference for F13 to F12 and F11 (200 Kcal formulation) in terms of taste and aroma could be due to the roasting of sesame and soy which enhanced the sensory appeal (Mridula *et al*., 2007) of the product. The millet included in the formulation is a staple food in the study area and has been used for making porridge for infant feeding (Acheng, 2014). Therefore with low quantity of sesame and soy, the colour and flavour of millet (familiar to the local people) could not be masked hence making it more acceptable. In the case of 300Kcal composite formula meant for 9-11 months old children, preference of F21 in terms of taste, mouth feel and aroma could be due to a higher content of sesame in the formulation. Sesame improves the taste when added into diets due to its nutty pleasant flavor which also contributes to the aroma (Asghar *et al*., 2014). The moderate amounts of sesame and soy seems not to have significantly altered the colour of millet flour that the local people are familiar with.

For the energy category of 550Kcal (meant for children 12-23 months old), the preference of F31 could have been due to higher content of soy and moderate content of millet and sesame and roasting of the soy. Roasting enhances the flavor, taste and edibility of legumes hence increasing their sensory appeal (Subuola *et al*., 2012). This is because of the maillard reaction between the reactive carbonyl group of the sugar which reacts with the nucleophilic amino group of the amino acid resulting into a complex mixture of molecules responsible for a range of flavours (Martins *et al*., 2001; Makinde & Akinoso, 2014). It is important to note that maillard reaction can lead to loss of essential amino acids (Fastinger *et al*., 2006; Ajandouz *et al.*, 2001) and the extent of loss depends on temperature (Lan *et al*., 2010). In this study, indigenous experience of rural women was used to define the readiness of the roasted ingredients. However, it is yet unknown to what extent the indigenous method of roasting millet, sesame and soy promote maillard reaction and hence the loss of amino acids. This is a potential subject for future research.

It can be urged that acceptability of foods based on their sensory attributes may not guarantee that nutritional requirements of a child can be met because nutrients but not sensory attributes are key for child growth and development (Zimmermann, 2011; Lozoff *et al*., 2003). It is well known that several rural communities still use complementary foods that are nutritionally inadequate (Gibson *et al*.,1998). As presented in Table 4, most communities used cereals or legumes singly, a practice which creates deficiency in certain nutrients especially amino acids. However a combination of both cereals and legumes as demonstrated in this study is expected to improve nutritional quality of complementary foods. This is because cereals are low in the essential amino acid lysine, while legumes are low in essential amino acids methionine and cysteine, but are high in lysine (Nour *et al*., 2014). Therefore combining them provides for amino acid complementary benefit (Thapliyal & Singh, 2015).

The nutrient content of the selected formulae (Table 12) are in line with the minimum recommended requirements for a complementary food (WHO, 1994; WHO/PAHO, 2004; Dewey & Adu-afarwuah, 2008) and are also comparable to other formulae produced for local communities in other developing countries such as Kenya (Konyole *et al*., 2012) and Bangladesh (Satter *et al*., 2013). On dry matter basis serving 58, 65 and 121g per day of F13, F21 and F31 respectively would meet energy intake of 200, 300 and 550 Kcal recommended to come from complementary foods for breast fed children 6-8, 9-11 and 12-23 old, respectively in developing countries (WHO/PAHO, 2004; Dewey & Adu-afarwuah, 2008). Translating to local measures 58, 65 and 121g of the formulated composite would be equivalent to 5, 6.5 and 10 table spoonfuls of the composite flours (dry matter basis), respectively. Translating to local measures is necessary since in the rural areas weighing scales may not be readily available in households.

The flour formulae developed in this study were designed based on nutrient composition of roasted food materials to enhance sensory appeal (Mridula *et al*., 2007) and inactivate anti-

nutritional factors (Maidala *et al*., 2013). Several antinutritional factors (trypsin inhibitor, hemagglutinin, cyanogenic glycosides, alkaloids saponins, phytates, phenols, tannins, enzyme inhibitors, lectins, and antivitamins) are found in plant based foods (Doss *et al*., 2011; Mugendi *et al*., 2010). However, roasting as applied in this study is known to inactivate mostly protein inhibitors (Maidala *et al*., 2013; Ndidi *et al*., 2014), but does not improve mineral bioavailability (D'souza, 2013). Techniques such as malting/fermentation which are practiced in rural areas are known to improve mineral bioavailability of plant based foods (Kumar *et al*., 2010; Gibson *et al*., 2006). However, these processes also change physico-chemical properties (Phattanakulkaewmorie *et al*., 2011), factors that influence rheological and sensory properties and hence acceptability of foods (Martin *et al*., 2010). It is still unknown how malting or fermentation will affect sensory quality and acceptability of millet-sesame-soy composites developed in this study. This is a subject for future research.

Considering that knowledge on nutritional quality of foods is generally lacking in many rural communities in developing countries (Saaka, 2014), this study has illustrated how knowledge institutions (e.g. universities) can work with rural communities to find solutions to complementary feeding problems. Although the formulae were well accepted by the caregivers, community-wide training is still necessary to enable diffusion and uptake of the technology in the sub-region. Studies have shown that adoption of new technologies can be successful but may not necessarily be translated into application or use (Wustenhagena *et al*., 2007). Whereas the millet-sesame-soy composite formulae developed in this study were highly accepted by caregivers, it is still unknown whether the formulae will be accepted and used by the wider community in Acholi Sub-region. Therefore there is need to identify factors that are necessary for successful adoption and use of the formulae. This is a subject for future research. On the other hand, it would be important to test the effectiveness of the

developed formulae when applied for complementary feeding. A control feeding trial is therefore necessary. This is also a subject for future research.

CHAPTER SIX

CONCLUSIONS AND RECCOMENDATIONS

6.1 Conclusions

Based on the findings from this study, the following conclusions are drawn: (i) caregivers in Acholi sub-region have adequate knowledge and positive attitude towards complementary feeding, but the good knowledge and attitude are not translated into good feeding practices; (ii) animal source foods are very limited in the diets of children and adherence to recommended dietary diversity is very poor; (iii) food insecurity is a major constraint to achieving good complementary feeding practices; (iv) education of the household head and sex of the child predicted good knowledge on complementary feeding; (v) education of the household head also predicted good attitude towards complementary feeding; (vi) no socio-demographic factors predicted good practices on complementary feeding; (vii) millet-sesame-soy composite formulae were highly accepted by caregivers thus illustrating the potential of the innovation in addressing child undernutrition problem in the sub-region.

6.2 Recommendations

Based on the findings from this study, two fold recommendations are put forward:

Recommendations for the community

(i) Community-wide training is required to enable caregivers translate good knowledge and attitude into good feeding practices. The training should emphasize the role of nutrition in the child's growth and development. Such a training should stress the importance of using local food resources to improve child nutrition in households.

(ii) Demonstrations on how to prepare the formulae developed in this study should be conducted in the community to enable community-wide adoption and use.

(iii) Food security needs to be addressed to enable households adhere to recommended dietary diversity in the management of complementary feeding.

Recommendations for future research

(i) The optimization of traditional methods of roasting millet, sesame and soy on maillard reaction and loss of essential amino acids should be investigated to validate application of indigenous experience of rural women in determining readiness of roasted ingredients.

(ii) The effect of malting or fermentation on the sensory quality and acceptability of the composite formulae developed should be investigated to enable generation of formulae with improved mineral bioavailability and acceptable organoleptic properties.

(iii) Factors necessary for community-wide adoption and use of the developed formulae need to be identified to guide in promoting the formulae to the community. In addition a control feeding trial is necessary to test the effectiveness of the developed formulae in complementary feeding.

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APPENDICES

1.1 **Consent form**

Establishing the level of nutritional knowledge, nature of attitudes and complementary feeding practices of caregivers of children aged 6-23 months in Acholi sub-region of Uganda

Introduction and consent

Good morning/afternoon! My name is (Interviewer mentions his/her name).

This is a team from Gulu University conducting a research on the topic: **Development and acceptability evaluation of Millet-sesame-soy composite as a complementary food in Acholi sub-region of Uganda.** The aim is to establish nutritional knowledge and complementary feeding practices amongst caregivers of 6-23 months old children in Acholi sub-region of Uganda and during the study we will be asking you about the nutritional knowledge and complementary feeding practices in your household. We are therefore seeking your consent to participate in the study whose findings might be beneficial to your child and other children below two years in the community. There will be no direct reference of your name nor will your contact information be published at the end of the study. Any information you give about you or your family will be treated with the highest level of confidentiality. ***There is no financial or other personal benefit from participating in this study and there are no risks to you resulting from your participation!*** Please feel free to ask me about anything you would like to understand about the study. You can also contact **Ms. Nassanga Prossy** who is heading this research on 0787699089 or email her on pnassanga@gmail.com for any more details on this study. If you accept to participate in this study please sign or put your thumbprint here: ……..

Participant's Full name ……. …….. Contact;……..

Interviewer's name ……

Interviewer's signature …… Date ……

1.2 Focus group discussion guide

1. What is your view on the adequacy of feeding children in this community?
(The discussion should be based on both breastfeeding and complementary feeding but with special focus on complementary feeding ask why they think it is adequate or not adequate also include the following aspects; introduction of solid, semi-solid foods and soft foods, dietary diversity, frequency of feeding and continued breast feeding to 2 years and above).
2. What are the sources of information on complementary feeding in this community?

i. Is the information beneficial? (If yes-how or if no-why?)
ii. Is the information received adequate?
iii. What other aspects of CF would you like to receive information on?

3. In your opinion, do mothers initiate complementary feeding at the appropriate time?
4. What are the foods commonly given to children 6-23 months old in this community?
5. Is the community aware of complementary foods on the market?
6.What are some of these foods?
7. Are these foods affordable?
8. Is there a local complementary food formula in the community? (A formula that can be used to develop complementary foods using locally available food stuffs)
9. If not available, does the community wish to have one developed for them?
10. In your opinion, do mothers feed their children at the required meal frequency?
11. Does poor/inappropriate complementary feeding affect infant/child nutrition status?
12.What are the challenges experienced by mothers in complementary feeding in this community?
13. What are your suggestions on how to encourage appropriate complementary feeding could be improved in this community?

THANK YOU FOR YOUR PARTICIPATION!

1.3 Tool for collecting data on nutritional knowledge, attitudes and practices of caregiver of children 6-23 months towards complementary feeding

SECTION A : HOUSEHOLD DEMOGRAPHICS & SOCIO-ECONOMIC DATA

Instructions: Circle the number corresponding to the response that the caregiver gives. Record the appropriate response in areas where choices have not been given. All 'Any other' responses should be specified)

	QUESTION	RESPONSE	CHOICE
Q1	Sex of household head	Male Female	1 2
Q2	Age of mother/ caregiver	……. Years	
Q3	Marital status	Single Married Separated Widowed	1 2 3 4
Q4	Occupation of household head (skip to A6 if the mother is the household head)	Not employed Employed (salaried) Small scale trading Casual labor Any other(specify)	1 2 3 4 5
Q5	Occupation of mother	Not employed/house wife Employed (salaried) Small scale trading Casual labor Any other (specify)	1 2 3 4 5
Q6	Education level of the household head	No formal education Primary Secondary Tertiary	1 2 3 4
Q7	Education level of the caregiver	No formal education Primary Secondary Tertiary	1 2 3 4
Q8	Household size (people who usually eat from the same pot/house)	…….. people	
Q9	How many children do you have? (1-17 years)	…….. children	
Q10	How many children are below 5 years of age?	…….. children	

Q11	How many children are below two years?	……children	
Q12	Main source of family income	Formal employment Casual labor Small scale business Sale of agriculture produce Any other (specify)	1 2 3 4 5
Q13	How is food obtained in the household? (*Probe for all responses)*	Farming Purchase Food aid/donation Transfers Any other (specify	1 2 3 4 5
Q14	Who has the primary responsibility of providing food for the household?	Father Mother Grandparent Relatives Any other (specify)	1 2 3 4 5
Q15	What is the estimated percentage of household income that is allocated to food? / What is the estimated amount of money that you spend on food per month?		
Q16	Who usually decides how family income is used?	Husband/Partner Wife/mother Any other (specify)	1 2 3
Q17	Who usually decides on what food to be cooked each day in the household?	Husband/Partner Wife/mother Any other (specify)	1 2 3
Q18	Residential area of the respondent	Rural Urban/trading centre	1 2

<u>SECTION B</u>: CHILD'S DATA

If there is more than 1 child 6-23 months in the household, identify each child's mother or primary caregiver starting with the youngest and arrange to interview her once. This Section of the interview schedule is completed after you have completed the questionnaire for the first child.

	Question	Response	Choice
Q1	What is your child's name? [Use this NAME in remaining questions] Please get his/her card	……..	
Q2	Sex of the child	Male Female	1 2
Q3	Child's date of birth (If there is no documentary source, probe using memorable dates /calendar of events until a mother provides the most accurate answer)	Date: _____ / ____/ 20…..	

Q4	Source of birth date	Child health card Mother/caregiver Any other source (specify)	1 2 3
Q5	Source of birth e.g hospital, home	Hospital Home	1 2
Q6	Order of birth of the child (Whether the child is the 1st , 2nd, 3rd, born e.t.c)	**……..**	
Q7	Birth interval (Spacing between the children)	……	

SECTION C: NUTRITIONAL KNOWLEDGE OF THE CAREGIVER

Q1. What do you understand by the term good nutrition?

a) Eating at right meal time
b) Eating many food groups
c) Eating right portions according to age and health status
d) Eating 3 meals per day
e) Others (specify)

Q2. How many times have you participated in any training on nutrition?

a) Never
b) One training
c) 2-3 trainings
d) More than 3 trainings

Q3. Why is it important to initiate breast feeding the child within one hour after birth? **(Circle all the correct alternatives)**

a) Protects the newborn from acquiring infection and reduces newborn mortality
b) It facilitates emotional bonding of the mother and the baby
c) Because the breast milk is too much and the breasts are very heavy
d) It stimulates production of breast milk
e) The yellow or golden first milk produced in the first days is an important source of nutrition and immune protection for the newborn.
f) Because the baby is hungry
g) Others specify

Q4. How many times should a mother breast feed a child of 6-23 months in a day?

a) Once in a day
b) Four times in a day
c) Breast feed on demand
d) 7 times per day
e) Others

Q5. According to you, for how long should a mother breastfeed a child before weaning him or her off?

a) 1 year
b) 2 or more years

Q6. What do you think is the best time for introducing complementary foods for your child?

a) 2 months
b) 9 months
c) 6 months
d) 12 months

e) Others

Q7. What kind of food should be given to such children?

a) Thick pureed foods
b) Light soups
c) Specially prepared food that is soft, solid, semi-solid or liquid
d) Family foods

Q8. Why are these foods introduced at this time?

a) An infant is developmentally ready for other foods.
b) To prevent faltering of the infant's growth
c) The infant's need for energy and nutrients have increased
d) Because the child can now eat with other family members
e) Others

Q9. What are the risks of starting complementary feeding too late?

a) It leads to faltering of the infant's growth
b) The infant's need for energy and nutrients may be compromised
c) The child will not be healthy
d) No risks
e) Others

Q10. What is the risk of starting complementary feeding too early?

a) Increases the risk of diarrhea diseases
b) Increases rates of morbidity and mortality
c) No risk
d) Don't know
e) Others

Q11. How many times should a breast feeding child of 6 to 8 months be fed on complementary food each day?

a) 2-3 times
b) Once
c) Never
d) 6 times
e) Others

Q12. How many times should a breast feeding child of 9 to 23 months be fed on complementary food each day?

a) 4 times
b) 3-4 times
c) Never
d) 9 times
e) Others

Q13. If the child is not breast feeding, how many times should the child be fed on complementary foods?

a) Once
b) 3 times a day
c) 4 or more times
d) 8 times

Q14. Why should a child consume different types of foods?

a) In order for the child to get micronutrients from different foods
b) To avoid monotony
c) To increase the child's appetite
d) Because there is plenty of different foods
e) To enable the child get used to different types of foods

Q15. Why should animal foods like milk or eggs be included in the child's diet?

a) Because they are sources of proteins and minerals like calcium
b) Because they are nutritious
c) They are a source of carbohydrates
d) They contain a lot of vitamins

Q16. What should a child of less than 6 months be fed on?

a) Breast milk only
b) Breast milk and Porridge
c) Breast milk and water
d) Juice
e) Others (Specify)

SECTION D: ATTITUDE OF THE CARE GIVER

Q1. It is important to initiate breast feeding to the child within one hour after birth

a) Agree
b) Nether agree nor disagree
c) Disagree

Q2. It is important to breast feed a child on demand

a) Agree
b) Neither agree or disagree
c) Disagree

Q3. I find breast feeding a child for 2 or more years embarrassing

a) Agree
b) Neither agree nor disagree
c) Disagree

Q4. It is not important to give a child of less than 2 years other food apart from breast milk.

a) Agree
b) Neither agree nor disagree
c) Disagree

Q5. I am so mindful about the quality of the food that I give to my baby. (Look at variables like texture, nutrient composition amongst others variables)

a) Agree
b) Neither agree nor disagree
c) Disagree

Q6. I think introducing food late could affect my child.

a) Agree
b) Neither agree nor disagree
c) Disagree

Q7. I am not bothered when I give food to a child of less than 6 months.

a) Agree
b) Neither agree nor disagree
c) Disagree

Q8. It is important for my child to consume different types of foods.

a) Agree
b) Neither agree nor disagree
c) Disagree

Q9. Do you agree that introducing animal's food to the child's diet helps?

a) Agree
b) Neither agree nor disagree

c) Disagree

SECTION E: COMPLEMENTARY FEEDING PRACTICES

- ✓ ***Note for questions 15-17, ask according to the child's age i.e 6-8 months, 9-11 months and 12-23 months.***

	QUESTION	RESPONSES	CHOICES
Q1	Are you breastfeeding *(Name)*? / did you breast feed *(Name)*?	Yes No	1 (Skip to Q3) 2 (Skip to Q2)
Q2	If No, why?	No milk Did not want to breast feed Traditional beliefs (child will die) Other (Specify)	1 (Skip to Q8) 2 3 4 (Skip to Q8)
Q3	If yes, how soon after birth did you put *[Name]* on the breast?	In less than an hour In less than 24 hours record number of Hours If more than 24 hours record number of Days If mother does not know record	00 …..Hrs …..Days 88
Q4	During the first 3 days after delivery, did you give *[Name]* the yellow or golden fluid/liquid that came from your breasts?	Yes No	1 2
Q5	Yesterday during the day or at night, did *[Name]* consume breast milk?	Yes No	1 2
Q6	Are you still breastfeeding [Name]?	Yes No	1 (Skip to Q8) 2
Q7	If No how old was the child when you stopped breastfeeding?	.....months.	
Q8	Has *[Name]* had diarrhea in the last one week?	Yes No	1 2
Q9	Yesterday, did **(mention the child's name)** eat solid or semi solid foods during day or at night?		
Q10	How many times did **(mention the child's name)** eat solid or semi-solid foods yesterday?		Record the number of times as reported by the caregiver
Q11	How much food did you give to the child per serving?		
Q12	At what age did you start, giving **(mention the child's name)** the complementary foods?		
Q13	Does what you feed to the child increase as the child grows?	1. Yes 2. No	
Q14	If Yes, why?		Let the caregiver give her view. These should be written down.
Q15	What was the nature of the food given to (**child's name**) yesterday? (6-8 months old children)	1. Correct 2. Wrong	The care giver can explain the nature. Probe about the consistency of the food
Q16	What was the nature of the complementary food given to (**child's name**) yesterday? (9-11	1. Correct 2. Wrong	Let the caregiver explain the nature of the food and how it

	months children)		was prepared. Note down everything the caregiver says, including the processes for preparation
Q17	What was the nature of the complementary food given to (**child's name**) yesterday? (12-23 months old children)	1. Correct 2. Wrong	The caregiver can explain the nature. Please note down everything the caregiver says
Q18	What is your source of information regarding complementary feeding?	Doctor/ health worker Friends and relatives Radio Others specify	1 2 3 4

SECTION F: DIETARY DIVERSITY

Please describe everything that *[Name]* ate yesterday during the day or night, whether at home or outside the home.

✓ Keep probing 'Anything else?' until the respondent says 'nothing else.' If respondent mentions mixed dishes like a sauce or stew, probe: find out what ingredients were in that **mixed dish**? Probe: 'Anything else?' Until respondent says 'nothing else'

✓ If foods are used in small amounts for seasoning or as a condiment, include them under the condiments food group.

✓ If a food recalled by the respondent is not listed in any of the food groups below, write the food in the box labeled 'other foods' at the end of this section.

Instructions for recording responses

✓ As the respondent recalls each food, underline the food in the food group below.

✓ Once the respondent tells you everything s/he remembers the child eating yesterday during the day or at night, look at each food group. If **one or more foods** in a food group are underlined, circle **'1'** in the column to the right. Now return to the list of foods. Are there any food groups with no '1' circled? Read the entire list of food items in that line to the respondent. If s/he indicates that one or more of the foods has been given to the child, underline that food and circle '1.' if none of the foods has been given to the child, circle **'2'** If the caregiver does not remember or does not know, circle **'3'.**

No	Questions	Coding categories (Circle as applicable).		
		Yes	No	DNK
A	Grains or grain products e.g porridge, bread, rice or other foods made from grains	1	2	3
B	Vitamin A rich foods e.g pumpkin, carrots or sweet potatoes that are yellow/orange inside, ripe mangoes, ripe papayas e.t.c.	1	2	3
C	Roots and tubers e.g. white potatoes, white yams, cassava, or any other foods made from roots	1	2	3

D	Any dark green leafy vegetables	1	2	3
E	Any other fruits or vegetables	1	2	3
F	Flesh foods e.g. liver, kidney, heart, or other organ meats	1	2	3
G	Any meat, such as beef, pork, lamb, goat, chicken, or duck	1	2	3
H	Eggs	1	2	3
I	Fresh or dried fish	1	2	3
J	Any foods made from beans, peas, lentils, nuts, or seeds	1	2	3
K	Dairy products e.g yogurt, or other milk products	1	2	3
L	Any oil, fats, or butter, or foods made with any of these	1	2	3
M	Any sugary foods such as sweets, cakes, or biscuits	1	2	3
N	Condiments for flavor, such as spices, herbs, or fish powder	1	2	3
O	Insects e.g. white ants	1	2	3
P	Foods made with sunflower oil, sesame oil, shear nut oil	1	2	3
Q	Other foods	1	2	3

(Adapted with modification from WHO, 2010a, and FAO, 2014).

END . Thank you very much!

2.1 Consent to participate in sensory evaluation

Introduction and consent

Good morning! My name is (Interviewer mentions his/her name).

We are a team from Gulu University and I am (we are) conducting a research on the topic: **Development and acceptability evaluation of Millet-sesame-soy composite as a complementary food for children 6-23 months old in Acholi sub-region of Uganda.** The aim is to establish the factors that determine the acceptability of millet-sesame-soy composite in Acholi sub-region of Uganda. During the study we shall be asking you questions about the sensory attributes of porridge made from a composite flour of millet, sesame and soy. We are therefore seeking your consent to participate in the study whose findings might be beneficial to your child and other children below two years in the community. There will be no direct reference of your name nor will your contact information be published at the end of the study. Any information you give will be treated with the highest level of confidentiality. ***There is also no financial or other personal benefit attached to your participation in the study and there are no risks to you resulting from your participation!***

Please feel free to ask me about anything you would like to understand about the study. You can also contact **Ms. Nassanga Prossy** who is heading this research on 0787699089 or email her on pnassanga@gmail.com for any more details on this study. Please sign or put your thumb print if you accept to participate in the study.

Name of the participant…….Signature ….. ……...

Name of the interviewer ……...Signature ……...

2.2 Tool for assessing the acceptability (Sensory evaluation) of Millet-sesame-soy composite in Acholi sub-region of Uganda

2.2.1 Sensory evaluation of millet-sesame-soy composite (Formulation 1)

Participant's name …… Signature ……
Interviewer's name …… Signature…….
Time ……
Date …….
Village name ……

Socio- demographic characteristics

Age of the respondent in years				
Level of education	No formal education	Primary level	Secondary level	Tertiary level

Sensory Evaluation

Using the scale given below, rate the product basing on your degree of liking. Write the **code** for each response category e.g **5** for like very much.

5. Like very much
4. Like
3. Neither like nor dislike
2. Dislike
1. Dislike very much

Attribute	**Formulation 11: Label …..**	**Formulation 12: Label…..**	**Formulation 13: Label…..**
Taste			
Mouth feel			
Aroma			
Thickness			
Color/Appearance			
Overall acceptability			

END

Thank you very much.

2.2.2 Sensory evaluation of millet-sesame-soy composite (Formulation 2)

Participant's name …….Signature ……
Interviewer's name …… ……...Signature…….
Time ……
Date …….
Village name ……

Socio- demographic characteristics

Age of the respondent in years				
Level of education	No formal education	Primary level	Secondary level	Tertiary level

Sensory Evaluation

Using the scale given below, rate the product basing on your degree of liking. Write the **code** for each response category e.g **5** for like very much.

5 Like very much

4 Like

3 Neither like nor dislike

2 Dislike

1 Dislike very much

Attribute	**Formulation 21: Label ……**	**Formulation 22: Label……**	**Formulation 23: Label…….**
Taste			
Mouth feel			
Aroma			
Thickness			
Color/Appearance			
Overall acceptability			

END

Thank you very much.

2.2.3 Sensory evaluation of millet-sesame-soy-composite (Formulation 3)

Participant's name …… …. Signature ……
Interviewer's name…… ……. Signature…….
Time ……
Date ……
Village name ……..

Socio- demographic characteristics

Age of the respondent in years				
Level of education	No formal education	Primary level	Secondary level	Tertiary level

Sensory Evaluation

Using the scale given below, rate the product basing on your degree of liking. Write the **code** for each response category e.g **5** for like very much.

5 Like very much

4 Like

3 Neither like nor dislike

2 Dislike

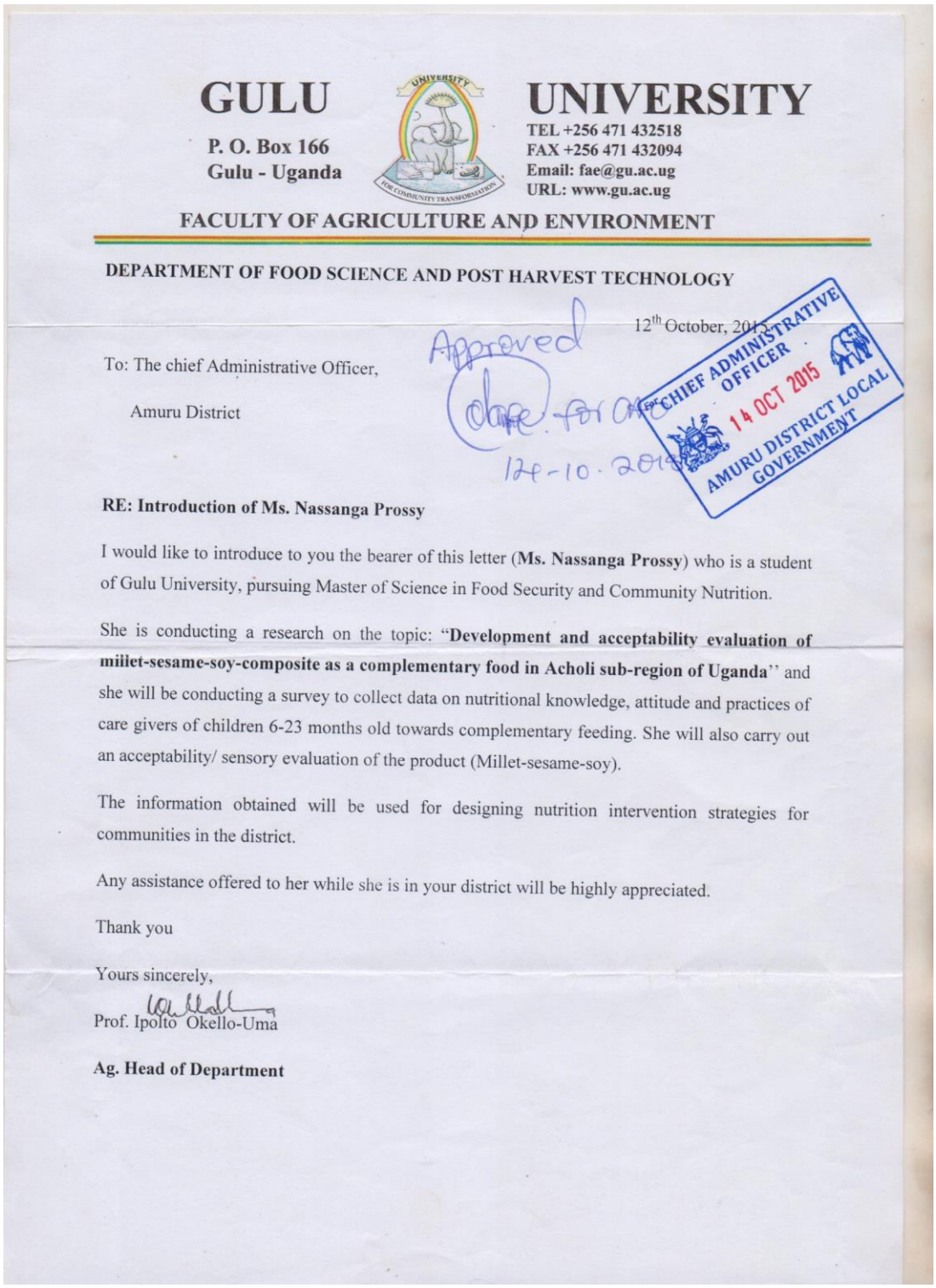
1. Dislike very much

Attribute	**Formulation 31: Label ….**	**Formulation 32: Label….**	**Formulation 33: Label….**
Taste			
Mouth feel			
Aroma			
Thickness			
Color/Appearance			
Overall acceptability			

END

Thank you very much.

3.1 Permission to conduct research in Amuru district



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FACULTY OF AGRICULTURE AND ENVIRONMENT

DEPARTMENT OF FOOD SCIENCE AND POST HARVEST TECHNOLOGY

12th October, 2015

Approved done for CAO 12-10-2015

FOR CHIEF ADMINISTRATIVE OFFICER 14 OCT 2015 AMURU DISTRICT LOCAL GOVERNMENT

To: The chief Administrative Officer,

Amuru District

RE: Introduction of Ms. Nassanga Prossy

I would like to introduce to you the bearer of this letter (**Ms. Nassanga Prossy**) who is a student of Gulu University, pursuing Master of Science in Food Security and Community Nutrition.

She is conducting a research on the topic: "**Development and acceptability evaluation of millet-sesame-soy-composite as a complementary food in Acholi sub-region of Uganda**'' and she will be conducting a survey to collect data on nutritional knowledge, attitude and practices of care givers of children 6-23 months old towards complementary feeding. She will also carry out an acceptability/ sensory evaluation of the product (Millet-sesame-soy).

The information obtained will be used for designing nutrition intervention strategies for communities in the district.

Any assistance offered to her while she is in your district will be highly appreciated.

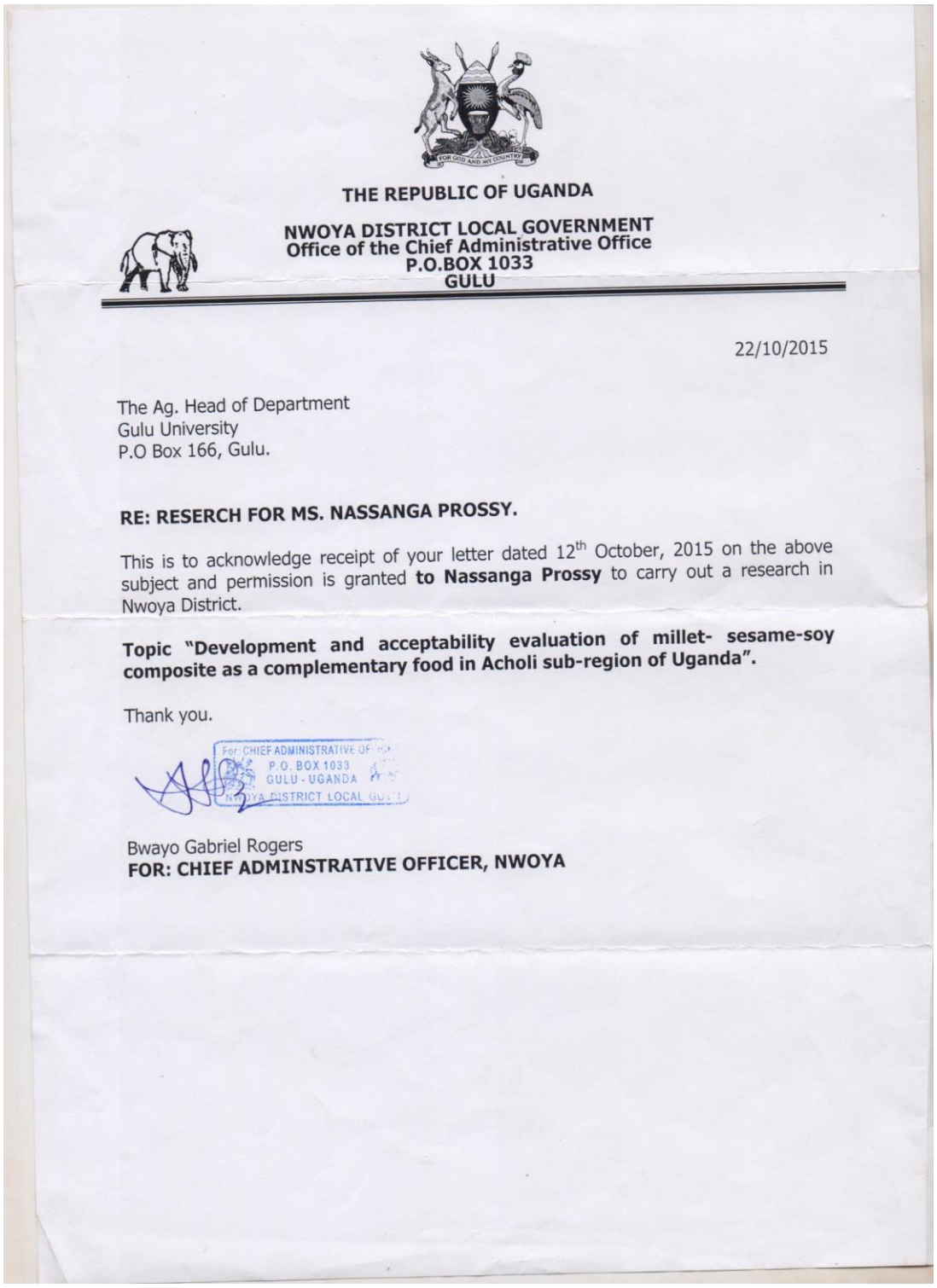
Thank you

Yours sincerely,

Prof. Ipolto Okello-Uma

Ag. Head of Department

3.2 Permission to conduct research in Nwoya district



THE REPUBLIC OF UGANDA

NWOYA DISTRICT LOCAL GOVERNMENT
Office of the Chief Administrative Office
P.O.BOX 1033
GULU

22/10/2015

The Ag. Head of Department
Gulu University
P.O Box 166, Gulu.

RE: RESERCH FOR MS. NASSANGA PROSSY.

This is to acknowledge receipt of your letter dated 12th October, 2015 on the above subject and permission is granted **to Nassanga Prossy** to carry out a research in Nwoya District.

Topic "Development and acceptability evaluation of millet- sesame-soy composite as a complementary food in Acholi sub-region of Uganda".

Thank you.

For: CHIEF ADMINISTRATIVE OFFICER
P.O. BOX 1033
GULU - UGANDA
NWOYA DISTRICT LOCAL GOVT

Bwayo Gabriel Rogers
FOR: CHIEF ADMINSTRATIVE OFFICER, NWOYA