CONTRIBUTION OF FISH IN IMPROVING MICRONUTRIENTS CONTENT IN COMPLEMENTARY FOODS FOR CHILDREN AGED 6 TO 23 MONTHS IN LINDI RURAL

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ABSTRACT

Lindi region has high stunting prevalence (35.2%), and one of the stunting attributors is inadequate intake of micronutrients for children under 2 years old. Therefore, aim of this study was to assess contribution of fish in improving micronutrients contents in complementary foods for children aged 6 to 23 months old children in Lindi Rural. A cross-sectional study was done whereby, an interview was done (through structured questionnaire) to 212 caregivers with children aged 6 to 23 months at Mchinga ward. Information collected included children's feeding practices as well as fish availability and consumption among children. Also, laboratory analysis for zinc, iron and vitamin A contents and proximate composition was done for both fish and non-fish based complementary foods. Results of present study revealed that exclusive breastfeeding was poorly practiced in the study area as 48.6% of children were introduced to complementary foods prior the age of 6 months. About 89.2% of children were given fish based complementary foods. On average fish based complementary foods have higher vitamin A concentrations (342 mcg RE/100g serving) compared to non-fish based complementary foods (4 mcg RE/100g serving), but low in iron and zinc concentrations (0.66 and 0.067 mg/100g serving respectively) than non-fish based complementary foods (0.74 and 0.074 mg/100g serving respectively). Moreover, fish based complementary foods had higher proximate composition (except for % moisture content) compared to non-fish based complementary foods. Among the fish based complementary foods, those with *dagaa* (*Sardinella longiceps*) and *tasi* (*Siganus sutor*) type of fish were observed to have higher micronutrients concentration than those with *kibua* (*Rastrelliger kanagurta*). In general, fish based complementary foods contributes

significantly on both macro and micronutrients concentration. Therefore, consumption of fish based complementary foods among children should be promoted.

DECLARATION

I, HOPE MASANJA, do hereby declare to neither the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution for a degree award.

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LIST OF ABBREVIATIONS AND SYMBOLS

AA	Atomic Absorption
AAS	Atomic Absorption Spectrophotometer
AOAC	Association of Official Analytical Chemists
DFTNCS	Department of Food Technology, Nutrition and Consumer Sciences
FAO	Food and Agriculture Organization
g	gram
IZiNCG	International Zinc Nutrition Consultative Group
kcal	kilocalories
mcg	microgram
mg	milligram
NBS	National Bureau of Statistics
^{o}C	Degree Celsius
OCGS	Office of Chief Government Statistician
ORS	Oral Rehydration Solution
PAHO	Pan American Health Organization
RDI	Recommended Daily Intake
RE	Retinal Equivalent
SUA	Sokoine University of Agriculture
UNICEF	United Nations Children's Fund
URT	United Republic of Tanzania
UV	Ultraviolet
WF	World Fish
WFP	World Food Programme
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Under nutrition is still a problem in developing countries, especially high prevalence of stunting which signifies chronic undernutrition in general (Save the Children, 2014). Undernutrition can permanently impair a child's physical and cognitive development. The damage often leads to poorer school performance, hence future income reductions. These children are also at increased risk of illness and disease in their adulthood (UNICEF, 2012).

In Tanzania mainland the rate of stunting for children between 0-59 months of age is currently 34.7% (NBS and ICF Macro, 2015). According to WHO (2016) countries with stunting prevalence range from 30% to 39% in a population are categorized as having high prevalence. Stunting can be prevented or corrected during pregnancy and before the age of 2 years (first 1000 days of life) through giving children good quality diets and basic health care (Weise, 2012). Dietary energy forms the biggest proportion of complementary foods for children in the developing countries, but with low micronutrients levels causing micronutrient deficiency (Greco *et al.,* 2006). Meeting micronutrients requirements during the early days of life contributes in preventing and correcting stunting (Imdad and Bhutta, 2012). Among others, adequate intake of vitamin A, zinc, iron and universal promotion of iodized salt is essential in stunting reduction (Bhutta *et al.,* 2008).

Adequate intake of zinc has a positive effect on length growth, especially in children under 2 years of ages (Wieringa *et al.,* 2015). Iodine and iron are known to be essential for metabolic rate, development of body structures and neuronal maturation, in case of deficiency in early life stages it can lead to brain damage in children (Rydbeck *et al.,* 2014). Deficiency of iron may also lead to anemia. Vitamin A intake is essential for the immune system and reduce the child’s risk of contracting and dying from infections like measles, and diarrheal illness (Mason *et al.,* 2014).

These micronutrients can be accessible to the child through breast milk and the complementary foods when breast milk alone is no longer sufficient to meet nutritional requirements. Timely introduction of appropriate complementary foods promotes good nutritional status and growth in infants and young children (Ijarotimi, *et al.,* 2013). Unfortunately, most complementary foods in Tanzania are usually cereal based with little or no vegetables and often lacking animal proteins hence low in micronutrient levels (Zimmermann *et al.,* 2007).

Researches have demonstrated and strongly emphasized on food based approaches as best and sustainable strategies in improving micronutrient status of populations (Blasbalg *et al.,* 2011; Gibson *et al.,* 2000; Underwood, 2000). These include food production, dietary diversification and food fortification. Also, multiple micronutrient interventions with a minimum of three micronutrients (iron, zinc and vitamin A) most important in child growth and development have shown a promising effects on linear (Souganidis, 2012).

1.2 Problem Statement and Justification

Currently in Lindi region, prevalence of stunting is 35.2% for under-five years children which is more than the national prevalence of 34.7% (NBS and ICF Macro, 2015). Vitamin A deficiency in Lindi is at 30.8% and anaemia at 61.1% (NBS and ICF Macro, 2015). Although the information about zinc is limited, according to IZiNCG (2004) estimates, 37.5% of the population in Tanzania is at risk of inadequate zinc intake, which places Tanzania in the 'high' risk category for zinc deficiency. In addition consumption of iodized salt is still a problem in Lindi region (Save the Children, 2014). The basic causes of micronutrient deficiencies are related to diet, where poor people are highly affected because of not consuming sufficient amount of nutrient rich foods (Longley *et al.,* 2014). In Lindi, 55% of population rely on food purchase, and this is being offset by own production, gifts and food aid as an important source of food making 21.4% of the households vulnerable to food insecurity (WFP, 2007). This contributes to micronutrients deficiency problems among individuals especially children in Lindi.

Complementary feeding strategies have been linked with a reduction in stunting, in food insecure populations (Souganidis, 2012). Promoting fish based complementary foods in fishing communities is important because, fish is the major source of animal protein for the poor people especially in coastal areas. Fish is an irreplaceable animal source especially for the species that are consumed as whole such as sardines as they provide essential nutrients including the micronutrients of high bioavailability which are found in limiting amounts in the diet (Kawarazuka, 2010). Fish consumption can be used as a cost effective food based strategy to enhance micronutrient intake in vulnerable populations in Lindi. Therefore, it is important to assess the contribution of fish species available at Lindi on micronutrients intake which are essential for growth of children 6 to 23 months old. Through this study we will be able to obtain the information about the gap existing as far as child nutrition and fish consumption is concerned which will be used to improve the quality of the currently used complementary foods by the nutritionists.

1.3 Objectives

1.3.1 General objective

Assessment of iron, zinc and vitamin A contents in fish and non-fish based complementary foods commonly used for 6 to 23 months old children in Lindi Rural District.

1.3.2 Specific objectives

i. To assess feeding practices for children aged 6-23 months in Lindi Rural District
ii. To assess iron, zinc and vitamin A contents in non-fish based commonly used complementary foods in Lindi Rural District.
iii. To assess iron, zinc and vitamin A contents in commonly used fish based complementary foods in Lindi Rural District.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 General Information

The child's nutrition starts to be built up while still on mother's womb, therefore pregnant women are recommended to eat healthy and live a healthy lifestyle. After birth, it is recommended that mothers initiate breastfeeding within one hour of birth (Thapa, 2005) and practice exclusive breast feeding for the first six months of life in order to achieve optimal growth, development and health. This is because, before six months mother's breast milk is enough to provide all nutrients essential for the child growth. The mother is also required to eat healthily since maternal nutritional status can affect the secretion of some micronutrients to be available into the milk for the child, including thiamine, riboflavin, vitamin A, vitamin B6, vitamin B12, iodine and selenium (WHO, 1998). Breastfeeding frequency of 8 to 12 times per day is required for the child under six months so as to ensure the child meet nutritional requirements. From 6 months and above breastfeeding frequencies can be reduced after introducing complementary foods which should be nutritionally adequate and safe. Continued breastfeeding is very important in the first two years of life, and its nutritional impact is most evident during periods of illness, when the child's appetite for other foods decreases but breast milk intake is maintained. It thus plays a key role in preventing dehydration and providing the nutrients required for recovery from infections (PAHO and WHO, 2003). After six months of age, it becomes difficult for breastfed infants to meet their nutrient needs from breast milk alone. Furthermore, most infants are developmentally ready for other foods to meet their nutritional needs (Naylor and Morrow, 2001). Thus, six months is the appropriate age for introducing complementary foods.

2.2 Complementary Foods

Complementary food is the food given to the child when breast milk alone is no longer sufficient to meet his/her nutritional requirements and therefore other foods and liquids are needed, along with breast milk. Complementary foods given to the child should be of good quality balanced meal composed of foods from all groups to ensure nutrient needs are met. Meat, poultry, fish or eggs should be eaten daily, or as often as possible. Vitamin A-rich fruits and vegetables should also be eaten daily as well as providing diets with adequate fat content (PAHO and WHO, 2003). It is recommended to introduce children to complementary foods starting with one type of food to another, in order for the child to adopt tastes of different foods independently and to be able to trace which food causes allergic reactions to the child if any.

When a child is six months an infant can eat pureed, mashed and semi-solid foods can be given on the 8th month most infants can also eat “finger foods” (that a childcan pick and eat). When the child is 12 months, most children can eat the same types of foods as consumed by the rest of the family foods (PAHO and WHO, 2003). WHO, 2005 recommends that a breastfed infant who is healthy breastfed on average should be provided with complementary foods 2-3 times per day at 6-8 months of age and 3-4 times per day at 9-11 and 12-24 months of age, with additional nutritious snacks (such as a piece of fruit or bread or chapatti with nut paste) offered 1-2 times per day, or as desired. If energy density or amount of food per meal is low, or the child is no longer breastfed, more frequent meals may be required (PAHO and WHO, 2003). In order to meet the infant’s requirements and abilities gradual increase of food varieties as the infant gets older is important (WHO, 2005). It is recommended that the caregiver should make sure that the child eats healthy by ensuring that their meals contain five food groups in appropriate amount required by the body (FAO, 2014). In addition to that drinks with low nutrient value, such as tea, coffee and sugary drinks such as soda should be avoided (WHO, 2005).

In rural areas, undernutrition not only occurs during the lean season when households run out of food stocks but also during harvesting season due to the poor food choices of infants' complementary foods (NBS and ICF Macro, 2011). Tanzania is dependent on cereal and non-cereal based traditional complementary foods such as maize, sorghum, millet, rice, cassava, potatoes, yams and plantains (Mosha *et al.,* 2000). In Tanzania for example, plain maize porridge, finger millet, rice and peanut composite flour porridge, observed to be the main complementary foods given to children aged 3 to 23 months (Mamiro *et al.,* 2005) with very few families including beans and sardines in their children's complementary foods. Which causes limited micronutrients intake hence micronutrients deficiencies problems, with iron, zinc, iodine and vitamin A being micronutrients of public health concern (URT, 2015a).

2.3 Initiatives to Improve Micronutrients Intake in Tanzania

Due to high stunting rate, Tanzania has been taking various measures to improve the micronutrients intake. There is universal salt iodization for improving iodine intake, however, not all individuals consume iodized salt as reported by NBS and ICF Macro (2011), many people from salt extraction areas including Lindi do not consume iodized salt. Vitamin A supplementation after every six months for under-fives is done so as to reduce the risks of vitamin A deficiencies. However, it has been observed that the proportion of children given vitamin A supplementation is high in urban than rural areas. In addition iron and zinc supplementation coverage is generally low in the country in which zinc is always given in form of ORS to children who experiencing diarrhea (NBS and ICF Macro, 2011). Moreover, there is promotion of food fortification in maize flours, wheat flours and rice with folic acid, iron and zinc.

While undernourishment can be improved by increasing energy intake, the problem of micronutrient deficiencies is of a different nature as it results from an inadequate quality of diet (Allen, 2006). Therefore, improvement of the diet quality of the Tanzanian complementary foods in terms of micronutrients is very important with food based approach as the preferable strategy. Food based approach in addition to breastfeeding will ensure the adequate and reliable intake of micronutrients hence meeting their respective recommended daily intake (RDI) for the children as well as improving their nutritional status.

2.4 RDI for Micronutrients of Public Health Importance

Referring to micronutrients of public health concern children's nutrients requirements per day for vitamin A, iron and zinc are 350 mcg RE vitamin A, 11 mg iron and 5 mg zinc for a normal 6 to 8 months child, 350 mcg RE, 11 mg and 5 mg respectively for a normal 9 to 11 months child, and 400 mcg RE vitamin A, 6 mg for iron and 6.5 mg zinc for a normal 12 to 24 months child. On average the RDIs for 6 to 59 months old children are approximately 400mcg RE, 10mg, 4.1mg and 90µg for vitamin A, iron, zinc and iodine respectively (WHO and FAO, 2004)**.** Also, key micronutrients supplements (iron, zinc, calcium and vitamin A) need to be given if diets are plant-based.

2.5 Use of Fish as Composite in Complementary Foods

Various interventions by using food based strategy have been done. Some of the interventions promote production and consumption of locally available nutritious foods instead of supplement distribution as a sustainable way of tackling micronutrient deficiencies (Roos *et al.,* 2007). Due to high micronutrients levels found in fish as reported by Michaelsen *et al.* (2009) some food based interventions used different fish species in complementary foods formulations though limited in number. A study conducted in Ghana on the nutritional role of local fish in complementary food showed the potential role of local fish to improve infant growth. The fish powder from smoked small fish mixed with local fermented maize porridge supported growth of infants to the same extent as a cereal legume blend with vitamin and mineral fortified supplement (Davis *et al.,* 2003). Another study in Uganda utilized local dried fish, mukene (Rastrineobolaargentea) mixed with maize porridge to feed undernourished children. It showed better outcomes in terms of nutritional status than the diet of imported skimmed milk that are usually used for undernourished children in hospitals (Greco *et. al.,* 2006).

A study by Konyole *et al.* (2012) in Kenya showed that fish based complimentary food was less accepted compared to other complimentary foods formulations. In addition, the inclusion of sugar was observed to be important on acceptability of product by targeted groups (Konyole *et al.,* 2012). Also, mother's acceptability influences the child's acceptability of the complimentary food hence fish based complementary foods consumption by the children is possible.

2.6 Nutritional Importance of Fish in Developing Countries

Fish is among important foods in the first 1000 days of life since it contains multiple nutrients for growth, development and wellbeing, and specifically as a source of essential fats for brain development and cognition (Longley *et al.*, 2014). Apart from essential fats other nutrients include animal protein, vitamins and an excellent source of many essential minerals such as iodine, selenium, zinc, iron, calcium, phosphorus, potassium, vitamins A and D, and several B vitamins, especially for small sized species consumed whole with heads and bones. Fish enhances the bioavailability of iron and zinc from the other foods in a meal. Sea fishes are almost the only natural source where iodine, iron and zinc are found in significant amounts (WF, 2011) whereby, adequate intake of zinc has a positive effect on length growth, especially in children under 2 years of ages (Wieringa *et al.*, 2015). Iodine together with iron are essential for controlling metabolic rate, development of body structures and neuronal maturation (Rydbeck *et al.*, 2014) which play part in preventing anemia as well as brain damage. Vitamin A intakes are essential for the immune system and increase the child's risk of contracting and dying from infections like measles, and diarrheal illness (Ash, 2011). In addition, small sized dried fish when consumed with plant based diets tends to enhance the content and bioavailability of iron, zinc and calcium (R. S. Gibson et al., 2000). Therefore, utilizing locally available small sized fish has the potential as a food based strategy to enhance micronutrient intakes hence reduce the risk of stunting among children.

2.7 Importance of Micronutrients of Interest

2.7.1 Importance of zinc in the body

Zinc is among essential micronutrient in child growth and development. It plays a central role in cellular growth, differentiation and metabolism (Petry *et al.*, 2016). It is able to constitute strong, but readily exchangeable and flexible complexes with organic molecules, thereby enabling it to modify the three-dimensional structure of nucleic acids, specific proteins, and cellular membranes and influence the catalytic properties of many enzyme systems and intracellular signaling (Brown *et al.*, 2001). It is also associated with more than 50 distinct metalloenzymes, which have a diverse range of functions, including the synthesis of nucleic acids and specific proteins, such as hormones and their receptors. Zinc is especially important during periods of rapid growth, both pre and postnatal, and for tissues with rapid cellular differentiation and turnover, such as the immune system and the gastrointestinal tract. Critical functions that are affected by zinc nutriture include pregnancy outcome, physical growth, susceptibility to infection, and neurobehavioral development, among others. Brown *et. al.*, 2001 reported a small but highly significant impact of zinc supplementation on children's height increases, with an average effect size of 0.22 standard deviation. Therefore, it is evident that zinc adequacy is important in child's growth and development hence playing important role stunting reduction.

In addition to that, it has been observed that continuous zinc supplementation produces substantial and consistent reductions in both diarrhea and acute lower respiratory infections. Because of the known negative association between diarrheal prevalence and growth velocity, it is conceivable that zinc therapy might also reduce the impact of these illnesses on growth. (Brown *et. al.*, 2001).

2.7.2 Importance iron in the body

Iron has several vital functions in the body. It serves as a carrier of oxygen to the tissues from the lungs by red blood cell haemoglobin, as a transport medium for electrons within cells, and as an integrated part of important enzyme systems in various tissues. Most of the iron in the body is present in the erythrocytes as haemoglobin, a molecule composed of four units, each containing one haem group and one protein chain. The structure of haemoglobin allows it to be fully loaded with oxygen in the lungs and partially unloaded in the tissues (for example, in the muscles). The iron-containing oxygen storage protein in the muscles, myoglobin, is similar in structure to haemoglobin but has only one haem unit and one globin chain. Several iron-containing enzymes, the cytochromes, also have one haem group and one globin protein chain. These enzymes act as electron carriers within the cell and their structures do not permit reversible loading and unloading of oxygen. Their role in the oxidative metabolism is to transfer energy within the cell and specifically in the mitochondria. Other key functions for the iron-containing enzymes (for example, cytochrome P450) include the synthesis of steroid hormones and bile acids; detoxification of foreign substances in the live and signal controlling in some neurotransmitters (WHO and FAO, 2004).

With respect to the mechanism of absorption, there are two kinds of dietary iron: haem iron and non-haem iron. In the human diet, the primary sources of haem iron are the haemoglobin and myoglobin from consumption of meat, poultry, and fish whereas non-haem iron is obtained from cereals, pulses, legumes, fruits, and vegetables. The average absorption of haem iron from meat-containing meals is about 25%. The absorption of haem iron can vary from about 40% during iron deficiency to about 10% during iron repletion. Haem iron can be degraded and converted to non-haem iron if foods are cooked at a high temperature for too long. Calcium is the only dietary factor that negatively influences the absorption of haem iron and does so to the same extent that it influences non-haem iron (WHO and FAO, 2004).

Reducing substances must be present for iron to be absorbed. The presence of vitamin C, meat, poultry, and fish in the diet enhance iron absorption. Other foods contain chemical entities that strongly bind ferrous ions, and thus inhibit absorption. Examples are phytates and certain iron-binding polyphenols. In addition to that, Gibson and Ferguson, 2008 suggest dietary assessment as a field applicable method for determining the adequacy of dietary zinc (and iron) intakes in developing countries.

2.7.3 Importance of vitamin A in the body

Vitamin A is an essential nutrient required for maintaining immune function, eye health, vision, growth and survival in human beings (Rice *et al*., 2004). Vitamin A deficiency (VAD) is defined as tissue concentrations of vitamin A low enough to have adverse health consequences even if there is no evidence of clinical xerophthalmia. In addition to the specific signs and symptoms of xerophthalmia and the risk of irreversible blindness, non- specific symptoms include increased morbidity and mortality, poor reproductive health, increased risk of anaemia, and contributions to slowed growth and development. VAD is most common in populations consuming most of their vitamin A needs from provitamin carotenoid sources and where minimal dietary fat is available. About 90% of ingested preformed vitamin A is absorbed, whereas the absorption efficiency of provitamin A carotenoids varies widely, depending on the type of plant source and the fat content of the accompanying meal. Where possible, an increased intake of dietary fat is likely to improve the absorption of vitamin A in the body (WHO and FAO, 2004). Many more preschool-age children, and perhaps older children and women who are pregnant or lactating, have their health compromised when they are subclinically deficient. In young children, subclinical deficiency and like clinical deficiency, increases the severity of some infections, particularly diarrhea and measles, and increases the risk of death (FAO and WHO, 2001).

To express the vitamin A activity of carotenoids in diets on a common basis, retinol equivalent (RE) was introduced and established the following relationships among food sources of vitamin A:

1 mg retinol = 1 RE 1

1 mg β-carotene = 0.167 mg RE

1 mg other provitamin A carotenoids = 0.084 mg RE (WHO and FAO, 2004).

2.8 Anti-nutritional Factors

Anti-nutritional factors are defined as those substances generated in natural foods by the normal metabolism and by different mechanisms (for example inactivation of some nutrients, diminution of the digestive process or metabolic utilization of feed) which exerts effect contrary to optimum nutrition. Anti-nutritional factors are substances which can cause detrimental effects to humans growth and performance either by themselves or through their metabolic products, interfere with food utilization or affect the health of human body or which act to reduce nutrient intake, digestion, absorption and utilization and may produce other adverse effects (Tadele, 2015).

The anti-nutritional factors mainly occur in pulses and grain legumes, leaving fish to be a safe food to consume as far as anti-nutritional factors are concerned. Their elimination can be achieved either by selection of plant genotype with low levels of such factors or through post-harvest processing (germination, boiling, leaching, fermentation, extraction etc.). One of the common anti-nutritional factors is phytates. Since, phytates contains complex zinc, iron, magnesium and calcium ions in the digestive tract, they can cause mineral ions deficiency in human. Phytate content of food can be lowered by addition of enzymes which hydrolyze them (Bora, 2014).

Thiaminases are other anti-nutritional factors, they are found in raw fish and are enzymes which destroy vitamin B1 or thiamine. Thiaminase is destroyed by heat treatment and also by the acidification. Those individuals who practice the fashion of eating raw fish in the form of sushi are susceptible to it (Dong *et al.*, 2000).

2.9 Fish Consumption and Allergic Reactions

Food allergy is the consequence of maladaptive immune responses to common and otherwise innocuous food antigens. The most common allergenic foods are cow's milk and dairy products, hen's egg, peanuts, nuts, gluten containing cereals (for example, wheat, rye, barley), sesame, soybeans, mustard, fish, crustaceans and shellfish. Even though data on food allergy prevalence rates in Africa is limited, some studies shows that approximately 10% of 14 000 patients of all ages referred to the only specialist allergy clinic in Harare, Zimbabwe, in the 5-year period from September 1997 to September 2002, were reportedly diagnosed with fish allergies.

Children have been observed to be at even greater risk for adverse reactions with rush immunotherapy (Hossny *et al*., 2010). Apart from that, in many other studies carried in Africa, fish has been observed to always be among the foods causing allergies (Boye, 2012). Although the majority of victims are experience allergic reaction to multiple fish species, the following are some of the fish species frequently reported causing allergic reactions in Africa are anchovies, catfish, codfish, hake, mackerel, salmon, snoek, tuna and yellow tale (Sharp and Lopota, 2014).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Area

The study was conducted in Lindi rural district, which is one of the 6 districts in Lindi Region which covers a total area of approximately 6979 km^2 with a population of 194 143 (URT, 2014). Administratively, it is divided into 10 divisions and a total of 28 wards. It is bordered to the North by the Kilwa district, to the South by Mtwara region, to the West by Ruangwa district, and to the East by the Indian Ocean and the Lindi municipal (NBS and OCGS, 2016). About 95% of the population is dependent on agriculture which is mainly subsistence, growing staples and horticultural crops (Eaton, 2014). Livestock production mostly based on traditional husbandry practices and fishing activity along the coastal villages (URT, 2015b). Thus fishing makes community involved in fishing less pertinent to hardship during drought seasons because fishing activity is carried throughout the year (NBS and OCGS, 2016).

3.2 Study Design

This was cross-sectional, which involved collecting dietary data from a selected population. It involved collection of information on frequently used complementary foods, which were then cooked in the traditional way and analyzed for zinc, iron and vitamin A concentration.

3.3 Sampling Procedure

Simple random sampling was used to select Lindi rural district among other districts practicing fishing activities. Then one division named Mchinga among the three divisions that are located along the Indian Ocean practicing fishing activity and one ward called Mchinga was involved in the study. Mother-child pairs (children aged 6-23 months) from two villages were selected randomly from the list of villagers in local village offices in Mchinga ward.

3.4 Sampling Frame

Female caregivers with children age 6-23 months participated in the study with many of them being from Mchinga 1 village. Selection of sampling frame based on the involvement of females in children's and family food preparations based on cultural context of African/Tanzanian populations (Owen, 2003) and the involvement of children 6-23 months was because this age is the window of opportunity where malnutrition can be corrected or/and prevented.

3.4.1 Inclusion criteria

Female caregivers with children 6-23 months permanently residing in Lindi rural district at least in past 12 months were included in the study.

3.4.2 Exclusion criteria

All female caregivers who are either visitors or currently migrated to the district regardless of having children with 6-23 months were not included in the study.

3.5 Sample Size

According to Kothari (2004), sample size was calculated taking into consideration the percentage of children (86.4%) aged 6 to 23 months in Tanzania who are breastfeeding and consuming complementary foods (NBS and ICF Macro, 2015), at

95% confidence interval with 5% allowable margin of error. A total of 180 mother-child pair were included in the study (Appendix 1). As a precaution that attrition may occur 32 mother-child pair were added to the study population giving total of 212 female caregivers to be included in the study with majority (57.5%, n = 121) of them being from Mchinga 1 village and the rest from Mchinga 2 village.

3.6 Data Collection

3.6.1 Data collection tools

Questionnaire with semi structured questions was used as the tool for data collection, (Appendix 3). The data collected included the demographic information, child feeding practices and food availability information. For validity reasons, prior to data collection the questionnaire was pre-tested among 10 individuals with similar characteristics as the sample population in Mchinga 1 village in Lindi rural district. Data obtained from pre testing were not included in the analysis. Questionnaire was then administered through face to face interview with the female caregiver.

3.6.2 Actual data collection

Demographic information for child and child's caregiver information such as age, gender, child-caregiver relationship, marital status, occupation, education level and average income of the caregiver were included. Feeding practices information included the frequency of feeding, modes of feeding and types of food as well as the ingredients used. Some of the feeding practices information was also obtained through assessing the dietary intake of the children by the use of 24 hours dietary recall of the child as well as dietary diversity chart. The information obtained was also useful on assessing the dietary diversity and fish consumption. Information on the availability of foods which are used in complementary foods preparation and information about the type of fish available in Lindi rural district was also obtained.

3.6.3 Nutrients intake determination

The information obtained from the 24 hours dietary recall was also used to calculate the amount of protein, energy, zinc, iron and vitamin A consumed by the child. This was done by comparing the amount of the commonly consumed complementary food and amount of each micronutrient under the study per 100 g serving. Then the values obtained were put against their recommended daily allowance (RDI) (WHO and FAO, 2004) for each specific nutrient. Thereafter, the information about whether the children meet or do not meet their RDI's was obtained.

3.6.4 Dietary diversity

The information obtained from the dietary diversity chart was supposed to be used to provide information about the dietary diversity of the study population. It is achieved by finding the minimum dietary diversity indicator which is calculated as the percentage of children aged 6-23 months who receive foods from four or more food groups. Unfortunately, this formula was not applicable to this study because children did not meet the minimum requirement of consuming at least four food groups per day.

$$\text{Minimum dietary diversity indicator (FAO, 2014)} = \frac{\text{Number of children aged 6–23 months who received food from four or more food groups during the previous day}}{\text{Number of children aged 6–23 months}} \times 100$$

Breast milk is not included among the food groups; this indicator reflects the quality of the complementary foods.

3.6.5 Complementary foods preparation

The common complementary foods consumed by the children aged 6-23 months were obtained by using 24 dietary recalls in which information on foods with highest frequency for both fish based and non-fish based were obtained. About 17 food samples were prepared using various ingredients (Appendix 4) and after preparation the samples were cooked. Cooking included 5 different types of porridge with different composite flour but without fish and 12 different fish based complementary foods depending on the types of fish mostly consumed at the study area.

Table 1: Summary of cooked complementary food samples for laboratory analysis

Number of samples	Food sample	Varieties
1	Unrefined maize porridge (UM)	
2	Cassava porridge (C)	
3	Refined maize porridge (RM)	
4	Unrefined maize porridge, millet, beans and rice (UMMBR)	
5	Unrefined maize porridge, millet, groundnuts and rice (UMMGR)	
6	Boiled fish (BF)	*Dagaa, Tasi, Kibua*
7	Fish stew with stiff porridge (FSSP)	*Dagaa, Tasi, Kibua*
8	Fish with irish potatoes (PTF)	*Dagaa, Tasi, Kibua*
9	Fish with green bananas (BNF)	*Dagaa, Tasi, Kibua*

* *Dagaa* (*lupapa* type) – English named as Indian oil sardine (*Sardinella longiceps*)
* *Tasi* – English named as Rabbit fish (*Siganus sutor*)
* *Kibua* – English named as Indian mackerel (*Rastrelliger kanagurta*) (FAO, 1983)
* The abbreviations will be used in the text

3.6.5.1 Preparation of non-fish based complementary foods

All the grains were sorted, winnowed, washed, sundried for 8 hours and then mixed together (for those required mixing) in appropriate ratios (Appendix 4) and milled ready for cooking. Only two composite flour (UMMBR and UMMGR) were prepared, while the rest were single ingredient flour. Cassavas were pilled, washed, chopped into slices and then sun dried for 8 hours and then milled.

Table 2: Steps for processing flour for non-fish based complementary foods

	Pill	Sort	Winnow	Wash	Chop	Sundry	Refine	Mill
Maize		√	√	√		√	√	√
Maize		√	√	√		√		√
Millet		√	√	√		√		√
Rice		√	√	√		√		√
Groundnuts		√	√	√		√		√
Beans		√	√	√		√		√
Cassava	√			√	√	√		√

3.6.5.2 Preparation of fish based complementary foods

Potatoes and onions were pilled, washed and then chopped ready for cooking. Tomatoes were washed, pilled and then chopped. The lemons were washed, cut and lemon juice was squeezed out. Each type of fish was washed to remove internal unwanted matters as well as the externals. Then salt and lemon juice were added to the fish ready to be cooked with respect to the kind of dish to be prepared.

Table 3: Steps for processing flour for fish based complementary foods

	Pill	**Wash**	**Chop**	
Potatoes	√	√	√	
Bananas	√	√	√	
Onions	√	√	√	
	Wash	**Cut**	**Pill**	**Chop**
Fish	√	√		
Lemon	√	√		
Tomatoes	√		√	√

3.6.5.3 Cooking procedures

The ready prepared food ingredients were then cooked accordingly using aluminum pots, wooden cooking spoon and firewood as source of heat. All of the non-fish based complementary flour, were cooked as porridge by boiling method for 30 minutes on average.

For fish based complementary foods, there were four different dishes to cook, using three different fish varieties for each. For the case of boiled fish, all three types of fish were put in three separate pots. Then water was added into them and placed on the firewood stove. For green banana dishes depending on the type of fish used, the bananas were put on the pans, together with onions and tomatoes. Left on firewood stove for some time to boil (20 minutes on average), and then the respective type of boiled fish and coconut cream were added to it. The same was done for the potatoes. For the last type of dish, stiff porridge was prepared using unrefined maize flour and it was relished by fish stew in which fish was boiled separately and then added with tomatoes, onions and coconut cream. All the complementary foods were prepared and cooked under the same procedure to all age groups within the targeted population.

Cooked complementary foods samples were left to cool. Then samples were taken in small clean plastic containers in duplicate and placed into the cool box filled with ice packs. The samples were transported to the Department of Food Technology, Nutrition and Consumer Sciences (DFTNCS) laboratory at Sokoine University of Agriculture (SUA) in Morogoro for proximate analysis as well as iron, zinc and vitamin A analysis.

3.6.6 Laboratory analysis

Samples collected and taken to the DFTNCS, were received and stored in the laboratory freezer (-40°C) for 12 hours. Samples were then ground to ensure homogeneity and subjected into procedures for proximate analysis following AOAC (1995) method No 925.10. Other samples were subjected into procedures for minerals content (iron and zinc) determination following AOAC (1995) method No. 968.08, by Atomic Absorption Emission Spectrophotometer (AA 630-12). Total vitamin A for both β-carotene and retinol content were determined using ultra-violet visible spectrophotometer. Each analysis was conducted in duplicate.

3.6.6.1 Mineral contents

Minerals (zinc and iron) were analyzed as described in Pearsons, 1975 where by 5g of the homogenized water bath warmed sample was mixed with 10ml concentrated nitric acid, slowly boiled and evaporated down to 5ml on a hot plate and left to cool. The sample was then filtered using No. 1 Whatman filter paper into 100ml volumetric flask and diluted to 100ml mark using distilled water. The samples were analyzed for Iron and Zinc using Shimadzu Atomic Absorption Spectrophotometer (AAS) UNICAM 919, England.

3.6.6.2 Vitamin A (Retinol)

A measurement of 1ml of homogenized water bath warmed oil sample was taken into 22ml screw cap test tube, then 1ml of 5% pyrogallol with 1% Ascorbic acid were added followed by 2ml of 50% alcoholic Potassium hydroxide solution and vortex mixed for 15 seconds followed by the ultasonic agitation for 60 minutes at 45^{o}C. Then 2ml of distilled water was added followed by the addition of 2ml extraction mixture of n-Hexane: Ethyle acetate (90%:10%). The mixture was then vortex mixed for 15 seconds. The organic phase was transferred into another clean test tube (Lietz *et al.*, 2001). The extraction was repeated twice and organic phases combined which were then washed with 2ml solution of anhydrous sodium sulphate. The organic phase was then transferred to a clean test tube and evaporated to dryness. The dried extract was eluted with 2ml absolute alcohol, vortex mixed for 15 minutes and absorbance read at 325nm using X-Ma 3000 UV spectrophotometer.

Sample concentrations are calculated using the following equation (Craft, 2008);

$$Rc = \frac{A \times El \times 10000}{E \times S \times ET}$$

Where; Rc = Retinol concentration (mg/L)

A = Sample absorbance as read at 325 nm using UV-Visible spectrophotometer (The machine calibrated using pure ethanol as blank sample)

El = Elution volume

E = Extinction coefficient of retinol in ethanol (1850)

S = Amount of sample taken for analysis

Et = Extraction volume.

10000 = conversion factor from % to mg/l

3.6.6.3 Vitamin A (β-carotene)

A measurement of 10ml of water bath was warmed at 40^{o}C. The samples were extracted with 150ml cold acetone and poured into 30ml petroleum ether (BP 40-60^{o}C) layer, then washed with distilled water until free from any acetone (Rodriguez-Amaya and Kimura, 2004). Samples were then saponified for 12 hours with 30ml 60% Methanolic potassium hydroxide, washed with distilled water until free from potassium hydroxide by controlling the washings using phenolphthalein indicator. The clear extracted Carotenoids were then passed through the activated anhydrous sodium sulphate, collected into volumetric flask. Absorbencies were read at 450nm sin UV-Visible spectrophotometer. Standard calibration plot prepared by dissolving 10mg of standard β-carotene into 100ml dry petroleum ether, actual concentration of the obtained standard solution was determined. From this, serial dilution was prepared and absorbencies read at 450nm which was used to construct a standard plot. Samples concentrations were calculated using the obtained linear regression equation.

3.6.6.4 Fat

Thoroughly ground and well mixed sample of about 3g (W_1) was loaded in the thimble and covered by a thin layer of cotton wool. The thimble with sample was then dried in the oven and inserted into the Soxtec HT. Extraction cups were dried and pre-weighed (W_2). Then 25-50 mls of solvent was added into the cups and inserted into the Soxtec HT. Extraction was done for 15 minutes in the boiling position and for 30-45 minutes into the rinsing position. Evaporation was done for 15 minutes. The cups were then released and oven dried at 100°C for 30 minutes. From the oven, the cups were cooled in a desiccator and weighed (W_3). Fat/oil was then calculated using the following formula.

$$\% \text{ fat/oil} = \frac{W_1 - W_2}{W_3} \times 100$$

3.6.6.5 Protein

About 0.5-1 gram food sample was weighed and transferred to the clean and dry digestion tube. Also, the blank sample was prepared by digesting reagents only without sample. Thereafter 2g of mixed catalyst (Methly red and Bromocrassol green) and H_2SO_4 was added to the digestion tube with sample. Digestion tubes were placed in the digestion chamber in inclined position and heated for 1-3 hours. The samples were cooled and 75ml distilled water was added into them. Then, the sample was distilled by placing the digestion tube with the digested sample into the distilling unit. Alkaline was filled in the tank of the distillation unit and the machine was activated to dispense the alkali into the digestion tube. Then 25 ml of 4% boric acid solution was added in the receiving flask. Distillation apparatus was connected with the delivery tube dipping below the boric acid solution. Ammonia was then distilled into boric acid solution and about 150ml distillate was collected. The distillate was then titrated with 0.1 N HCL on a titrated unit.

% Nitrogen = (a – b) × Normality of acid × 14.008/Wt of sample (g) × 10

Where; a = ml of titration acid for sample

b = ml of the blank value.

% Protein = % N × Protein factor (6.25)

3.6.6.6 Fibre

An amount of 1000 ml of sulphuric acid was heated on hotplate to 95-100°C. Reweighed crucibles were loaded with samples and inserted on position in the hot extraction unit by using the holder to ensure safety. The reflectors were placed in front of the crucibles, all values were pulled to close position and cold water tape for the reflux system was opened. Then 1.25% sulphuric acid was added to the column using the funnel up to 150 ml and heat was turned on for 45 minutes. Heater was then turned off and the water suction pump was started with valves placed into vacuum position. After that process the drainage samples were washed 3 times with hot distilled water and left for drainage. Then, hot 1.25% NaOH was added into the column and the heat was turned on for 45 minutes, washed and drained again as previous. After, crucibles with samples were dried in an oven at 100°C, left to cool in the desiccator and weighed again.

$$\% \text{ fibre} = \frac{\text{Weight of residue after digestion}}{\text{Weight of original sample}} \times 100$$

3.6.6.7 Ash

Thoroughly ground samples were weighed and put in the already weighed crucibles (W_1). Then, crucibles with samples were place in the muffle furnace at 550°C for 12 hours until grey ash was obtained. Later, crucibles were cooled in the desiccator for about 45 minutes and reweighed (W_2).

$\% \text{ Ash} = W_2 - W_1 \times 100$

3.6.6.8 Carbohydrate

The amount of carbohydrate was calculated using;

% Carbohydrate = organic matter (%) – (%protein + %fat + %fibre + %moisture + %ash)

= 100 - (%protein + %fat + %fibre + %moisture + %ash)

3.6.6.9 Energy

The amount of energy was obtained using;

Energy (kcal) = (fat × 9) + (protein × 4) + (carbohydrate × 4).

3.7 Data Analysis

Collected data was entered and subjected to statistical analysis using Statistical Product and Service Solutions (SPSS) version 20 to compute for descriptive and inferential statistics. Descriptive statistics was used to measure of central tendency of different variables. Analysis of variance of the laboratory results was done at 95% confidence interval ($P \leq 0.005$).

3.8 Ethical Consideration

Ethical clearance was obtained from the ethics committee of the National Institute for Medical Research (NIMR) (Appendix 5). Permission to conduct the study was obtained from Sokoine University of Agriculture and Lindi District Executive Director. The study's purpose and objectives were explained to each participant prior to interview. Consent was sought from the subjects to affirm their willingness to participate in the study (Appendix 2). Confidentiality of the data collected was assured by making no one outside the research team able to access the information about an individual.

CHAPTER FOUR

4.0 RESULTS

This chapter presents results of the study organized into three sections; socio-demographic information, feeding practices and fish availability and micronutrient contents in complementary foods. Feeding practices include breastfeeding and complementary feeding information. Information of fish availability includes sources, availability and challenges faced on accessing them. Information on micronutrients in foods commonly consumed by children this includes amount of iron, zinc, vitamin A and proximate analysis information, as well as comparison between fish based and non-fish based complementary foods.

4.1 Socio-demographic Information

4.1.1 Caregivers' socio-demographic information

A big proportion (98.1%, n = 206) of respondents were the biological mothers of the children (Table 4). Most mothers (78.8%) had an age range of 20-29 years with mean age of 27.9±8, while (7.1%) were above 40 years and the remaining percentage of 13.9% comprised of young mothers (below 20 years) with 14 years being the youngest. Single parenting also exists in this area (25.5% single mothers), and the majority of the women were married in monogamous while a small proportion of respondents (7.1%) were married in a polygamous type of marriage. In terms of occupation levels majority (68.4%) were farmers, with majority of them having their income less than 100 000 TSh per month. The illiterate rate among the respondents was also high (33.49%) and the majority having just primary education (57.1%) with 78% finished their education more than 5 years ago. Also, the mean household size was 4.87 ± 1.8 (range 2 to 12), with majority (68.6%) of the households having members equal or less than 5.

Table 4: Socio-demographic information of the caregivers

Variables	Frequency	Percent
Age group distribution		
<20	29	13.9
20-29	97	47.1
30-39	66	31.7
<40	15	7.2
Child-caregiver relationship		
Mother	206	98.1
Others	4	1.9
Area of residence		
Mchinga 1	122	57.5
Mchinga 2	90	42.5
Marital status		
Married (monogamous)	121	57.1
Married (polygamous)	15	7.1
Widowed	1	0.5
Divorced	21	9.9
Single	54	25.5
Occupation		
Housewife	41	19.3
Farmer	145	68.4
Formally Employed	1	0.5
Self-employed	14	6.6
Farmer and self-employed	6	2.8
Farmer and livestock keeper	4	1.9
Average income per month (TSh)		
0	23	10.8
<100000	122	57.5
100000-199999	32	15.1
200000-299999	9	4.2
300000-399999	21	9.9
>=400000	5	2.4
Level of education of the caregiver		
Never gone to school	71	33.5
Primary school	121	57.1
Secondary school	19	9.0
High school	1	0.5
Age of within which caregivers finished their education		
Within 2 years	11	9.0
Within 3 to 5 years	33	27.1
More than 5 years	78	63.9

4.1.2 Children's socio-demographic information

The mean age of the children is 13.9 ± 5.1 months with majority of them in the age range of 12 to 23 months (53.1%, n = 212). More than half (52.6%) of these children were female.

Table 5: Demographic information of the children

Characteristics	Frequency	Percent
Sex of the children		
Male	100	47.2
Female	112	52.8
Age of the children		
6 to 8 months	51	24.2
9 to 11 months	48	22.7
12 to 23 months	112	53.1

4.2 Feeding Practices

4.2.1 Breastfeeding practices

At Mchinga village all children were breastfed at some point of their lives and some are still breastfeeding. Majority of these children (82.5%, n = 174) were breastfed within one hour after birth and most of them (96.7%, n = 202) were fed on colostrum. About 84.4% of mothers still breastfeed their children while 15.6% (n=34) had already stopped breastfeeding their children at the age of 18 months (25%). It was observed that early cessation of breastfeeding was contributed by the children's laziness on eating other foods, death of the child's mother, child living away from the mother, child refused the breast milk and child's sickness. Only 49.5% (n = 105) of the children were exclusively breastfed while 49.1% (n= 104) of the children were introduced to complementary foods before 6 months. In this ward the breastfeeding frequencies for majority of mothers was over 8 times or more within 24 hours. Breastfeeding of children 8 times or more per day is much practiced by the mothers with children from 6 to 11 months (56.9%).

Table 6: Breastfeeding practices

Variables	Frequency	Percent
Initiation of breastfeeding soon after delivery		
Within 1 hour	174	82.5
More than 1 hour	37	17.5
Colostrum feeding after delivery		
Yes	204	96.7
No	7	3.32
Age for breastfeeding cessation		
Within 6 to 11 months	2	5.6
Within 12 to 22 months	34	94.4
Reasons for early breastfeeding cessation		
Lazy on eating complementary foods	10	27.0
Death of the mother	2	5.4
Leaving away from the mother	3	8.11
Just decided to quit	17	46
Child refused the breast	1	2.7
Child was sick	1	2.7
The child is grown enough	3	8.11
Breastfeeding frequency within 24 hours		
1 to 4 times	6	3.7
5 to 7 times	34	20.9
8 times and above	123	75.5

4.2.2 Complementary feeding

4.2.2.1 Complementary feeding practices

In this study all children from the age of 6 months consumed other foods apart from breast milk since some of them (49.1%) were introduced to complementary foods even before the age of 6 months and almost half of the children were initiated complementary foods at their 6th month. Results of this study revealed that most of the children aged 6-8 months were being served with special prepared complementary foods (74.5%). About 50% of children aged 9-11 months are being served both family foods and special prepared complementary foods. Majority of those who are aged 12-23 months are being served with family foods (79%). More than half of the children (51.2%) were being served foods on their own plates, while 45.5% used to eat foods on the same plate with the family members. Children who were mostly served foods on their own plates are those with age of 6-8 months (40.7%). Those children who are mostly served food on the same plate with their family members are of age group 12-23 months (80.2%). In addition, most (63.5%) of the children especially those aged 6-8 months are fed either by their mothers or caregivers. Regardless of the feeding mode on practice, majority of the children (91%) are being supervised during feeding process to ensure proper feeding.

The families at Mchinga ward depend on their own production (52.1%) such as maize, sorghum, rice, fishing and other. While 30.03% of the families depends on both own production and purchase from the market. In addition to that, no child met the minimum dietary diversity of four or more food groups as far as dietary diversity is concerned, with grains, roots and tubers; vitamin A fruits and vegetables; and legumes and nuts; or flesh products mostly fish being the most food groups consumed by the children according to the 24 hours dietary recall. In the population, consumption of 1 to 4 food groups indicates “low dietary diversity”.

Table 7: Complementary feeding practices

Variables	Frequency	Percent

Age group in which complementary feeding was initiated		
At six months	105	49.5
Before six months	104	49.1
Don't know	3	1.4
Specific age in months the child was initiated complementary feeding		
1 to 3	25	12.0
4 to 5	76	36.6
6	107	51.4
If the child has a special complementary food		
Food preparation together with family members	97	46.0
Special preparation	64	29.9
Both special food and sometimes shared with the family	51	24.2
Mode of serving food to the child		
Served on his/her own plate	109	51.2
Served with the family members	96	45.5
Either his/her own plate or served with the family members	7	3.3
Child supervision during feeding		
Self-supervision	19	9.0
Assisted supervision	193	91.0

4.2.2.2 Complementary feeding frequencies

At Mchinga village more than half of the children (70.4%) were being fed main meals thrice a day. Of all children 36.9% consumed snacks 24 hours prior the study, among them 6.3% consumed both nutritious and non-nutritious snacks, while only 29.6% nutritious snacks. Also, regardless the season of the year most of the mothers provide their children with three meals per day. However, the provision of meals three times per day is more practiced during wet season (68.6%) than on dry season (54.6%). Also, some mothers cannot provide complementary foods three times per day or more to their children regardless the season due to economic problems.

Table 8: Complementary feeding frequencies

Variables	Frequency	Percent
Frequency of complementary feeding in last 24 hours apart from water and juices		
Once	6	2.9
Twice	39	18.9

Thrice	145	70.4
Four times	16	7.8
Frequency of complementary feeding per day during lean/drought season		
Once	31	15.0
Twice	57	27.5
Thrice	113	54.6
Four times	4	1.9
Five times	2	1.0
Frequency of complementary feeding per day during wet/harvesting season		
Once	8	3.8
Twice	52	24.8
Thrice	144	68.6
Don't know/no answer	2	1.0
Four times	3	1.4
Five times	1	0.5
Food that frequently given to the child (almost every day)		
Porridge (either maize based or mixed)	121	59.3
Ugali with relish (either fish or not)	61	29.9
Porridge and ugali	17	8.3
Potatoes and porridge	3	1.5
Stiff porridge and rice	2	1.0

4.2.3 Non-fish based complementary food

The common kind of complementary foods fed to children were porridge (59.3%) made from composite flour, followed by stiff porridge (*ugali*) with side dishes mostly beans and vegetables. Maize based porridge especially unrefined maize porridge (UM) is more commonly used (60.9%) followed by the refined maize porridge (RM) (6.5%), cassava porridge (C) (3.8%), unrefined maize, millet, beans and rice porridge (UMMBR) (4.3%), unrefined maize, millet, groundnuts and rice porridge (UMMGR) (5.4%) and other mixed flours porridges (19%).

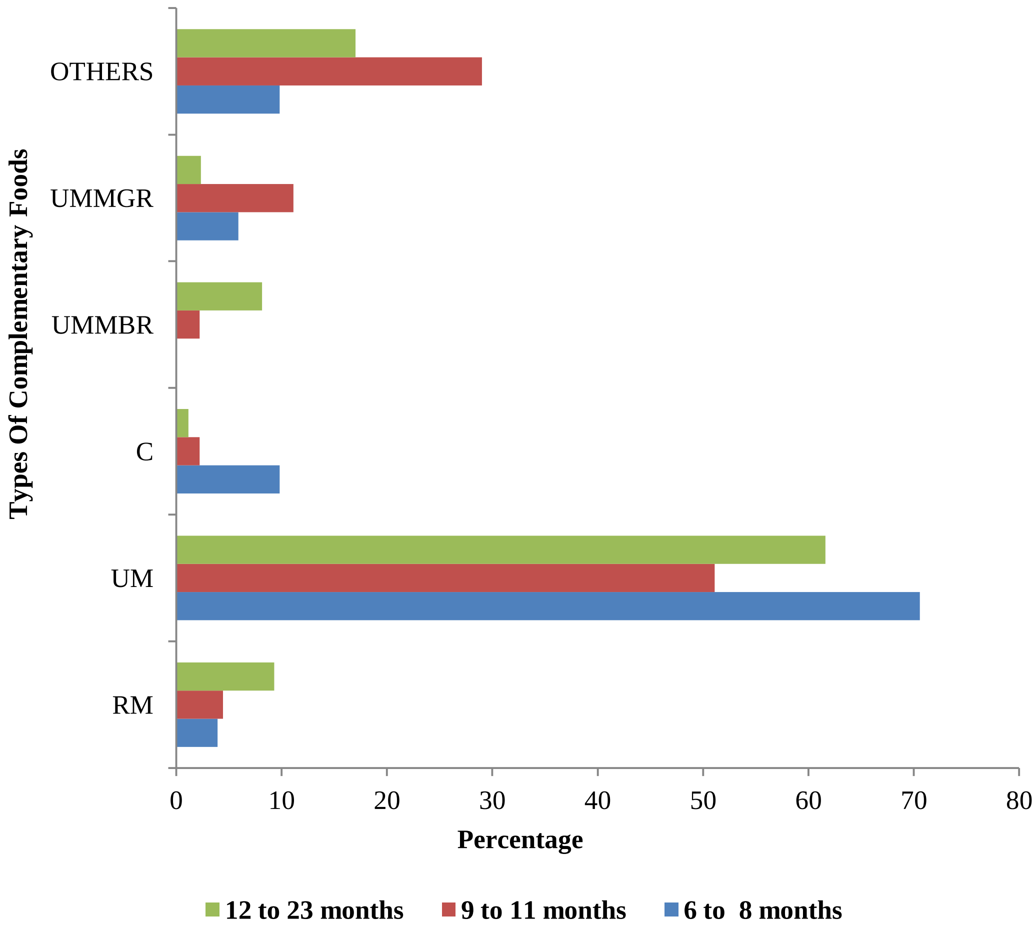

Figure 1: Percentage of children aged 6-23 months consuming various types of non-fish based complementary foods (n=212)

Key: RM = Refined maize porridge, UM = Unrefined maize porridge, C = Cassava porridge, UMMBR = Unrefined maize, millet, beans and rice porridge, UMMGR = Unrefined maize, millet, groundnuts and rice porridge.

4.2.4 Fish Based Complementary Foods

4.2.4.1 Fish consumption information and availability

Majority of households (98.6%) consumes fish, and children (89.2%) are fed with fish in their diets (Table 9). More than half of the targeted population was not fed on fish by their mothers with the reason of them being young (56.5%). The majority of the children who were not given fish are those of age 6 to 8 months. Most children were fed on boiled fish (65.4%), some were given both boiled and fried (25%), and 9.6% were served with fish prepared in either form.

Many children (86.7%) are being served with fish based complementary foods during the main meal time, which is lunch and dinner. About 0.5% of the children were served fish based complementary food as a snack. About 0.5% of the whole study population had history of experiencing reactions due to fish consumption with three types of fish *Mkunga, Pweza* and *Chewa*. Among all the respondents' households 65% of children's fathers and 19.3% of the mothers practiced fish businesses.

Caregivers face difficulties on providing any type of fish to their children when is either off season (66.3%) or during the season (41.2%). During fish season, fish unavailability is low (2.5%) but the main reason for the caregivers failure to provide fish to their children during this season is due to inability to afford the fish at the given prices (96.3%). The more fish are available the higher the prices are being set by the fishermen. When fish are off season, fish unavailability increases especially to those who live far from the shore and prices are being reduced a little due to the fact that fishermen become unsures of selling the few fish they have making problem of affordability to be reduced (70.9%).

Table 9: Fish consumption information

Variables	Frequency	Percent
Household fish consumption		
Yes	208	98.6
No	3	1.4
Child fish consumption		
Yes	189	89.2
No	23	10.8
Reasons for not giving any type of fish to the child		
No specific reason	2	13.0
Fish bones	15	65.2
Fish reaction	1	4.3
Fish greediness	3	13.0
Cannot afford	1	4.3
In which forms the fish are being given to the child		
Flesh (boiled)	123	65.4
Smoked	1	0.5
Fried	11	5.9
Flesh and fried	47	25.0
Any form of fish	6	3.2
How to prepare a fish based complementary foods		
Fish with stiff porridge	139	74.3
Boiled fish	14	7.5
Fish with potatoes	26	13.9
Fish with banana	3	1.6
Fish with rice	4	2.1
Fish porridge	1	0.5

4.2.4.2 Types of fish consumed by children

Many varieties of fish are being consumed by the children aged 6-23 months having *Dagaa* as the leading type of fish consumed by the children aged 6 to 23 months (Figure 2).

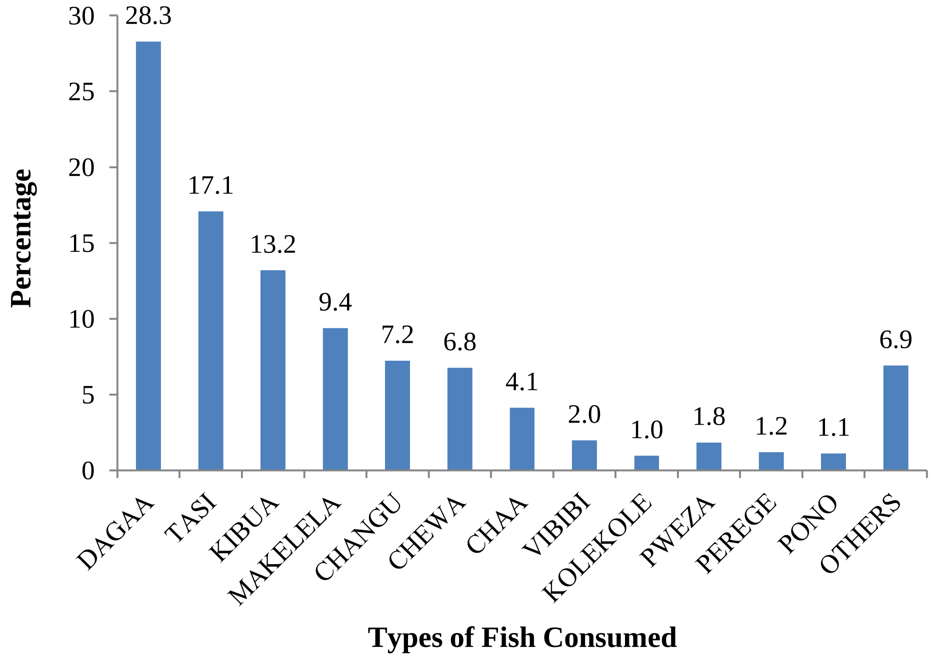

Figure 2: Frequency of type of fish consumed by the children aged 6-23 months in percentage (n=189)

4.2.4.3 Types of fish based complementary foods consumed by children

At the age of 6 to 8 months, 35.2% of children do not consume any fish based complementary food. Only few of them are provided with fish, whereby 25.92% are given fish meals in form of soup while 24.07% as relish. The majority of children aged 9 to 23 months consume fish based complementary foods (Figure 3).

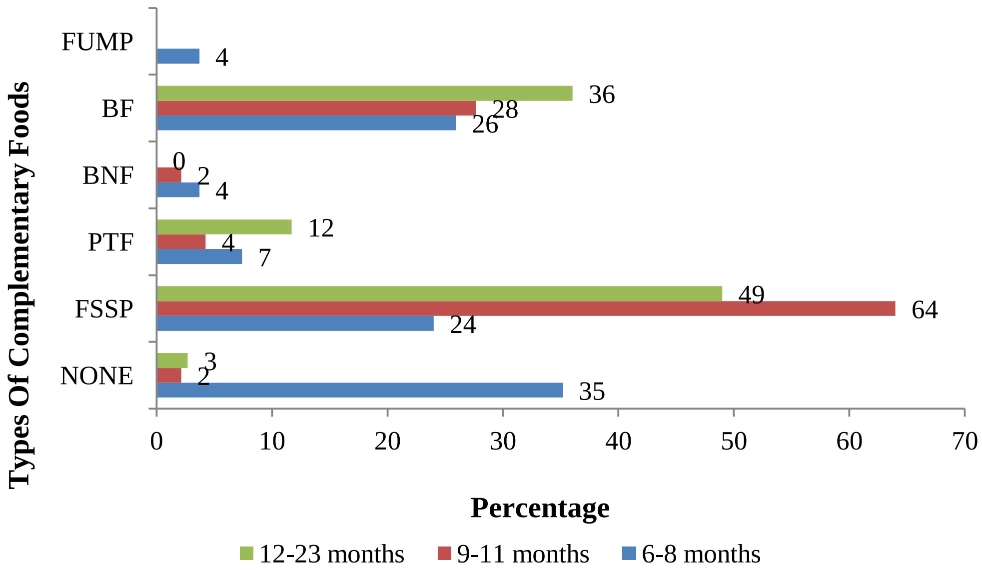

Figure 3: Percentage of children aged 6-23 months consuming various forms of fish based complementary foods (n=189)

Key: None= Not consuming any type of fish, FSSP= Fish with stiff porridge, PTF= Fish with irish potatoes, BNF= Fish with bananas, BF= Fish soup, FUMP= Fish with unrefined maize porridge.

4.2.5 Factors associated with complementary feeding

Possible factors that may have influenced infant feeding practices were reported in Table 10. Caregivers' demographic characteristics; age, occupation, education level, income level and marital status and children's age were the variable of interest. Age, marital status and the average income of the caregivers showed no any influence against the child's complementary feeding. The age of the child has shown to have a relationship with the timing for complementary feeding initiation, and a very strong relationship with number of food groups consumed and initiation of child's fish consumption. Also, the occupation of the caregiver seemed to have strong association with the child's feeding frequency and child's initiation of fish consumption.

Table 10: Complementary feeding practices by demographic characteristics

Variable	Total n=212	Chi-squire (p-value) Complementary foods initiation	Feeding frequency	Number of food groups consumed	Child's fish consumption
Age of caregiver					
<20	29				
20-29	98	0.874	0. 784	0.200	0.200
30-39	66				
≥40	15				
Age of the child					
6 to 8 months	51				
9 to 11 months	48	0.012*	0.262	0.000*	0.000*
12 to 23 months	112				
Caregiver's marital status					
Married (monogamous)	121				
Married (polygamous)	15	0.075	0.498	0.230	0.341
Widowed	1				
Divorced	21				
Single	54				
Caregiver's occupation					
Housewife	41				
Farmer	145				
Self-employed	14				
Farmer and self- employed	6	0.491	0.001*	0.000*	0.653
Farmer and livestock keeper	4				
Education level					
Never gone to school	71				
Primary school	121	0.332	0.024*	0.951	0.946
Secondary school	19				
Caregiver's income per month					
<100000	122				
100000-199999	32	0.804	0.995	0.988	0.072
200000-299999	9				
300000-399999	21				
≥ 400000	5				

***** Significant association between variables at $p<0.005$

4.3 Food analysis

Food analysis was done to the cooked food samples which were commonly consumed by the children aged 6-23 months at Mchinga ward, 12 samples for fish based and 5 samples for non-fish based complementary foods. All samples were analyzed for proximate parameters, iron, zinc and vitamin A.

4.3.1 Proximate analysis

4.3.1.1 General proximate analysis results

Proximate analysis involved the food analysis for percentage protein, fibre, fat, ash, dry matter and moisture content. Then the percentage carbohydrate and total energy (kcal) was calculated based on the results obtained from the analyzed proximate parameters. Fish based complementary foods had higher proximate parameters mean values than non-fish based complementary foods.

Table 11: Mean values for proximate composition (per 100g wet matter)

Complementary Foods	Fish based	Non-fish based
% Crude Protein	4.92	1.70
% Crude Fibre	4.69	3.47
% Fat	2.32	0.18
% Ash	2.81	0.83
% Dry Matter	22.02	8.19
% Moisture Content	77.98	91.81
% Carbohydrate[1]	7.27	2.02
Energy (kcal)[2]	69.70	16.45

[1] 100 – (%Crude protein + %Crude fibre + %Crude fat + %Ash content + %Moisture content)
[2] (fat x 9) + (protein x 4) + (carbohydrate x 4)

Table 12: Proximate composition of common used complementary foods (per 100g wet matter)

Sample name	% Crude Protein	% Crude Fibre	% Fat	%Ash	%Moisture Content	% Dry Matter	% Carbohydrate[3]	Energy (Kcal)[4]
BF-K[1]	5.3±2[abc]	4.8±1[ab]	2.4±0[a]	4.7±0[a]	78.9±1[efg]	21.1±1[efg]	4.0±0 [abcd]	58.3±10[cd]
BF-S[1]	5.5±1[ab]	3.6±1[ab]	0.2±0[bc]	3.6±0[bc]	86.1±0[d]	13.9±0 [h]	1.1±0[d]	28.5±4[efg]
BF-T[1]	5.5±1[ab]	5.6±0[ab]	0.7±0[b]	3.6±0 [b]	80.5±0[e]	19.51±0 [g]	4.1±1[abcd]	44.2±1[def]
BNF-K[1]	8.7±2[a]	2.3±0 [b]	4.1±1[de]	1.6±0[de]	74.4±0 [j]	25.7±0[b]	8.9±2[abcd]	107.2±1[a]
BNF-S[1]	4.2±1[abc]	3.4±1[ab]	3.2±1[d]	1.9±0[d]	78.5±0[efgh]	21.5±0[defg]	8.9±3[abcd]	80.4±3[abc]
BNF-T[1]	2.8±0[bc]	3.0±0[ab]	2.3±1[d]	2.2±0[d]	77.5±1 [fghi]	22.5±1[cdef]	12.2±2[ab]	80.8±3[abc]
FSSP-K[1]	4.5±2[abc]	6.6±0[ab]	3.2±0[cd]	2.5±0[cd]	75.8±0[ij]	24.2±0[bc]	7.4±3[abcd]	76.0±5[bc]
FSSP-S[1]	3.6±1[bc]	4.6±3[ab]	0.3±0[ab]	4.3±0[ab]	79.6±1[ef]	20.4±1 [fg]	7.7±3[abcd]	47.7±9[de]
FSSP-T[1]	4.0±3[abc]	7.2±1[a]	2.8±1[cd]	2.5±0[cd]	71.3±1[k]	28.7±1[a]	12.3±3 [ab]	90.3±12 [ab]
PTF-K[1]	2.9±1[bc]	4.4±1[ab]	0.9±0 [d]	2.3±0 [d]	76.9±1[ghi]	23.1±1[cde]	12.5±2 [a]	70±7[bcd]
PTF-S[1]	3.6±1[bc]	4.5±1[ab]	5.1±2 [d]	2.4±0 [d]	78.5±0[efgh]	21.5±0[defg]	5.9±3[abcd]	84±6[abc]
PTF-T[1]	1.3±0[bc]	5.5±2[ab]	2.9±0 [d]	2.3±0 [d]	76.8±0 [hi]	23.2±0[cd]	11.2±2 [abc]	76.4±7[bc]
C[2]	0.4±0 [c]	1.9±1 [b]	0.1±0 [f]	0.5±0 [f]	94.3±0[a]	5.7±0[k]	2.8±1[c]	14±1[g]
RM[2]	1.3±1[bc]	3.6±3[ab]	0.2±0[ef]	0.8±0[ef]	90.3±1[c]	9.8±1 [i]	3.8±4[abcd]	22.4±17[efg]
UM[2]	3.4±0.8[bc]	2.7±1[ab]	0.1±0 [f]	0.1±0 [f]	92.5±1[ab]	7.5±1[jk]	1.1±1 [d]	19.2±0[fg]
UMMBR[2]	3.6±0.9[abc]	1.9±0 [b]	0.1±0[ef]	0.8±0[ef]	90.1±0 [c]	9.9±0[i]	3.5±1[bcd]	29.0±1[efg]
UMMGR[2]	2.7±0.5[bc]	2.7±0[ab]	0.3±0[de]	1.7±0[de]	90.9±0[bc]	9.1±0[ij]	1.6±1 [d]	20.1±0[efg]

FSSP = Fish with stiff porridge, PTF = Fish with mashed irish potatoes, BNF = Fish with mashed bananas, BF = Fish soup,
RM = Refined maize porridge, UM = Unrefined maize porridge, C = Cassava porridge,
UMMBR = Unrefined maize, millet, beans and rice porridge, UMMGR = Unrefined maize, millet, groundnuts and rice porridge.
Results are presented as means and standard deviations. Analysis of variance (ANOVA) was used to find significant difference between samples (P<0.005).Means with the same superscripts are not significantly different from each other.

[1]Fish based complementary foods

[2]Non-fish based complementary foods

[3]100 – (%Crude protein + %Crude fibre + %Crude fat + %Ash content + %Moisture content)

[4](fat x 9) + (protein x 4) + (carbohydrate x 4)

4.3.1.2 Contribution of protein, fat and carbohydrates to total energy

In fish based complementary foods carbohydrates contribute more to the total energy followed by fat and then protein, while for the non-fish based complementary foods carbohydrates contribute more to the total energy followed by protein and then fat.

Table 13: Percentage of energy as contributed by protein, fat and carbohydrates on the complementary foods at Lindi rural district

Complementary Foods	Carbohydrate	Protein	Fat
	Means±SD	Means±SD	Means±SD
Fish Based	76.90±14.85	41.46±7.42	50.40±13.86
Non-Fish Based	10.30±4.71	9.06±5.52	1.60±0.95

4.3.2 Micronutrients

4.3.2.1 General micronutrients analysis results

In general fish based complementary foods had high mean for vitamin A content (342 mcg RE) than non-fish based complementary foods (4 mcg RE). It is vice versa for the case of minerals whereby iron and zinc were found to be high on non-fish based complementary foods (0.74 mg and 0.074 mg respectively) than on fish based complementary foods (0.66 mg and 0.067 mg).

Table 14: Mean and standard deviation of micronutrients concentration on commonly used complementary foods (per 100g wet matter)

Complementary Foods	Vitamin A (mcg RE)	Iron (mg)	Zinc (mg)
Fish based	362.12±229.27	0.6649±0.35	0.0665±0.04
Non-fish based	3.8623±2.61	0.7386±0.40	0.0739±0.04

Results are presented as means and standard deviations.

4.3.2.2 Contribution of β-carotene and retinol on total vitamin A concentration

High vitamin A concentration on fish based complementary foods is more contributed by the retinol content from the fish. As it is observed on the table below, that those complementary foods with no fish at all had low vitamin A concentration due to the absence of retinol content.

Table 15: Vitamin A concentration of commonly complementary foods (mg/100g wet basis)

Sample name	β-Carotene (mcg/100g RE)	Retinol (mcg/100g RE)	Vitamin A (mcg/100g RE)
BF-S[1]	0.0	109.3	109.3
BF-T[1]	0.0	103.3	103.3
BF-K[1]	0.0	212.1	212.1
BNF-S[1]	80.9	337.8	418.7
BNF-T[1]	53.0	256.9	149.2
BNF-K[1]	54.3	534.9	311.2
FSSP-S[1]	129.8	135.9	265.7
FSSP-T[1]	69.1	429.5	498.6
FSSP-K[1]	52.5	316.8	369.3
PTF-S[1]	70.0	317.7	387.7
PTF-T[1]	66.2	151.7	217.9
PTF-K[1]	54.3	252.4	306.7
C[2]	4.9	0.0	4.9
RM[2]	1.5	0.0	1.5
UM[2]	7.6	0.0	7.6
UMMBR[2]	2.5	0.0	2.5
UMMGR[2]	2.9	0.0	2.9

FSSP = Fish with stiff porridge, PTF = Fish with mashed irish potatoes, BNF = Fish with mashed bananas, BF = Fish soup, RM = Refined maize porridge, UM = Unrefined maize porridge, C = Cassava porridge, UMMBR = Unrefined maize, millet, beans and rice porridge, UMMGR = Unrefined maize, millet, groundnuts and rice porridge.

[1]Fish based complementary foods

[2]Non-fish based complementary foods

4.3.2.3 Micronutrients concentration differences among complementary foods

No significant difference ($p < 0.05$) of vitamin A content among non-fish based complementary foods (UMMGR, UMMBR, C, RM and UM). But there are differences among some fish based complementary foods (FSSP, BF, PTF and BNF). Also, there is difference of vitamin A content between fish based and non-fish based complementary foods. Six fish based complementary foods statistically differ ($p < 0.05$) with all non-fish based complementary foods in terms of vitamin A (see Table 15).

UM porridge contained the highest amount of iron content (25.15mg ± 0.3) than the rest, while PTF-K contained the lowest quantity of iron content 0.96mg ± 0.1 per 100gm serving. It was found that there is significant difference of iron content among the non-fish based complementary foods and among the fish based complementary foods. Also, there was a significant difference between fish based complementary foods and non-fish based complementary foods. Unlike vitamin A, iron content was found to be in high quantities on non-fish based complementary foods compared to the fish based complementary foods.

Also, non-fish based complementary foods had higher amount of zinc in grams per 100g except for sample C and RM. Sample UM has the highest amount of zinc content than the rest of the complementary foods 2.5161mg ± 0.1.

Table 16: Difference of vitamin A, iron and zinc concentration of commonly used complementary foods (mg/100g wet basis)

Sample name	Vitamin A (mcg/100g RE)	Iron (mg/100g)	Zinc (mg/100g)
BF-K[1]	212.12±0.6^{i}	0.53±0.05 ^{de}	0.05±0.0 ^{de}
BF-S[1]	109.30±0.5^{k}	0.34±0.02 ^{fg}	0.03±0.0 ^{fg}
BF-T[1]	103.30±0.5^{l}	1.26± 0.01^{a}	0.13±0.0 ^{a}
BNF-K[1]	311.15±0.6e	0.31±0.02 ^{gh}	0.03±0.0^{gh}
BNF-S[1]	418.66±0.1^{b}	0.95±0.03 ^{b}	0.10±0.0 ^{b}
BNF-T[1]	149.22±0.7^{j}	0.83±0.01 ^{c}	0.08±0.0^{c}
FSSP-K[1]	369.27±0.5^{d}	0.36±0.04 ^{fg}	0.04±0.0^{fg}
FSSP-S[1]	265.66±0.1^{g}	0.82±0.04 ^{c}	0.08±0.0^{c}
FSSP-T[1]	498.63±0.0^{a}	1.26±0.02^{a}	0.13±0.0^{a}
PTF-K[1]	306.69±0.6^{f}	0.22±0.02 ^{hi}	0.02±0.0^{hi}
PTF-S[1]	387.69±0.9^{c}	0.55±0.03 ^{d}	0.06±0.0^{d}
PTF-T[1]	217.92±0.8^{h}	0.55±0.03 ^{d}	0.05±0.0^{d}
C[2]	4.89±0.1^{n}	0.19±0.01^{i}	0.02±0.0^{i}
RM[2]	1.46±0.3^{o}	0.44±0.03^{ef}	0.04±0.0^{ef}
UM[2]	7.57±0.3^{m}	1.25±0.01^{a}	0.13±0.0^{a}
UMMBR[2]	2.53±0.3^{o}	1.03±0.00^{b}	0.10±0.0^{b}
UMMGR[2]	2.89±0.3^{o}	0.78±0.02^{c}	0.08±0.0^{c}

FSSP = Fish with stiff porridge, PTF = Fish with mashed irish potatoes, BNF = Fish with mashed bananas, BF = Fish soup, RM = Refined maize porridge, UM = Unrefined maize porridge, C = Cassava porridge, UMMBR = Unrefined maize, millet, beans and rice porridge, UMMGR = Unrefined maize, millet, groundnuts and rice porridge.
Results are presented as means and standard deviations. Analysis of variance (ANOVA) was used to find significant difference between samples (P<0.005).Means with the same superscripts are not significantly different from each other.
[1]Fish based complementary foods
[2]Non-fish based complementary foods

4.3.2.4 Contribution of commonly used complementary foods for children on meeting the recommended daily intake (RDI) for vitamin A, iron and zinc

On average all fish based complementary foods met the RDI for vitamin A for children aged 6 to 23 months unlike the non-fish based complementary foods (Table 17).

Table 17: Fish based complementary foods and non-fish based complementary foods that meet vitamin A RDI (mcg RE) according to the number of meals consumed per day

	6-8 MONTHS		9-11 MONTHS		12-23 MONTHS	
RDI (mcg RE)	**350**		**350**		**400**	
Sample Name	**Weight of Food (G)**	**Vitamin A (Mcg)**	**Weight of Food (G)**	**Vitamin A (Mcg)**	**Weight of Food (G)**	**Vitamin A (Mcg)**
FSSP-S[1]	60.9	161.79	90.2	239.63	151.4	402.22
FSSP-T[1]	61.9	308.65	90.2	449.76	151.4	754.93
FSSP-K[1]	62.9	232.27	90.2	333.08	151.4	559.07
BF-S[1]	128	139.91	178	194.56	230	147.56
BF-T[1]	135	139.45	180	185.93	229	142.55
BF-K[1]	138	292.73	182	386.06	236	301.21
PTF-S[1]	111	430.34	178	690.10	240	930.47
PTF-T[1]	125	272.40	182	396.61	256	557.87
PTF-K[1]	130	398.69	185	567.37	275	843.39
BNF-S[1]	115	481.46	160	669.85	212	887.56
BNF-T[1]	132	196.98	178	265.62	228	340.23
BNF-K[1]	137	426.28	186	578.74	235	731.21
UMMBR[2]	187.1	4.74	227.4	5.76	295.0	7.47
UMMGR[2]	187.1	5.41	227.4	6.57	295.0	8.53
RM[2]	187.1	2.74	227.4	3.33	295.0	4.32
UM[2]	187.1	14.16	227.4	17.20	295.0	22.32
C[2]	187.1	9.15	227.4	11.12	295.0	14.42

FSSP = Fish with stiff porridge, PTF = Fish with mashed irish potatoes, BNF = Fish with mashed bananas, BF = Fish soup, RM = Refined maize porridge, UM = Unrefined maize porridge, C = Cassava porridge, UMMBR = Unrefined maize, millet, beans and rice porridge, UMMGR = Unrefined maize, millet, groundnuts and rice porridge.

[1]Fish based complementary foods

[2]Non-fish based complementary foods

Only one fish based complementary food of *sardine* fish with mashed bananas (BNF-S) was able to meet the iron RDI while four non-fish based complementary foods met the iron RDI, unrefined maize porridge (UM); unrefined maize, millet, beans and rice porridge (UMMBR), and unrefined maize, millet, groundnuts and rice porridge (UMMGR). For the mentioned complementary foods to be able to meet the iron RDI they must be fully consumed three times a day (Table 18).

Table 18: Fish based complementary foods and non-fish based complementary foods that meet iron RDI (mg)

	6-8 MONTHS		9-11 MONTHS		12-23 MONTHS	
RDI (mg)	**11mg**		**11mg**		**6mg**	
Sample Name	**Weight of Food Consumed (g)**	**Iron (mg)**	**Weight of Food Consumed (g)**	**Iron (mg)**	**Weight Of Food Consumed (g)**	**Iron (mg)**
FSSP-S[1]	60.9	0.50	90.2	0.74	151.4	1.24
FSSP-T[1]	61.9	0.78	90.2	1.14	151.4	1.91
FSSP-K[1]	62.9	0.22	90.2	0.32	151.4	0.54
BF-S[1]	128	0.43	178	0.60	230	0.45
BF-T[1]	135	1.70	180	2.27	229	1.74
BF-K[1]	138	0.73	182	0.96	236	0.75
PTF-S[1]	111	0.61	178	0.98	240	1.32
PTF-T[1]	125	0.68	182	1.00	256	1.40
PTF-K[1]	130	0.29	185	0.41	275	0.61
BNF-S[1]	115	1.09	160	1.52	212	2.02
BNF-T[1]	132	1.09	178	1.47	228	1.89
BNF-K[1]	137	0.43	186	0.59	235	0.74
UMMBR[2]	187.1	1.47	227.4	1.78	295.0	3.02
UMMGR[2]	187.1	1.92	227.4	2.33	295.0	2.31
RM[2]	187.1	0.82	227.4	1.00	295.0	1.30
UM[2]	187.1	2.34	227.4	2.85	295.0	3.69
C[2]	187.1	0.36	227.4	0.44	295.0	0.57

FSSP = Fish with stiff porridge, PTF = Fish with mashed irish potatoes, BNF = Fish with mashed bananas, BF = Fish soup, RM = Refined maize porridge, UM = Unrefined maize porridge, C = Cassava porridge, UMMBR = Unrefined maize, millet, beans and rice porridge, UMMGR = Unrefined maize, millet, groundnuts and rice porridge.

[1]Fish based complementary foods

[2]Non-fish based complementary foods

Zinc was observed to be very low in both fish based and non-fish based complementary foods as no any complementary food was able to meet zinc RDI (Table 19).

Table 19: Fish based complementary foods and non-fish based complementary foods that meet zinc RDI (mg) according to the number of meals consumed per day

	6-8 MONTHS		9-11 MONTHS		12-23 MONTHS	
RDI (mg)	**5**		**5**		**6.5**	
Sample Name	**Weight of Food Consumed (g)**	**Zinc (Mg)**	**Weight of Food Consumed (g)**	**Zinc (Mg)**	**Weight of Food Consumed (g)**	**Zinc (Mg)**
FSSP-S[1]	60.9	0.05	90.2	0.07	151.4	0.12
FSSP-T[1]	61.9	0.08	90.2	0.11	151.4	0.19
FSSP-K[1]	62.9	0.02	90.2	0.03	151.4	0.05
BF-S[1]	128	0.04	178	0.06	230	0.05
BF-T[1]	135	0.17	180	0.23	229	0.17
BF-K[1]	138	0.07	182	0.10	236	0.07
PTF-S[1]	111	0.06	178	0.10	240	0.13
PTF-T[1]	125	0.07	182	0.1.0	256	0.14
PTF-K[1]	130	0.03	185	0.04	275	0.06
BNF-S[1]	115	0.11	160	0.15	212	0.20
BNF-T[1]	132	0.11	178	0.15	228	0.19
BNF-K[1]	137	0.04	186	0.06	235	0.07
UMMBR[2]	187.1	0.15	227.4	0.18	295.0	0.30
UMMGR[2]	187.1	0.19	227.4	0.23	295.0	0.23
RM[2]	187.1	0.08	227.4	0.10	295.0	0.13
UM[2]	187.1	0.23	227.4	0.28	295.0	0.37
C[2]	187.1	0.04	227.4	0.04	295.0	0.06

FSSP = Fish with stiff porridge, PTF = Fish with mashed irish potatoes, BNF = Fish with mashed bananas, BF = Fish soup, RM = Refined maize porridge, UM = Unrefined maize porridge, C = Cassava porridge, UMMBR = Unrefined maize, millet, beans and rice porridge, UMMGR = Unrefined maize, millet, groundnuts and rice porridge.

[1]Fish based complementary foods

[2]Non-fish based complementary foods

CHAPTER FIVE

5.0 DISCUSSION

5.1 Socio-demographic Information

Different studies (Mekonnen *et al*., 2017:Sika-Bright, 2014) showed the presence of effect of demographic characteristics towards child's feeding practices. In this study caregivers' education level has been observed to have an influence on child's feeding frequency. Many caregivers had only primary education as their level of education with most of them having completed primary school 5 years ago. Low education level among the female caregivers is also associated with child's exclusive breastfeeding, meal diversification and meeting the recommended minimum number of meals (Sika-Bright, 2014). Also, the availability and accessibility of various food materials is important for diversification of foods. Even though no significant association was observed between the caregivers' average income and feeding practices, caregivers' poor accessibility to foods in market which may be due to low household income less than 100 000 TSh per month can affect the child's feeding practices.

5.2 Feeding Practices

5.2.1 Breastfeeding

Adequate breastfeeding is very essential for the infants' growth and development. It is important to ensure timely initiation of breastfeeding the newborn which is within 1 hour of birth. At Mchinga majority of the children were initiated to breast milk within 1 hour after birth, higher than what was reported by the study conducted in rural Tanzania (Exavery, *et al*., 2015) and TDHS (NBS and ICF Macro, 2011) that only 51 % and 49% of the respondents respectively breastfed their newborns within 1 hour of birth. Mode of childbirth was reported to be the most important factor for late breastfeeding initiation (Exavery, *et al*., 2015). Early initiation of breastfeeding was more frequently practiced among women who had normal child delivery than those who gave birth through caesarean section. Mother's education, wealth quintile and who assisted the mother during delivery also affect timing of breastfeeding initiation (NBS and ICF Macro, 2011).

Almost all of the children at Mchinga consumed colostrum, which is very important to child growth and immunity during the first days of life (Thapa, 2005). However, about half of the targeted population failed to practice exclusive breastfeeding. Most of mothers start giving their children other foods before the age of 6 months, mostly during their 4th and 5th month of life. This early introduction of complementary foods does not improve growth before six months (PAHO and WHO, 2003). Instead, it tends to displace breast milk, it is well known that breast milk can meet nutrient needs of the child for the first 6 months of life (PAHO and WHO, 2003). The age at which children were started on complementary foods is probably dictated by the social, cultural factors that surround the women and common practiced within the area. This challenge of not practicing exclusive breastfeeding has also been reported in other developing countries, even though Cai *et al.*,2012 report the trend of mothers practicing exclusive breastfeeding to be improving as years passes. The TDHS as reported by NBS and ICF Macro, 2015 also shows exclusive breastfeeding practices has been improving as years passes. Currently, 51% of infants under 6 months are being exclusively breastfed, an increase from the 2010 TDHS (50%) and in 2004-05 (41 %).

Breastfeeding practices affect the child’s nutritional status and health in general. At Mchinga after the initiation of breastfeeding, mothers practice proper breastfeeding to their children. Mothers breastfed their children on demand and more than 8 times per day until they get satisfied, which is good as it is recommended. Proper breastfeeding frequencies seems not to be a problem in developing countries (Nkrumah, 2017).

Even though majority of mothers practicing breastfeeding up to 1 year of age, some children (15.6%) stop breastfeeding before the age of 2 due to death of the mother, child lives away from the mother, child refusal to breast feed, child’s sickness and the fact that the child is grown enough. Some of the reason also reported by Rao, 2007 and even though not mentioned, cultural and social factors may also contribute in early cessation of breastfeeding (Wanjohi *et al*., 2017). Mostly, breastfeeding termination is done at the age of 12 to 23 months with majority being terminated from breastfeeding at 18 months. This is not good since it is advised by PAHO and WHO, 2003 to continue breastfeeding up to 2 years and beyond if possible.

5.2.2 Complementary feeding

All the children under the study were already introduced to complementary foods. This was expected since it is recommended by PAHO and WHO, 2003 for the children to be introduced to the complementary foods at the age of 6 months. Also, it is recommended for complementary foods to be provided 2-3 times per day at 6-8 months of age and 3-4 times per day at 9-11 and 12-24 months of age, with additional nutritious snacks (such as a piece of fruit) offered 1-2 times per day, as desired for the average healthy breastfed infant. If energy density or amount of food per meal is low, or the child is no longer breastfed, more frequent meals may be required. On average all age groups tend to be fed three times per day as required. But those aged 12 to 23 months did not meet the recommendations as they were not given health snacks between meals. During this period they need more frequency of eating nutritious foods including the health snacks so as to satisfy the nutrients demands for their growth and health in general.

In different studies (Abeshu *et al.,* 2016: Kulwa *et al.,* 2015) it has been reported that porridge is most common used form of complementary food in developing countries. This has been observed at Mchinga as well, the commonly consumed form of complementary food is porridge with the addition of salt in it. In which, unrefined maize porridge (UM) found to be the most commonly used kind of complementary food for children aged 6 to 23 months. Followed by cassava porridge (C) for the children aged 6 to 8 months, porridge containing a mixture of unrefined maize, millet, groundnuts and rice flour for children aged 9 to 11 months, and porridge containing a mixture of unrefined maize, millet, beans and rice flour for the children aged 12 to 23 months compared to other complementary foods varieties. Then followed by the consumption of stiff porridge (*ugali*) with other side dishes, and very few who consumed rice, bananas and potatoes. All food materials used to prepare the porridge for the children are cereals as reported in other developing countries that basically dietary energy forms a big proportion of complementary foods (Greco *et al.,* 2006). Due to that, no infant met the minimum dietary diversity criterion of consuming 4 or more food groups within 24 hours at Mchinga, indicating low dietary diversity among study population. Gewa and Leslie, 2015 also reported Tanzania having mean DDS of below three. The low dietary diversity at the study area may be influenced by agricultural production as it is reported that cassava, maize, sorghum and pulses (pigeon and cow peas) to be common food crops produced at Lindi, with few people engaged in livestock keeping and fishing for only those living along the coast (Grootenhuis, 2003).

5.2.3 Fish consumption

WHO, 2004 advice meat, poultry, fish or eggs to be eaten daily, or as often as possible, since they are rich sources of many nutrients such as iron and zinc. At Mchinga generally, almost all households consume fish, only very few households do not consume fish due to economic reasons. Children are being provided with both fish based and non-fish based complementary foods. They consume fish mostly in forms of relish or soup. Children's fish consumption in fishing communities has been observed to be high (Bandoh and Kenu, 2017), compared to reports of fish consumption studies among children in developing countries in general (Kudlová and Schneidrová, 2012: Mekonnen *et al.*, 2017). Therefore, high fish consumption at this study area could be attributed by the fact it is a fishing community. A few number of children aged 6-8 months do not consume fish based complementary foods due to the fear of accidentally eat fish bones which will results in injuries. They instead provide them with other foods especially the staples. Most mothers cannot provide fish meals to their children especially when they are not in season because they are unavailable, also due to the high cost of the fish during that season. Unfortunately this is also the case even when they are in season, that fish may be available but the household economy may be low so they cannot purchase fish.

Different varieties of fish are consumed by children, with varieties consumed increases as the age increases. *Changu* being the leading type of fish consumed by the children aged 6 to 8 months and *Dagaa* being the variety more consumed by the children aged 9 to 23 months. At this age (9-23months), the children can be given *dagaa* with soft bones to eat themselves. In general, *dagaa* is a leading type of fish consumed by the children aged 6-23 months, followed by *tasi* and *kibua*. Only 39% of the households had household members who are involved in any fish business, which has no any association with child's fish consumption (p>0.01).

5.3 Nutrients Information in Both Fish Based and Non-Fish Based Complementary Foods

5.3.1 Proximate composition

In general fish based complementary foods had more percentage of energy content per 100g serving compared to the non-fish based complementary foods (Table 15). The amount of fats in these foods is much contributed by the coconut cream added during the cooking process, as coconut cream has high fat content per 100g serving (Lukmanji *et al*., 2008). It is recommended for children, that 45% to 65% of their calories come from carbohydrates, 25% to 40% from fat, and 10% to 35% from protein (FNB, 2002). As reported by Mamiro *et al*., 2005, in this study it has also been observed that carbohydrate contributes much to the total energy, followed by protein and then fat for non-fish based complementary foods. On fish based complementary foods it was also observed that carbohydrate contributes more to the total energy of the complementary foods, followed by fat and then protein (table 16). The high carbohydrate content might be contributed by non-fish food materials ever since fish has very low carbohydrate content (Palani *et al*., 2014). Even though carbohydrates contributes more to the total energy in terms of percentage than protein and fat as recommended, compared to the range provided by FNB, 2002 it was observed to be lower for non-fish based complementary foods and a bit higher but close to the ranges for fish based complementary foods. Hence the fish based complementary foods is more capable of providing energy as recommended than the non-fish based complementary foods.

Protein is an important nutrient for proper growth of children; thus, it is essential to ensure it is consumed in required amounts. BNF-K has the highest amount of protein followed by fish soup (BF) dishes. The high amount of proteins may be highly contributed by the fish variety used as well as amount of fish contents on those foods (Bogard *et al*., 2015). Generally, the fish based complementary foods had higher amounts of all proximate parameters as reported in other studies (Konyole *et al*., 2012) except for moisture content than the non-fish based complementary foods (see Table 14).

5.3.2 Vitamin A

It was observed from the 24 dietary recall that on average, children at Mchinga ward were able to meet the vitamin A RDI through their complementary foods consumed by 97.9%. That might be due to the contribution of fish based complementary foods, since vitamin A was observed to be in higher amounts on fish based complementary foods than non- fish based complementary foods (table 17). In addition to that, majority of the children consumed fish based complementary foods in the past 24 dietary recall. Fish is a source of vitamin A and it has been observed to contribute high proportion of total vitamin A on the foods as far as the retinol content is concerned (Table 18) as it is also reported in Lukmanji *et al*., 2008. *Tasi* fish with mashed irish potatoes (PTF-T), *dagaa* fish with mashed irish potatoes (PTF-S), *Kibua* fish with mashed green bananas (BNF-K) and *dagaa* fish with mashed green bananas (BNF-S) was able to meet the vitamin A RDI for children from 6 to 23 months if all consumed, then their consumption should be emphasized to the children followed by *kibua* fish with mashed irish potatoes (PTF-K). Also the combination of animal and plant sources of vitamin A contributes to the good result of vitamin A content in foods (Hess *et al*., 2005).

Apart from vitamin A concentration difference ($p<0.05$) among the complementary foods prepared, it is observed that among all the fish based complementary foods, *dagaa* fish soup (BF-S) and *tasi* fish soup (BF-T) cannot meet the RDI of the children at any age group. Since water content is an important determinant of levels of other food components (Greenfield and Southgate, 2003), high water content in fish soup samples contributed to high moisture content and reduced nutrient content. The water added during cooking diluted nutrients concentration of the foods. In addition to that, BF-S, BF-T and BF-K had no any vitamin A plant source, which also contributed to their low concentration of vitamin A (Lukmanji *et al*., 2008). With fish based complementary foods being at the top of the list as far as the vitamin

A concentration is concerned it indicates that, if fish contribute high ratio in formulating a meal it is possible to formulate complementary foods with adequate amount of vitamin A.

5.3.3 Iron and zinc

Iron is one among the micronutrients that are so essential during the first years of life. Its deficiency is very common to the young child (NBS, 2015). Fish based complementary foods has been observed to have high iron concentration than non-fish based complementary foods (Larsen *et al*., 2000). Unlike in this study, even though the iron concentration increases in complementary foods with the age, two servings per day of unrefined maize porridge (UM) and UMMGR if completely consumed can meet the iron RDI only for 12 to 23 months children while it has to be three serving per day of BF-T, UMMBR and BNF-S in order to meet iron RDI for children of that age group (see table 21). Also *dagaa* and *tasi* types of fish might have high concentration of iron than *kibua* fish as it is observed on fish based complementary foods with *dagaa* and *tasi* has high iron concentration per 100g serving than those complementary foods with *kibua*. *Dagaa* has been reported to have high micronutrients concentration as it is been consumed as whole (Palani *et al*., 2014).

Mixed flour with maize tend to have high amounts of iron and zinc than mixed flour without maize (Lukmanji *et al*., 2008). Among non-fish based complementary foods in this study those with unrefined maize as one of their ingredients (UM, UMMBR and UMMGR) was observed to have high iron and zinc concentrations than those without unrefined maize (RM and C). Large proportion of the minerals in maize are lost during milling as explained by (Suri and Tanumihardjo, 2016), that's the reason for RM and C to have low iron and zinc content as well. UM was observed to contain highest amount of zinc followed by UMMBR and UMMGR. Since UMMGR has the lower amount of zinc than UMMBR there is a possibility that the high quantities of zinc are contributed by the presence of beans (Lukmanji *et al.*, 2008). Also, for UM having the highest concentration while RM having low zinc concentration with a significant difference ($p<0.05$) between them indicating the contribution provided by the unmilling of the maize grains on improving zinc content as explained by Suri and Tanumihardjo, 2016.

Having complementary foods with high iron concentration enough to meet the children's RDI, indicate that it is possible for mothers to prepare complementary foods for their children with adequate iron concentration just at their homes whether are fish and non-fish based complementary foods. It will be more efficient to improve the fish based complementary foods since legumes and cereals are accompanied with high quantities of anti-nutritional factors (Bora, 2014), unless processing of removing them is done (Suri and Tanumihardjo, 2016).

It is also observed in this study that among the complementary foods zinc concentration still remains as a problem, as it is very low in milligrams per 100 g serving and low per meal for each age group (Table 20). Zinc concentration has always been a problem in complementary foods for children since it fails to meet the RDIs (Brown *et al.,* 2001). Generally, fish based complementary foods contribute significantly in both macro and micronutrients (Bogard *et al.,* 2015: Kawarazuka, 2010).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Malnutrition in Lindi rural may be due to the low micronutrients concentration in complementary foods. Mothers breastfeed their children as they demand up to over 1 year but complementary food feeding frequency is not adequate on providing nutrients as required by their bodies. No health snacks for the children, the only time the children get snacks mostly they are being provided with unhealthy snacks such as candies. Both of these contribute to the low micronutrients concentration of complementary foods.

Some of the current fish based complementary foods provide adequate amount of vitamin A as required for the targeted children unlike the non- fish based complementary foods. However, only some complementary foods if eaten twice or thrice a day they can meet the iron RDI. Zinc is found to be very low in both fish based and non-fish based complementary foods. In addition to that, among the fish based complementary foods, those with *dagaa* and *tasi* type of fish were observed to have higher micronutrients concentration than those with *kibua*

In general, fish based complementary foods contributes significantly on both macro and micronutrients concentration. That being observed it is therefore possible to formulate at home fish based complementary foods that meets zinc, iron and vitamin A RDI for the children age 6 to 23 months.

6.2 Recommendations

That following are being recommended:

- To assess micronutrients concentration on different varieties of fish other fish varieties apart from *sardines, kibua* and *tasi* present in Lindi rural.
- Further studies should be done on children fish consumption including issues of fish preparation methods that will increase micronutrients retention.
- Formulation of the home made fish based complementary foods that meet the RDI of the important micronutrients for growth.
- Ready to use commercial fish based complementary foods can also be formulated.
- Promote the consumption of fish to the children as complementary foods.
- Nutrition education should be more provided to mothers and caregivers about the importance of diversifying their children's meals.
- Studies to determine a better source of zinc in the area should be done and incorporated on children's complementary foods.

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APPENDICES

Appendix 1: Sample size

According to Kothari (2004),

n = Z^2 (pq)/d^2)

Where n = sample size

Z = standard normal deviate, set at 1.96 corresponding to 95% confidence level,

p = proportion in target population of children age 6 month to 23 month of age estimated to be breastfed and consume complementary foods (0.864) in Tanzania.

q = (1-p), proportions of the children aged 6 month to 23 month are estimated to not be breastfed and consume complementary foods (0.136) in Tanzania.

e = acceptable error (the precision), set at 0.05.

= 1.96^2 (0.864 × (0.136)/0.05^2

n = 180 individuals.

Appendix 2: Informed consent form

PART 1. RESEARCH INFORMATION SHEET

Research title: Contribution of fish in improving micronutrients content in complementary foods for children aged 6 to 23 months at Lindi

Purpose of the research: To assess iron, zinc and vitamin A contents in fish and non-fish based complementary foods commonly used for 6 to 23 months old children in Lindi Rural District.

Research description and assessments during the research: This study will assess child feeding practices, food availability, and assessing micronutrients content of fish and non-fish based complementary foods commonly used for 6 to 23 months old children. Therefore it will require collection of the cooked foods samples from you (mother).

What will happen if you take part in the research?: If you agree to participate in this research, you are kindly requested to participate in all activities. Please try to respond to questions truthfully, and ensure that you are present at all research activities and assessments. Your answers, opinions or suggestions are important to us. If you don't understand the questions do not hesitate to ask for more clarification.

Do you have to take part in the research?: Your participation is entirely voluntary. It is completely up to you to decide whether or not to take part. If you decide to take part you will need to sign a consent form. You have the right to withdraw at any time, even after you have signed the informed consent, without any penalty.

Who will have access to your information and what will become of the information after completion of the research?: All information that is collected about you and your family during the course of the research will be kept confidential. Any information about you will have your name removed and replaced by a number so that you cannot be identified from it. The results will be shown in aggregate form and will be published for international and national audience. You will not be identified personally in any report or publications.

Alternative Procedures or Courses of Treatments. None

Further information. If you want more information before deciding, or have any queries about anything concerning the research, please feel free to contact the researcher Hope Masanja on the phone number 0784150351 or write to our address (Sokoine University of Agriculture, Department of Food Technology, Nutrition and Consumer Sciences and P.O. Box 3006, Morogoro).

Part 2: Certificate of Informed Consent

I, undersigned.. (first name and surname) have been invited to participate in the research "____________________."

1. I confirm that I have read and understood the information sheet for the above research.
2. I have asked all the questions that I wanted to ask and they have been answered.
3. I understand what participation in the research means to me.
4. I understand that the information regarding our household and family that is collected in this research will remain confidential.
5. I understand that my participation is voluntary, I can choose not to answer any individual question or all of the questions, and I am free to withdraw from the research at any time and without giving any reason.
6. I agree to be re-contacted and I note that when and I am re-approached, I will be provided with full information about any additional questions.
7. I agree to take part in this research.

____________________	________________	________________
Name of participant	Date	Signature or Thumb print
________________________	______________	________________
Name of research leader/researcher	Date	Signature

In case a parent or guardian is unable to read and/or write, an impartial witness should be present during the informed consent discussion. After the written informed consent form is read and explained and the participant (or guardian) gives verbal consent, the witness should fill in the following information:

________________________________	________________
Name of participant	Thumb print of participant

_____________________	____________	________________
Name of person witnessing consent	Date	Signature or Thumb print
____________________	________________	________________
Name of research leader/researcher	Date	Signature

Appendix 3: Questionnaire

Note to Enumerator: Explanation to interviewer My name is………….. from SUA. We are working on a research concerned with "Ccontribution of fish in improving micronutrients content in complementary foods for children aged 6 to 23 months at Lindi". In this study we are requesting information on fish and non-fish based complementary foods commonly used for 6 to 23 months old children, feeding practices and food availability information in Lindi Rural District. The study will also involve collection of cooked foods samples of the commonly used complementary foods. We therefore request for your willingness and time to participate in the interview. The interview will take 30 minutes only. All the information we obtain is for educational purposes only and will strictly remain confidential. Also, you are not obliged to answer any question you do not want to, and you may stop the interview at any time.

A. Demographic Information (write the code/number/answer on space provided)

i. Caregiver

Name of the caregiver		
Code number		____
Respondent phone number		
Relationship with the child	1. Mother 2. Grandmother 3. Other (specify)	
Caregiver's age	day/month/year	__ / __ /____
	Age in completed years	
Village	1. Mchinga 1 2. Mchinga 2 3. Mchinga 3	
Marital status	1. Currently married (monogamous) 2. Currently married (polygamous) 3. Widowed	

	4. Divorced 5. Single 6. Others (specify)	
Occupation	1. Housewife 2. Farmer 3. Livestock keeper 4. Employed 5. Self employed 6. Others (specify)	
Educational level	1. None 2. Primary school 3. Secondary school 4. Higher (specify)	
	Year you completed at that level?	
Number of household members	Including the children	
Number of children per household		

ii. Child

Child's name		
Child's sex	1. Male 2. Female	
Child's age	day/month/year	__ /__ /____
	Age in completed months	

B. CHILD FEEDING PRACTICES (tick/write an answer on the dash)

i. Breastfeeding practices

Question 1: Has the child ever breastfed?

1. Yes □
2. No □

Question 2: How soon was the child breastfeed after delivery?

1. Within 1 hour □
2. In more than 1 hour □

Question 3: Was the child fed the first milk (colostrum) or it was discarded?

1. Yes □
2. No □

Question 4: Was the child breastfed yesterday during the day or at night?

1. Yes □
2. No □
3. Don't know/no answer □

Question 5: If the child is no longer breastfeed, at what age your child stop breastfed? ______________________

Question 6: Why did you stop breastfeeding your child?__________________

Question 7: If the child still breastfeed, how many times do you normally breastfeed your child per day?

1. 1 to 4
2. 5 to 7
3. 8 and above

ii. Complementary feeding practices

Question 8: Does the baby consume any food other than breast milk?

1. Yes □
2. No □

Question 9: At what age did your baby start eating foods in addition to breast milk?

1. At six months □
2. Before six months □
3. After six months □
4. Don't know □

Question 10: Dietary diversity (**tick/write the number on the dash)**

Group	**Food List**	**No**	**Yes**
Group 1: Grains, roots and tubers	Porridge, wheat, rice, maize, millet		
	Sweet potatoes, Irish potatoes, yams, cassava, bananas		
Group 2: Legumes	Cowpeas, pigeon peas, beans,		

and nuts	peanuts,		
Group 3: Dairy products	Infant formula		How many times? ______
	Milk (powdered or fresh animal milk)		How many times? _______
	Yogurt		How many times? _______
	Other dairy products		
Group 4: Flesh foods	Liver, kidney, heart or other organ meats		
	Any meat, such as beef, goat, chicken or duck		
	Fresh or dried fish, shellfish or seafood		
	Insects		
Group 5: Eggs	Eggs		
Group 6: Vitamin A fruits and vegetables	Pumpkin, carrots, sweet potatoes (yellow or orange)		
	Any dark green vegetables (amaranth, sweet potatoes leaves, cassava leaves, pumpkin leaves, spinach)		
	Ripe mangoes, ripe papayas, others		
	Foods made with red palm oil,		
Group 7: Other fruits and vegetables	Any other fruits or vegetables		
Others	Any oil, fats, or butter or foods made with any of these score		
	Any sugary foods, such as sweets, candies, pastries, cakes or biscuits		
	Condiments for flavor, such as chilies, spices, herbs or fish powder		

Question 11: How many times did the baby eat foods (meals and snacks) other than liquids yesterday during the day or at night?

1. Number of times ______
2. Don’t know/no answer

Question 12: What kind of food you frequently (almost everyday) give your child?

____

Question 13: Do you process it yourself (mixing the food ingredients) before cooking or purchase ready to use ones?

1. Purchase ◻
2. Self-processed ◻

Question 14: If purchased (qn 14 above),

1. Mention name of the processed food product
   ____
2. Mention where/from who you purchased
   it____

Question 15: If you self-process the food, how do you prepare a common complementary food used for the child (for non-fish based)

Name Of The Food			
Ingredients	**Preparation of Ingredient**	**Amount**	**Preparation of the Food**

Question 16: Did you use salt to cook the meal eaten by the child last night?

1. Yes □
2. No □
3. Don't know/no answer □

Question 17: If Yes: What kind of salt did you use? (Probe)

1. Packed salt in industrialized sealed packets □
2. Rock salt/ground salt in plastic bags □
3. Don't know/no answer □

Question 18: Why do you prefer to use salt you mentioned above

1. Availability □
2. Affordability □
3. Preference □
4. No reason □
5. Other (specify)____

C. FOOD AVAILABILITY AND ACCESSABILITY

Question 19: What is the major source(s) of food for your household?

1. Own production □
2. Purchase □
3. Gifts □
4. Food aid/donation □

Question 20: If you self-process (mixing the food ingredients) the complementary foods for your child before cooking, where do you get the raw materials?

1. Purchase □
2. Self-produce (cultivate/animal keeping/fishing) □
3. Food aid/donation □

Question 21: How many times per day do you normally feed your child apart from breast milk during lean/dry season?

1. Once □
2. Twice □
3. Thrice □
4. Don't know/no answer □
5. Other (specify) □

Question 22: How many times per day do you feed your child apart from breast milk during wet/harvesting season?

1. Once □
2. Twice □
3. Thrice □
4. Don't know/no answer □
5. Other (specify)

____

Question 23: How difficult is it for you (in terms of access either by money or physically) to provide different types of food to your child each day?

1. Not difficult □
2. Somehow difficult □
3. Difficult □

If difficult: Can you tell me the reasons why it is difficult?

____

____

Question 24: Do you consume any type of fish in your household?

1. Yes □
2. No □

Question 25: What kind of fish do you normally consume in your household?

Type of Fish	Frequency per week	Frequency per month

Question 26: Do you give your child fish of any type (either as food or snack)?

1. Yes □
2. No □

Question 27: If no (qn 26), why?

____

____

IF YES (QN 26)

Question 28: What are the types of fish do you normally give your child?

Type of Fish	Frequency per week	Frequency per month

Question 29: How difficult is it for you (in terms of access either by money or physically) to provide any type of fish to your child when it is out of season?

1. Not difficult □
2. Somehow difficult □
3. Difficult □

Question 30: If somehow difficult/difficult: Can you tell me the reasons why is it so?

____

____

Question 31: How difficult is it for you (in terms of access either by money or physically) to provide any type of fish to your child when it is in season?

1. Not difficult □
2. Somehow difficult □
3. Difficult □

Question 32: If somehow difficult/difficult: Can you tell me the reasons why is it so?

____

____

Question 33: In what forms do you give your child a fish? (as a snack or added in the porridge)

1. Flesh (boiled) □
2. Sun dried □
3. Smoked □
4. Fried □

Question 34: At what meal time is fish based diet normally served to your child?

1. During breakfast □
2. At snack time □
3. Main meal (lunch or dinner) □
4. Others____

Question 35: How to prepare a fish based food for the child

Fish Based Food			
Ingredients	**Preparation of Ingredient**	**Amount**	**Preparation of the Food**

Question 36: Is there any person who is involved in fish business in your household?

1. Yes □
2. No □

Question 37: If yes (qn 32 above), who is involved in fish business in your household?

____

Question 38: If yes (qn 32 above), how exactly?

1. Fishing □
2. Vending fish □
3. Others (specify)____

Question 39: How do you benefit from the fish business?

1. Meal diversification □
2. Source of income □
3. Both (1 and 2) □
4. Others (specify)____

Question 40: 24-hours dietary recall

Meal	Food List	Description	Preparation method	Amount		Net Grams	
				Served	Consumed	Served	Consumed
Breakfast							
Snack							
Lunch							
Snack							
Dinner							
Snack							

THANK YOU VERY MUCH FOR YOUR COOPERATION

Enumerator's name:………………………………………

Appendix 4: Ingredients for preparing complementary foods

Type of dishes common consumed	Ingredients	Cooking time (min)	Method of cooking
NON-FISH BASED COMPLEMENTARY FOODS			
RM	132g dehulled maize flour; 20g salt; water.	22	Boiling
UM	124g hulled maize flour; 18g salt; water.	25	Boiling
C	112g cassava flour; 22g salt; water.	30	Boiling
UMMBR	127g (0.25kg millet; 0.25kg soya beans; 0.5kg rice; 0.5 hulled maize flour); 20g salt; water.	27	Boiling
UMMGR	132g (0.25kg millet; 0.25kg groundnuts; 0.5kg rice; 0.5 hulled maize flour); 20g salt; water.	16	Boiling
FISH BASED COMPLEMENTARY FOODS			
Boiled fish 1	193g *kibua* fish; 29g salt; lemon (1), water	20	Boiling
Boiled fish 2	187g *tasi* fish; 32 g salt; lemon (1), water	20	Boiling
Boiled fish 3	112g *lupapa* fish; 33g salt; lemon (1), water	18	Boiling
Stiff porridge	100g hulled maize flour; water;		Boiling
Fish stew 1	240g boiled *kibua* fish; 249g tomatoes, 47g onions; 125g irish potatoes; 499ml coconut cream; 20g salt.	18	Stewing
Stiff porridge	100g hulled maize flour; water.		Boiling
Fish stew 2	220g boiled *tasi* fish; 246g tomatoes, 49g onions; 129g irish potatoes; 354ml coconut cream; 25g salt.	15	Stewing
Stiff porridge	100g hulled maize flour; water.		Boiling
Fish stew 3	153g boiled *lupapa* fish; 194g tomatoes, 16g onions; 120g irish potatoes; 389ml coconut cream; 20g salt.	20	Stewing
Banana dish 1	255g boiled *kibua* fish; banana; 219g tomatoes; 28g onions; 306ml coconut cream.	18	Boiling
Banana dish 2	223g boiled *tasi* fish; banana; 208g tomatoes; 22g onions; 343ml coconut cream; 20g salt.	20	Boiling and Stewing
Banana dish 3	130g boiled *lupapa* fish; banana; 188g tomatoes; 19g onions; 276ml coconut cream; 20g salt.	17	Boiling and Stewing
Potato dish 1	245g boiled *kibua* fish; 402g irish potatoes; 132g tomatoes; 24g onions; 262ml coconut cream; 20g salt.	26	Boiling and Stewing
Potato dish 2	212g boiled *tasi* fish; 416g irish potatoes; 166g tomatoes; 16g onions; 249ml coconut cream; 20g salt.	28	Boiling and Stewing
Potato dish 3	1320g boiled *lupapa* fish; 410g irish potatoes; 128g tomatoes; 24g onions; 284ml coconut cream; 20g salt.	22	Boiling and Stewing

Appendix 5: Ethical clearance certificate

THE UNITED REPUBLIC OFTANZANIA

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NIMR/HQ/R.8a/Vol. IX/2372

22nd December 2016

Hope Masanja
C/o Dr. Theresia Jumbe
Sokoine University of Agriculture
College of Agriculture
Department of Food Technology, Nutrition and Consumer Sciences
P. O. Box 3006
MOROGORO

CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH IN TANZANIA

This is to certify that the research entitled:Contribution of Fish in Improving Micronutrients Content in ComplementaryFoods for Children Aged 6 to 23 Months at Lindi Rural (Masanja H et *al)* has been granted ethical clearance to be conducted in Tanzania.

The Principal Investigator of the study must ensure that the following conditions are fulfilled:

1. Progress report is submitted to the Ministry of Health, Community Development, Gender, Elderly & Childrenand the National Institute for Medical Research, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from National Institute for Medical Research.
3. Copies of final publications are made available to the Ministry of Health, Community Development, Gender, Elderly & Childrenand the National Institute for Medical Research.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine. NIMR Act No. 23 of 1979, PART III Section 10(2).
5. Site: Lindi Rural, Lindi.

Approval is for one year: 22nd December 2016to 21st December 2017.

Name: Dr Julius J Massaga

Signature
Ag CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE

Name: Prof. Muhammad Bakari Kambi

Signature
CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH, COMMUNITY DEVELOPMENT, GENDER, ELDERLY &CHILDREN

CC: **RMO** LINDI
DED LINDI RURAL
DMO LINDI RURAL