

**CONTRIBUTION OF CASSAVA TO NUTRITION OF CHILDREN 2-5 YEARS AND
THEIR PRIMARY CARE GIVERS IN COASTAL KENYA**

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HUMAN NUTRITION OF THE UNIVERSITY OF NAIROBI**

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2015

DECLARATION

I, Evangeline Wangari Nginya, hereby declare that this dissertation is my original work and has not been presented for a degree in any other university.

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DEDICATION

This work is dedicated to my loving husband Gachiengo Ng'ang'a and dear children Ng'ang'a Gachiengo and Waithera Gachiengo for their endless support in my academic journey.

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OPERATIONAL DEFINITIONS

Household

A household refers to people who cook and share a meal from the same pot.

Nutrient adequacy

This refers to experimentally derived intake that has been taken from a population that appears healthy. No criteria are applied other than absence of deficiency.

Food Security

Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Nutrition Security

Nutrition security refers to the ability of individuals to obtain and utilize adequate nutrients from the food they consume.

Food Availability

This refers to a situation where people have sufficient quantity of food for consumption.

Food Access

This is the ability to obtain food regularly through own production or purchase.

Stability of Access to food

This refers to the access to food by people not changing over time, hence they remain food secure.

Utilization

This refers to ability of people to consume food maximally without wastage, in addition to the body being in a state that is healthy to enable it to metabolize the food consumed.

Ugali

This refers to a thick paste made by mixing water and flour. It's a common dish in Kenya

ABBREVIATIONS

EAAPP	Eastern Africa Agricultural Productivity Project
KALRO	Kenya Agricultural and Livestock Research Organization
DDS	Dietary Diversity Score
P:E	Protein energy ratio
ANOVA	Analysis of Variance
FAO	Food and Agriculture Organization
WHO	World Health Organization
KDHS	Kenya Demographic and Health Survey
MUAC	Mid-Upper Arm Circumference
WAZ	Weight for Age Z-score
WHZ	Weight for Height Z-score
HAZ	Height for Age Z-score
DRC	Democratic Republic of Congo
SSA	Sub-Saharan Africa
FE	Foreign exchange
SD	Standard deviation
SPSS	Statistical Package for Social Scientists
CN	Cyanide

ABSTRACT

Malnutrition remains a major threat to child survival, growth and development in Kenya. To mitigate this threat, cassava, a crop that was initially seen as a poor man's crop, has received intensive promotion in East Africa, Kenya included. The current study was part of a larger intervention project known as the Eastern Africa Agricultural Productivity Project(EAAPP) which together with the Kenya Agricultural and Livestock Research Organization (KALRO), was undertaken to promote research in cassava as well as ensure increased production and utilization of cassava in different parts of Kenya, particularly Western and Coastal regions. The main objective of this study was to establish the contribution of cassava to nutrition of children 2-5 years and their primary care givers in coastal Kenya.

The study was a cross-sectional survey carried out in Mombasa, Kilifi and Kwale Counties. Multi-stage sampling was used, where 20 villages were selected in the region, in which a total of 220 households were randomly selected. Data was collected on household demographic characteristics, cassava production and consumption, dietary diversity of 2-5 years old children, their morbidity experiences and anthropometric measurements which included weight, height and the mid upper arm circumference (MUAC) were taken and the age of each child recorded. Eight samples from two cassava varieties were collected from KALRO Mtwapa for laboratory analysis to determine the effects of boiling on cyanide and protein content. A semi-structured questionnaire, food frequency questionnaire and dietary diversity questionnaire were the main tools used to collect the data. Results were analyzed using the statistical package for social scientists (SPSS), Nutri-survey and ENA for SMART softwares.

Respondents for this study were the primary care givers of the children, mostly mothers. The results showed that households in Coastal Kenya had a mean of 5 people, with a sex distribution

of 45% males and 55% females. Sixty three per cent of the households were farming households, out of which 88% produced cassava in addition to other crops. About 98% of the households consume cassava, most preferred variety being Kibanda Meno by 54% of the households. Primary care-givers obtained up to 28% of their daily energy from cassava every consumption time, while children obtained approximately 22% of their daily energy requirements from cassava every consumption time. Boiling resulted in losses of protein and cyanide in the two varieties of cassava analyzed. Significant ($p < 0.05$) losses were noted in protein content of Kibanda Meno roots and leaves. The mean dietary diversity score of the children was found to be 5.2 with a standard deviation of 1.45. This was above the expected dietary mean score of 4. Food consumption patterns indicated that the children consumed various protein rich foods more than 3 times in a week, which, together with appropriate dietary diversification, serves as a positive step towards preventing cases of protein energy malnutrition (PEM).

Nutritional status of the children showed that more than 90% of the children had normal weight for age and weight for height. However, stunting levels, which indicate chronic malnutrition, showed that 22% of the children were moderately stunted, while 7% were severely stunted, indicating prolonged periods of food shortage. About 94% of the children had received all the necessary immunizations, although more than 50% of the children were found to have been sick two weeks prior to the survey.

It can be concluded that cassava serves as a good source of energy for children and primary care givers in Coastal Kenya. Majority of the children had normal levels for the three indicators of malnutrition assessed. However, due to the low nutrient content of cassava, adequate dietary diversification is required in order to meet dietary requirements and prevent deficiencies.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Cassava plays an important role in food security, income generation and employment creation, thus improving the livelihoods of the rural population in Kenya (Egesi et al., 2007; Mwang'ombe et al., 2013). However, the high burden of malnutrition in Kenya presents a threat to achieving Millennium Development Goals (MDGs) and Vision 2030. The achievement of these global and national policy strategies, such as eradication of extreme poverty and hunger by 2015 (MDG 1) and ensuring environmental sustainability (MDG 7), is likely to be derailed by climate change phenomenon. Climate change threatens to exacerbate existing threats to food security and livelihoods; as it is expected to affect all of the components that influence food security: availability, access, stability and utilization. Climate change could affect staple crop production, especially in the most vulnerable and food insecure areas of Kenya (Lobell and Field, 2007). Identification and promotion of energy dense crops that can resist drought and do well in nutrient poor soils is one such solution.

Cassava, yams and sweet potatoes are important sources of food in the tropics. The cassava plant however, is grown throughout the tropics and can be regarded as the most important crop, in terms of area cultivated and total production (Akinpelu et al., 2011). It gives the third highest yield of carbohydrates per cultivated area among crop plants, after sugarcane and beetroot. The importance of the crop to many Africans is also reflected in the name given for the plant in some West African countries, *agbeli*, meaning there is life (Akinpelu et al., 2011).

Cassava is strategically valued for its role in food security, poverty alleviation and as a source of raw materials for agro-allied industries, with a huge potential for the export market (Egesi et

al., 2007). A wide range of products can be processed from cassava as demonstrated by data from the collaborative study of cassava in Africa (COSCA) by Kenyon et al. (2006). In West Africa for example, it is principally consumed in fermented form as a meal known as '*gari*'. In addition, the crop can also be processed into starch for many food and non-food uses. Cassava flour is used in preparation of porridge, *ugali*, bread, biscuits, confectionery, pasta and couscous-like products and in the preparation of adhesives while cassava starch is used in foodstuff and can also be used for alcohol production, among other agro-based industrial uses (Kenyon et al., 2006)

However, cassava roots contribute to calories and are a good source of vitamin C, but lack most of the other nutrients. They have the lowest protein-energy ratio (P:E), approximately 2% compared to other staple crops (Lukmanji, 2008). Though the leaves have a higher proportion of proteins, minerals and vitamins than the roots, the roots still remain the most important portion of the plant due to their high consumption levels (Lukmanji, 2008). Therefore, although cassava remains an important food security crop, there is need for the populations relying on it as a staple food to properly diversify their diets to meet all their nutrient needs and avoid deficiencies.

Malnutrition has adverse effects on the growth and development of children. Children, especially those between 2 and 5 years are the most at risk because of their high nutrients requirements for growth and development (Mariara et al., 2009). It can lead to disability, illnesses and death and jeopardize future economic growth by reducing the intellectual and physical potential of the entire population (Mariara et al., 2009). It also has a great negative effect on the health of women, affecting their general well-being, productivity and at times the

health of their children. All possible measures should therefore be put in place to solve the existing problem of malnutrition and prevent the situation from worsening in future

(Mariara et al.,2009). The current study sought to establish the contribution of cassava to nutrition and nutritional status of children 2-5 years and their primary care-givers in Coastal Kenya.

1.2 Problem Statement

Cassava plays an important role in food security, income generation and employment creation (Egesi et al., 2007; Mwang'ombe et al., 2013). It is a calorie dense root, with ability to survive in harsh conditions and remain available for consumption throughout the year (Lukmanji et al., 2008). There has been intensive promotion to improve cassava production in the Coastal region of Kenya, both as a food security and an industrial crop. With increased production and promotion, there is a tendency for many households to over-depend on the crop as a major source of calorie. However, due to its predominant deficiencies in protein and other nutrients such as Zinc, Iron and Vitamin A, populations that solely rely on cassava have been shown to suffer deficiencies from most of these nutrients (Stephenson et al., 2010). The need to assess cassava utilization in the households together with dietary diversity and protein energy intake, especially for children below 5 years who are most at risk can therefore not be overemphasized. Such information is lacking as far as the coastal Kenya where the crop is heavily consumed is concerned. The study sought to understand the diversity of the diets of cassava consumers, especially children 2-5 years as well as their nutritional status.

1.3 Justification

It is estimated that 190 million under-five year old children in developing countries are chronically malnourished and in Africa, 38.6% are stunted and 7.2% wasted (WHO, 2008). Globally, malnutrition is estimated to contribute to over 50% of child deaths (UNICEF, 2009). Malnutrition is a big public health problem in Kenya. According to the Kenya Demographic and Health Survey (2008-09) 16% of children below 5 years are underweight (low weight-for-age), 4% are severely underweight, and 35% are stunted. If this problem is not addressed, more children will continue to die before their fifth birthday, while those who survive will not be able to achieve their full potential. Cassava being a drought resistant crop that can be produced throughout the year can play a major role in solving the problem of food insecurity in Africa.

With continued promotion of increased cassava production, the quantity of cassava available for consumption is likely to increase. However, this will not automatically result to increased consumption of a crop that has over the years been considered as the poor man's crop. There is therefore need to establish the level of consumption of cassava in areas where intensive promotion is ongoing.

With a study by Stephenson et al. (2010) in western Kenya and the lake Victoria region indicating that 89% of Kenyan children in the study population obtained >25% of their daily energy from cassava, and 53% of them had inadequate protein intake, there is need to establish the dietary diversity and nutritional status of children 2-5 years in coastal region so as to prevent the risk of inadequate nutrient intake.

Information generated from this study could be useful to the local communities consuming cassava, by enabling them to understand the nutritional status of their children, scientists

carrying out intensive research in cassava value addition and crop improvement and the donors funding such projects to understand how their effort is benefiting the target population.

1.4 Aim

The aim of the current study was to improve utilization of cassava as a food and nutrition security crop in Kenya.

1.5 Purpose

The purpose of the study was to provide information on the contribution of cassava to nutrition, dietary diversity and nutritional status of children 2-5 years and their primary care givers in coastal Kenya

1.6 Study Objectives

The overall objective was to establish the contribution of cassava to nutrition of children 2-5 years and their primary care givers in coastal Kenya.

The specific objectives were:

1. To establish the socio-demographic characteristics of the study population
2. To determine the dietary diversity of children 2-5 years in coastal region of Kenya
3. To determine the amount of dietary energy and protein obtained from cassava by the children 2-5 years and their primary care-givers in Coastal Kenya

4. To determine the effect of boiling on protein and cyanide content of cassava roots and leaves
5. To establish nutritional status and morbidity experience of children 2-5 years in the study region

1.7 Study hypothesis

1. There is no significant difference between the socio-demographic characteristics of Coastal Kenya and the Kenya national averages
2. There is no significant difference between diets of children below 5 years in Coastal region and the recommended minimum of 4 food groups per day
3. Consumption of cassava in Coastal Kenya is high (>25% of daily energy intake)
4. Boiling has no significant effect on protein and cyanide content of cassava roots and leaves
5. There is no significant difference in nutritional status of children under 5 years in Coastal region and the Kenya national average

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

Cassava plays five major roles to varying extent in African development. It is a famine reserve crop, rural food staple, cash crop for urban consumption, livestock feed and industrial raw materials (Curran and Cook, 2009). Cassava production in Sub-Saharan Africa (SSA) was historically a significant staple crop for smallholder farmers and it continues to be the second most important food crop in Africa (after maize) in terms of the calories consumed (Curran and Cook, 2009). Although it has primarily been grown as a staple crop, it is now expanding as a cash crop as markets continue to expand in urban areas of Africa and around the world.

Cassava production in SSA is dominated by Nigeria, which produces nearly 40% of SSA cassava. Other key producers include DRC, Ghana, Tanzania and Angola. DRC leads consumption both in terms of tons per year (15.9 million tons per year) and per capita yearly consumption (300kg|person|year). Nigeria also consumes a large amount of the crop (14.2 million tons per year), but because of her large population, their per capita yearly consumption ranks 15th in SSA at 257 Kcal/capita/day (FAOSTAT, 2009). Data show that in Angola, Ghana and Nigeria, cassava consumption is slightly less than half of the amount produced in respective countries (FAOSTAT, 2009).

Unfortunately, official trade statistics do not usually record intra-SSA cassava trade. However, it is known that trade in fresh cassava is limited due to its bulkiness and high perishability, therefore most of the cassava in SSA is used domestically or traded among bordering countries, which limits its role in foreign exchange and import substitution (Curran and Cook, 2009)

2.2 Cassava production and consumption in Africa

Cassava, once seen as a poor man's crop in some places, is fast becoming an elite food crop in sub-Saharan Africa (Phillips et al., 2004). It's an ideal food security crop since it combines abilities to produce high yields under poor conditions and store its harvestable portion underground until needed (Nweke, 2003). Cassava is the most important food staple in Nigeria and Bénin and ranks second after rice in Sierra Leone (Sanni et al., 2009). In terms of volume, Bénin is the third and Sierra Leone the seventh among producers of fresh cassava roots in West Africa (FAOSTAT, 2009). According to FAO statistics, worldwide production of cassava roots has nearly doubled in the last 30 years, reaching 213 million tons in 2005.

Annual population growth is about 2.8% in most West African countries while annual urban growth is generally significantly higher (about 5%) than rural growth (1%). An annual urban growth rate of 5% for a 10-year period implies a 63% increase in the urban population and the demand for food (Essers et al., 2005). To feed the urban dwellers, food supply from every farm household has to increase by at least 63% in 10 years. An increasing trend emerging across Africa is the consumption of cassava as a basic urban food staple and an important cash crop for rural farmers. Therefore, high-yielding cultivars and labor-saving technologies are required. In the future, urbanization and the rural exodus will be driving forces behind the market demand for cassava. More of the harvest is being sold as *gari* (roasted, fermented granules), paste, or chips. The transition towards a cash crop is in a more advanced stage in Nigeria than in Bénin and Sierra Leone where the evolution from a food security crop to an income-generating commodity has commenced only recently (Essers et al., 2005).

2.3 Nutritional value of cassava

Composition of nutrients in cassava depends on the specific part of the crop (whether root or leaf) and on other factors such as geographic location, variety, plant age and the prevailing environmental conditions (Montaghac et al., 2009). The roots and leaves are nutritionally valuable parts of the plant and they constitute 50% and 6% of the mature plant respectively (Montaghac et al., 2009). The nutritional value of cassava roots is important because they are the main part of the plant that is consumed in developing countries. They are a good source of energy while the leaves provide proteins, vitamins and minerals (Montaghac et al., 2009). The proximate mineral and vitamin composition of roots and leaves are reported in Table 1, while Table 2 compares the nutrient composition of raw cassava to other staple crops.

Table 1: Proximate, vitamin, and mineral composition of cassava roots and leaves

	Cassava roots (100g)	Cassava leaves (100g)
Food energy in kcal	110 -149	91
Moisture (g)	45.9 -85.3	64.8 -88.6
Dry weight (g)	29.8 -39.3	19 -28.3
Protein (g)	0.3 -3.5	1.0 -10.0
Lipid (g)	0.03 -0.5	0.2 -2.9
Carbohydrate, total (g)	25.3 -35.7	7 -18.3
Dietary fiber (g)	0.1 -3.7	0.5 -10.0
Ash ^e (g)	0.4 -1.7	0.7 -4.5
Thiamin (mg)	0.03 -0.28	0.06 -0.31
Riboflavin (mg)	0.03-0.06	0.21 -0.74
Niacin (mg)	0.6 -1.09	1.3 -2.8
Ascorbic acid (mg)	14.9 -50	60 -370
Vitamin A (µg)	5.0 -35.0	8300 -11800
Calcium (mg)	19 -176	34 -708
Phosphorus, total (mg)	6 -152	27 -211
Ca/P	1.6 -5.48	2.5
Iron (mg)	0.3 -14.0	0.4 -8.3
Potassium (%)	0.25 - 0.72	0.35 -1.23
Magnesium (%)	0.03 - 0.08	0.12 - 0.42
Copper (ppm)	2.00 - 6.00	3.00 - 12.0
Zinc (ppm)	14.00 - 41.00	71.0 - 249.0
Sodium (ppm)	76.00 - 213.00	51.0 - 177.0
Manganese (ppm)	3.00 - 10.00	72.0 -252.0

Source: USDA, 2008

Table2: Nutritional composition of different kinds of foods (100 g) in comparison to cassava root

Food	Water (g)	Energy (kcal)	Energy (kj)	Protein (g)	Total lipid (g)	Ash (g)	Carbohydrate by difference (g)	Dietary fiber (g)	Sugars (g)
Cassava, raw root	59.68	160	667	1.36	0.28	0.62	38.06	1.8	1.7
Potato, raw	79.34	77	321	2.02	0.09	1.08	17.47	2.2	0.78
Cereals									
Wheat flour, unenriched	11.92	364	1523	10.33	0.98	0.47	76.31	2.7	0.27
Bread, wheat	35.74	266	1115	10.91	3.64	2.2	47.51	3.6	5.75
Rice, white, unenriched	12.89	360	1506	6.61	0.58	0.58	79.34	—	—
Corn, sweet, white, raw	75.96	86	358	3.22	1.18	0.62	19.02	2.7	3.22
Corn, yellow	10.37	365	1527	9.42	4.74	1.2	74.26	7.3	0.64
Sorghum	9.2	339	1418	11.3	3.3	1.57	74.63	6.3	—
Vegetables (raw)									
Green beans	90.27	31	129	1.82	0.12	0.66	7.13	3.4	1.4
Carrots	88.29	41	173	0.93	0.24	0.97	9.58	2.8	4.74
Spinach	94	14	59	1.5	0.2	1.8	2.5	—	—
Lettuce, green leaf	95.07	15	61	1.36	0.15	0.62	2.79	1.3	0.78
Soybeans, green	67.5	147	614	12.95	6.8	1.7	11.05	4.2	—
Animal products									
Raw egg (white)	87.57	52	216	10.9	0.17	0.63	0.73	0	0.71
Cheese, Cheddar	36.75	403	1684	24.9	33.14	3.93	1.28	0	0.52
Milk (whole)	88.32	60	252	3.22	3.25	0.69	4.52	0	5.26

Source: USDA, 2008

Cassava has nearly twice the calories provided by potatoes, perhaps the highest for any tropical starchy tubers and roots with 100g of the roots providing 160 calories. Sucrose forms the bulk of the sugars in the tubers (more than 69%) followed by a complex sugar amylose (16-17%). Though lower in proteins and fats than cereals and pulses, it has more protein than other tropical food sources such as yams, potatoes and plantain (Rudrappa, 2009). Like the other roots and tubers, cassava is free from gluten and hence can be used in preparation of special foods for patients suffering from celiac disease (Rudrappa, 2009).

Young tender cassava leaves are good sources of dietary protein and vitamin K which has a potential role in bone mass building by promoting osteotropic activity in the bones and also has established role in treatment of Alzheimer's disease patients by reducing damage in the brain (Rudrappa, 2009). It's also a moderate source of vitamins such as folates, thiamin, pyridoxine (vitamin B-6), riboflavin and pantothenic acid (Rudrappa, 2009). The root is a chief source of some important minerals like zinc, magnesium, copper, iron and manganese for many inhabitants in the tropical belt. It also contains a significant amount of potassium, 271mg per 100g or 6% of the RDA, which is an important component of the cell and body fluids that helps regulate heart rates and blood pressure (Rudrappa, 2009).

2.4 Cyanide presence in cassava

The cassava plant adapts to various climates and its harvest can be delayed for a long time. This makes cassava, a very important food reserve during the dry season, food shortage or famine (FAO, 2000). Indeed the plant contributes to solve food insecurity problems and poverty in rural areas in Africa. Nutritionally, it is a major source of calories in the form of starch. However, the roots of the cassava contain cyanogenic glycosides that can potentially release cyanide ions (Cliff et al., 2011). These cyanides are known by far to be toxic for human. Cyanide (CN) in the body, directly or indirectly interferes with the functioning of certain organs and enzymes (Rocha-e-Silva et al., 2010). Goiter, cretinism, tropical ataxic neuropathy or spastic paralysis are among the diseases attributed to the toxic effects of CN diets, dominated by root of cassava non or poorly treated, and of low protein content (Cliff et al., 2011). Therefore, the elimination of CN is very crucial in cassava processing (Nambisan, 2011).

Traditional methods proposed for this application have required long time treatment (Lüet al., 2009). However, during famine, these methods are ignored by the populations and cassava is not treated prior to processing and consumption (Cliff et al., 2011). In this way, CN content in the food only depends on cooking method, exposing consumers to CN intoxication (Nambisan, 2011).

2.5 Effect of cooking on the protein, energy and cyanide content of cassava roots and leaves

A study conducted in Togo to evaluate the influence of harvest time and cooking on the reduction of cyanide content in cassava-based foods (Tchacondo et al., 2011) showed that there were significant variation of CN content in the range of 375 ± 3.32 and 27 ± 14.28 ppm, within

cultivars. Ten cassava cultivars were collected from the National Collection in Togo. The CN content was measured to examine the influence of the cultivars, time of harvest, drying, grinding, boiling flour and the mixture of flour with corn flour. The maximum CN content was obtained when the crop was harvested during the dry season (375.3 ± 3.32 ppm) and the minimum in the rainy season (93.05 ± 2.35 ppm). Variations occurring within a 24 hour period (circadian variation) were also observed, with high concentration in the morning (67.3 ± 1.75 ppm) and low concentration in the evening (50.55 ± 4.32 ppm).

For the same cultivar, the cyanide content of fresh tuber was at least two times greater than that of the dried one and five times higher than that of the dough. The mixture of cassava flour with corn flour significantly reduced the CN content of the dough, but this decline was stabilized for corn flour above 40% (Tchacondo et al., 2011). Thus, by acting on the various studied factors, the amount of cyanide in cassava-based food can be sufficiently reduced. Cyanide content determined in fresh and dried cassava roots also indicated significant decreases. Fresh tubers were found to contain more cyanide than dried tubers, with drying resulting in cyanide decrease rate of 64.5% ($P < 0.02$). Cyanide determined in flour and cassava dough yielded 133.2 ± 2.27 and 71.4 ± 3.8 mg/kg, respectively. However, boiling flour resulted in 53.6% decrease in cyanide amount ($P < 0.027$) (Tchacondo et al., 2011).

A study conducted by Ayankunbi et al. (1991) on some cassava products (*gari*, *lafun*, and *fufu*) showed that there was a slight and variable decrease in protein content of the products with *gari* retaining the lowest amounts of protein. This was done by carrying out a proximate analysis on raw samples and a sample of the cooked products.

2.6 Malnutrition among children below 5 years

Malnutrition is a serious medical condition marked by a deficiency of energy, essential proteins, fats, vitamins, and minerals in a diet. Over 10 million children aged less than five years die annually from preventable and treatable illnesses, almost all these deaths occurring in poor countries (Black et al., 2003). Malnutrition contributes to more than one-third of all deaths of under-five children (UNICEF, 2009). Currently, 195 million under-five children are affected by malnutrition in the world, 90% of them living in sub-Saharan Africa and South Asia. At least 20 million children suffer from severe acute malnutrition (SAM), and another 175 million are undernourished (Black, 2008). Malnutrition is the most recognizable and perhaps most outward consequence of poverty in children (Goel, 2007).

Malnutrition affects physical growth, morbidity, mortality, cognitive development, reproduction, and physical work capacity, and it consequently impacts on human performance, health and survival. It is an underlying factor in many diseases for both children and adults, and is particularly prevalent in developing countries, where it affects one out of every 3 preschool-age children (Mahgoub et al., 2009). A well-nourished child is one whose weight and height measurements compare very well with the standard normal distribution of heights and weights of healthy children of the same age and sex. Factors that contribute to malnutrition are many and varied. The primary determinants of malnutrition, relate to unsatisfactory food intake, severe and repeated infections, or a combination of the two (Mahgoub, 2006).

2.6.1 Role of climate change in malnutrition

Climate change affects food production in complex ways. Direct impacts include changes in agro-ecological conditions; indirect impacts include changes in economic growth and distribution of incomes, which in turn affect demand for agricultural produce. Empirical

evidence suggests that increases in temperature in the period 1980–2008 have already resulted in average global maize and wheat yield reductions of 3.8% and 5.5% respectively, compared to a non-climate change scenario (Lobell et al., 2011a).

To date, climate trends have been largely offset by gains derived from technology, carbon dioxide fertilization, and other factors (Lobell et al., 2011a). Future changes in climate patterns coupled with population dynamics could result in higher vulnerability. In tropical latitudes, where much of the current food security problems exist, increases in temperature are expected to be predominantly detrimental. The quality and quantity of cropland available is projected to decrease under climate change. In West Africa, for example, crop yields could decrease by approximately 11% due to adverse effects of increased temperatures and lower precipitation (Roudier et al., in press). More specific country-level analyses show that adverse climate trends could reduce the quantity of land available for crop production in some countries. In Kenya, for instance, a long-term study by FEWS NET (2010) notes that long rains have declined more than 100 millimeters since the mid-1970s and this trend could continue. If this trend continues, food security would be affected due to reduction in available prime arable land, which could affect critical surplus maize growing areas in central Kenya (Williams and Funk, 2010).

Crop and climate models have also been used to assess the potential impact of climate change on the availability of food (Lobell and Field, 2007). Generally, the results indicate that changes in temperature and precipitation due to anthropogenic greenhouse gas emissions will affect land suitability and crop yields. Research suggests that higher temperatures will predominantly benefit agricultural production in the temperate latitudes; the areas for potential production expand, the growing season length increases, cold weather events are reduced and, for many

areas precipitation increases (IPCC, 2007). Climate change could affect food access, that is, the ability of individuals, communities and countries to obtain sufficient quantities of good-quality food. Over the last thirty years, falling real prices for food and rising real incomes have increased purchasing power in many developing countries but recent market volatility has highlighted the vulnerability of poor and marginal households to price shocks (Schmidhuber and Tubiello, 2007). The relationships between climate change and food access are complex especially because it is difficult to quantify and model the impacts of economic growth. Moreover, any benefits associated with income growth might be offset by increases in prices. If income levels rise moderately but remain low, and the amount of income spent on food remains high, increases in food prices will exacerbate food insecurity trends (Schmidhuber and Tubiello, 2007).

Understanding the specific impacts of climate change on food security is challenging because vulnerabilities are unevenly spread across the world and ultimately depend on the ability of communities and countries to cope with risks. In the context of food security, some regions of the world might experience gains under climate change, but developing countries are likely to be negatively affected. Projections suggest that the number of people at risk of hunger will increase by 10–20% by 2050 due to climate change, with 65% of this population in Sub-Saharan Africa. The number of malnourished children could increase by up to 21% (24 million children), with the majority being in Africa (Parry et al., 2009; Nelson et al., 2009).

2.7 Cassava consumption and nutrient adequacy

Cassava is the staple of more than 200 million individuals worldwide, most of who live in Africa (FAOSTAT, 2009). It is drought tolerant and grows well in soils with modest nutrient composition. Worldwide, cassava production is approximately 225 million tons, an increase of

30% over the past 15 years (FAOSTAT, 2009). Cassava, however, has the lowest P: E of any staple crop; the protein content among common cassava cultivars is typically only 1% (Stupak, 2006) Populations that consume large amounts of cassava may well be at risk for inadequate dietary protein intake. An observational study was conducted in Kenya and Nigeria, testing the hypothesis that consuming cassava as a staple food places children 2-5 years old at risk for inadequate protein intake. Inadequate protein intake was found in the diets of Nigerian and Kenyan children consuming cassava as a staple food (Stephenson et al., 2010).

Although cassava is rich in carbohydrates, it is very poor in proteins and vitamins and as such, several projects are underway to improve the nutrition potential of cassava such as the introduction of Vitamins A to make the crop more suitable for combating hunger and food security issues (Harvest Plus, 2012). Cassava leaves could serve as an unconventional protein resource for both humans and animals. However, the principal problems that could undermine this potential are the high fiber content and the presence of anti-nutrients typified by cyanide, tannin and phytin (Oyojedi, 2005).

2.8 Cassava Processing and Utilization

Nigeria, Benin and Sierra Leone have shown remarkable success in cassava processing at both commercial and domestic scales, although to varying degrees. Most unit operations of processing make use of machines, which has greatly eased the labor intensiveness of the trade, releasing time for women to get into other income generating activities and allowing them to attend to family responsibilities (Sanni et al., 2009). In all the three countries, cassava is processed into some common products: *gari*, *lafun* and starch. Each country also has some exclusive cassava-based products being traded for example *gari* cassava bread(very thin, small, flat round pieces) are mainly traded in Sierra Leon; *gari*, starch, chips and high quality cassava

floor (HQCF) are common in Nigeria and *gari* and starch are common in Benin (Sanni et al., 2009).

In the traditional areas of North and South America, the tubers are grated and the sap is extracted through squeezing or pressing. The cassava is further dried over a fire to make a meal, or it is fermented and cooked. The meal can then be rehydrated with water or added to soups or stews. In Africa generally, the tubers are processed in several different ways. They may first be fermented in water, and then either sun-dried for storage or grated and made into dough that is cooked. Alcoholic beverages can be made from the roots. Cassava has a high content of fermentable substances. This makes it appropriate for the production of alcohol. The fresh tubers contain about 30% starch and 5% sugars, and the dried tubers contain approximately 80% fermentable substances (which are equivalent to rice as a source of alcohol) (Rey, 2006).

2.9 Major Traditional Cassava Products in West Africa

Gari is the most traded and consumed of all food products of cassava roots. *Gari* the most popular cassava product consumed in Africa. To prepare *gari* cassava roots are washed, peeled and grated. The pulp is then placed in cloth bags or sacks made from jute and left to ferment, the fermentation time varying from three to six days. It is the fermentation process that gives *gari* its characteristic sour flavour, which distinguishes it from Brazilian *farinha* (FAO, 2009). During this stage pressure is applied to squeeze out the cassava juice. The cassava pulp, at about 50 percent water content, is taken out of the sacks and sieved to remove any fibrous material. It is then heated or "garified" in shallow pans and stirred continuously until it becomes light and crisp (FAO, 2009).

Fufu is also a fermented product. In the preparation of *fufu* the roots are peeled, washed, grated and left to ferment for two to three days. To ferment the cassava the grated mass is either simply left to stand or put into sacks and weighed with stones to squeeze out the juice. The resulting dough is used at once for cooking or it is stored in basins covered with cold water which is changed daily. The resulting product is consumed in different ways in different countries accompanied by stew or soup (FAO, 2009).

Tapioca is one of the names for the cassava plant. A granular product made from partly gelatinized cassava starch, known as *tapioca* too, is also common. It's made by roasting moist cassava in a mash or heat treating it in shallow pans in a manner similar to roasting *gari*. The roasted tapioca appears as irregular lumps, called flakes, or perfectly round beads. The product is however quite expensive because the processing steps are quite labor demanding. It is consumed in many parts of West Africa, soaked or cooked in water either with sugar and milk or without (Sanni et al., 2009)

Attieke (cassava granules) is steam-cooked and prepared from fermented pulp. The process makes it possible to obtain fresh *attieke*, which is usually sold in the markets. The dried form, obtained from the fresh product is similar to couscous. Other cassava-based products are also available in West African countries (Sanni et al., 2009).

2.10 Cassava production and utilization in Coastal Kenya

Cassava is the second most important staple crop after maize in the coastal lowlands of Kenya. Its productivity in the region is low, at 10 tons per hectare (Munga, 2000), compared to the potential yield of 50-70 t ha⁻¹ fresh root (Gethiet al., 2008). One of the reasons for low productivity is the use of low yielding varieties (Munga, 2000). The high perishability of the

roots also limits the duration of handling the unprocessed root. As a result of the poor productivity and the need to extend the root shelf life, there has been increased promotion of cassava production by the Ministry of Agriculture and KALRO through the use of improved high yielding varieties (Gethi et al.,2008), and value addition of the root (KARI, 2009).

About 38% of the cassava produced is for domestic consumption and 51% of the farmers make dried chips for domestic use or sale to starch or feed factories, or as an intermediate for flour production (Kiura et al., 2005). Cassava crisps for human consumption is also a value-added product in the Coastal lowland Kenya. The use of blended cassava flour for making bread, porridge, chapattis (unleavened flat bread) and *mahamri* has also been successfully demonstrated (KARI, 2009).However, farmers in the region complain of low prices of the chips, since the crop is bought at 0.066 USD per kilogram by a starch-producing factory in the coastal region (Kiura et al., 2005). In 2006, a feed producing company from Nairobi had offered to buy the chips at 0.088 USD per kilogram but later pulled out due to the anticipated high transport cost. Farmers had insisted on a price of 0.111 USD per kilogram. Farmers cited labor for weeding as the main cost during cassava production (Kiura et al., 2005).

2.11 Measuring food consumption by individuals

24-Hour Dietary Recall

In the 24-hour dietary recall, the respondent is asked to remember and report all the foods and beverages consumed in the preceding 24 hours or in the preceding day. The recall typically is conducted by interview, in person or by telephone, either computer-assisted or using a paper-and-pencil form, although self-administered electronic administration has recently become available (Thompson and Subar, 2008).

When interviewer-administered, well-trained interviewers are crucial because much of the dietary information is collected by asking probing questions (Thompson and Subar, 2008). Ideally, interviewers should be dietitians with education in foods and nutrition; however, non-nutritionists who have been trained in the use of a standardized instrument can be effective (Thompson and Subar, 2008).

The goal of this method is to document food and beverage consumption and nutrient intake in a given sample. This method records the daily, self-reported consumption of individuals and is most accurate when administered more than once for each participant (Benard, 2006). Some researchers argue that this interview method is most accurate when administered between 3 and 7 times, although others assert that administration at least twice is acceptable (Cupples et al., 1992).

Twenty-four hour diet recalls are useful for research that aims to gather nutritional information from individuals, but it also allows researchers to assess what types of foods are being consumed by individuals in a specific community (Benard, 2006). The interview style of the recall allows participants and researchers to interact and discuss food and food types during the interview. This can often give the researcher rich contextual and ethnographic data to accompany the quantitative nutritional assessment (Benard, 2006).

All interviewers should be knowledgeable about foods available in the marketplace and about preparation practices, including prevalent regional or ethnic foods. The interview is often structured, usually with specific probes, to help the respondent remember all foods consumed throughout the day (Thompson and Subar, 2008).

2.12 Estimating Nutrient Intake from Food Consumption Data

This requires conversions of food intakes to nutrient intakes, which require both a food composition database and ideal computer programmes for nutrient calculations. Nutrient values in food composition databases are derived from quantitative analysis of samples of each food (Gibson, 2005).

Food composition data (FCD) are detailed sets of information on the nutritionally important components of foods and provide values for energy and nutrients including protein, carbohydrates, fat, vitamins and minerals and for other important food components such as fibre. The data is presented in food composition databases (FCDBs) (Church, 2009).

Food composition databases (FCDBs) or food composition tables are resources that provide detailed food composition data (FCD) on the nutritionally important components of foods. FCDBs provide values for energy and nutrients including protein, carbohydrates, fat, vitamins and minerals and for other important food components such as fibre. Before computer technology, these resources existed in printed tables with the oldest tables dating back to the early 19th century (Colombani, 2011)

The data need to be representative of all regions of a nation. However, food composition values are often of variable quality and derived from many different sources. The values, therefore, may need to be augmented by use of several methods, especially for values of local foods, one such methods being direct chemical analysis (Gibson, 2005). Values in food composition databases are usually expressed in terms of the nutrient content of the edible portion per 100g of the food or per common household measurements.

2.13 Direct chemical analysis of foods

Direct chemical analysis (CA) is the recognized gold standard for the assessment of food composition. However, CA is expensive and requires substantial technical expertise so that it is generally used to develop and validate food composition tables (FCT) which are then employed in field studies of nutrient intake (Battistini et al., 1992).

Food items to be analyzed are selected with great care being taken to ensure that a representative sample of each foods item is collected. The sampling protocol should take into consideration factors such as seasons and regional differences in food composition, genetic variations, variations due to stages of ripeness, handling and storage procedures, differences due to the effects of fertilizers, methods of food preparation, processing and production practices (Gibson, 2005).

The analytical methods chosen need to be accurate, precise and feasible. However, food analysis is costly and time consuming, which requires one to draw a balance between making use of existing data and augmenting a database with new chemical analysis. Priority should therefore be given to analyzing those foods that meet all the following criteria: Have inadequate (or data is non-existent) on the component of interest in the food or the food as eaten; the food forms a significant component of the local diet and the food contributes significantly to the intake of the dietary component of interest (Gibson, 2005).

2.14 Gaps in Knowledge

Although there has been a lot of promotion to increase cassava production in coastal Kenya, the role that cassava plays in nutrition has not yet been established. Changes in protein and cyanide content of local varieties Kibanda Meno and Tajirika due to the common preparation practice of boiling has also not yet been established.

CHAPTER THREE

3.0 STUDY DESIGN AND RESEARCH METHODOLOGY

3.1 Study setting



Figure 1: A map of Coastal Kenya showing Mombasa, Kwale and Kilifi Counties

Source: Expert Africa (2012)

3.1.1 Coastal region of Kenya

Coastal region (Swahili: *Pwani*) of Kenya, is located along the Indian Ocean. It is mainly inhabited by the Mijikenda and Swahili among others tribes. The Coastal region, formerly Coastal Province covered an area of 79,686.1 km² with a population of 3,325,307 in 2009. Currently, Coastal region comprises of six Counties, which include Mombasa, Kwale, Kilifi, Lamu, Tana River and Taita-Taveta. The current study was carried out in three counties; Mombasa, Kilifi and Kwale.

3.1.1.1 Kwale County

The County's capital is Kwale although Ukunda is the largest town. The total population of the county is 649,941 people, with 122,047 households and covers a total area of 8270.2 square kilometers (KNBS, 2009). It is mainly an inland County but it has a coastline south of Mombasa. The county has four constituencies; Msambweni, Lungalunga, Matuga and Kihango. The population density is 79 per square kilometer and 74.9% of the population lives below the poverty line (KNBS, 2009).

3.1.1.2 Mombasa County

The County has a total population of approximately 939,370 people with 268,700 households and covers an area of 218.9 square kilometers. The population density is 4,292 per square kilometer with 37.6% of the population living below the poverty line (KNBS, 2009). Some strengths of Mombasa County include natural resources, for example, the Mombasa Marine Park and reserve, and tourist attractions such as beach tourism, historical and cultural.

3.1.1.3 Kilifi County

Kilifi County has a population of approximately 122,899 people and covers a total surface area of 12,610 KM², which accounts for 2.17 per cent of Kenya's total surface area. The population density is 88 per square kilometer with about 53% of the population lives below the poverty line (KNBS, 2009). It borders the Counties of Tana River to the North, Taita-Taveta to the West, Mombasa and Kwale to the South and the Indian Ocean to the East. The County's capital is the coastal town of Kilifi, which lies on the Kilifi Creek between Mombasa and Malindi towns. Other major towns include Malindi, Mtwapa, Watamu, Mariakani, Kaloleni, and Gongoni. The topography of the county is dominated by low-range sandstone hills, and a terrain that generally slopes towards the sea.

3.2 Study Design

The study comprised both analytical and descriptive components. The descriptive study was carried out in form of a survey (cross-sectional study) and was conducted to establish the socio-demographic characteristics and morbidity experiences of the study population together with other qualitative data.

Analytical component comprised of observational studies. This was conducted to determine the percentage of dietary energy and protein obtained from cassava and cassava based products, establish nutritional status of children 2-5 years in the study region, determine the relationship between the level of consumption of cassava and cassava based products by children 2-5 years old, their nutritional status and morbidity experience and in determination of the effect of boiling on the protein content of cassava roots and leaves.

3.3 Study population

The study was conducted in households in Kwale, Kilifi and Mombasa counties. The population studied comprised mainly of the rural coastal communities, with majority practicing some form of agriculture.

3.4 Inclusion and Exclusion Criteria

3.4.1 Inclusion criteria

The study included households with children aged 2-5 years. In households with more than one child within the age bracket, one child was randomly selected.

3.4.2 Exclusion criteria

The study excluded children not present in the household at the time of the survey and those on visit to the study households.

3.5 Sampling

3.5.1 Sample Size Determination

The sample size was determined using Fisher's formula (Fisher's et al., 1991) as follows:

$$n = (z^2 pq) / d^2$$

Where:

n=the desired sample size

z=the standard normal deviation which is 1.96 at 95% confidence interval

p=proportion of wasted (low weight for height) children in coast province being 14% (KDHS, 2008)

q =proportion of children in coastal Kenya who are not underweight ($q=1-p=0.86$)

d =the level of statistical significance was set at 5%

Therefore, the desired sample size was found to be 185 households ($n = (1.96^2 \times 0.86 \times 0.14) / 0.05^2 = 185$), plus 20% attrition=222 households.

3.5.2 Sampling Procedure

3.5.2.1 Sampling for the survey

In Coastal region, Mombasa, Kwale and Kilifi Counties were purposively selected due to the intensive promotion of increased cassava production by the Eastern Africa Agricultural Productivity Project (EAAPP) in the region. Ten locations from the three counties; four in Kwale, three in Kilifi and three in Mombasa were conveniently sampled considering the accessibility of the villages, population density and distances between households. Two hundred and twenty households were selected through random stratified sampling.

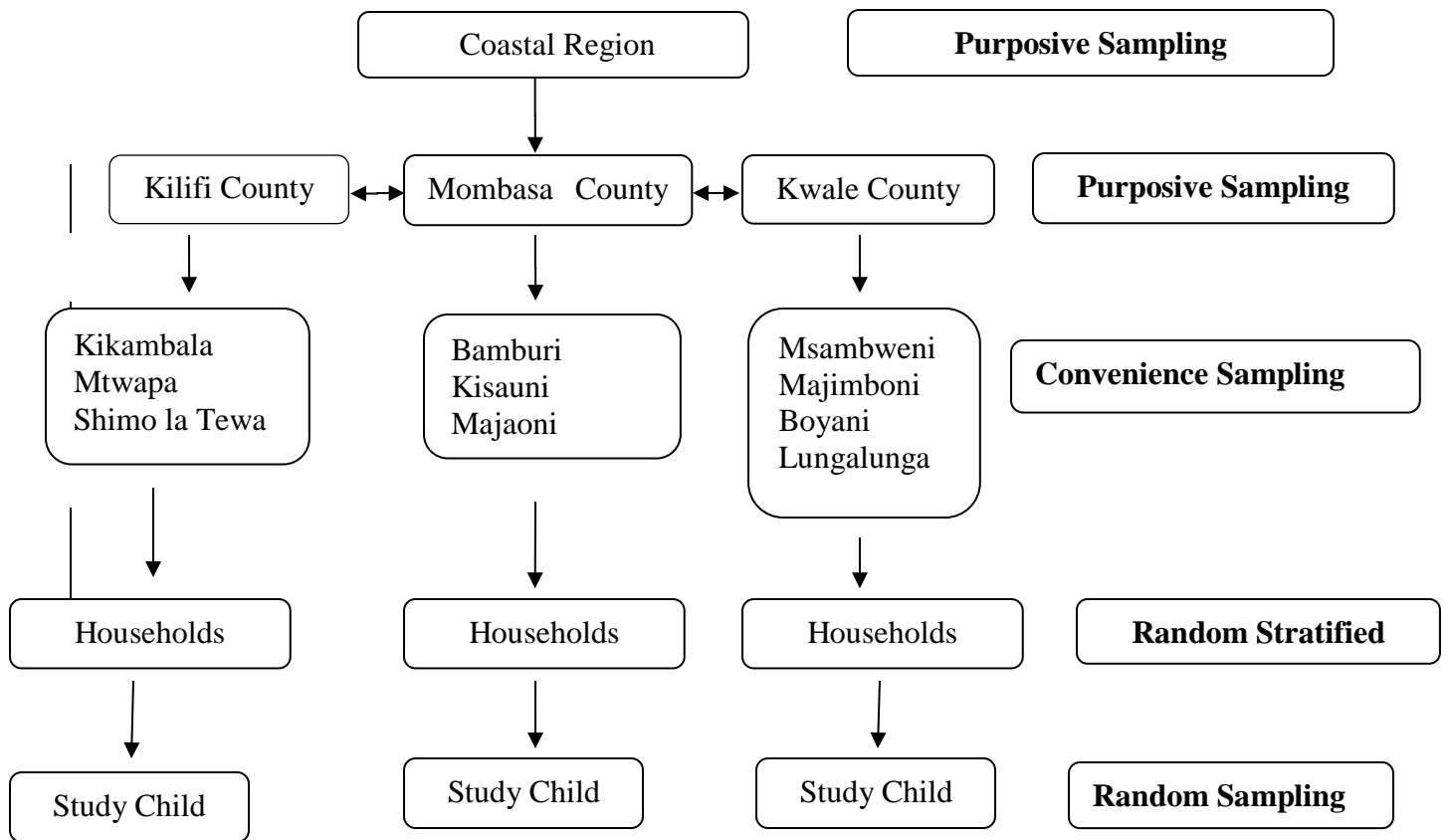


Figure 2: Sampling procedure

3.5.3 Sampling for determination of effects of cooking methods on protein and cyanide content of cassava

Raw samples of cassava roots and leaves from the two most common varieties were collected from KARI Mtwapa for laboratory analysis of protein and cyanide. Cooking method used was boiling, done in the laboratory imitating what goes on in the households.

3.6 Determination of crude protein and cyanide content of cassava

Cassava roots were peeled, boiled in water, and then grated to increase the surface area. The leaves were first washed in water then pounded using motor and pestle before boiling in water.

This was done in close supervision by a Mijikenda woman who was conversant with the practice in the community.

Crude protein was analyzed by weighing 0.5g of sample in a nitrogen-free filter paper, mixing the sample with Kjeldahl catalyst and 20ml concentrated sulphuric acid following the Kjeldahl method in AOAC 2000; while cyanide levels were determined through distillation of crushed cassava root samples and titrating in 5% potassium iodide solution according to AOAC, 1985.

3.7 Anthropometric measurements

The respondents were requested to avail their children for measurements where their height, weight and mid-upper arm circumference (MUAC) were measured and their age recorded. Anthropometric measurements were taken in duplicates, after which the average was calculated.

3.7.1 Height

In obtaining the height of children, the respondents assisted in removing excessive clothing especially head scarf and shoes. The two trained research assistants then guided the child on standing up straight on the height board with their feet together, knees straight, and heels, buttocks and shoulder blade in contact with the vertical surface of height board. Measurement of height was done to the nearest 0.1 cm using a height/length board recommended by UNICEF (2009).

3.7.2 Weight

The weight of the children was taken using Salter weighing scale. The respondents were asked to remove excessive clothing from the children. The trained field assistants then assisted in putting on the weighing pants in the children, and hanging on the scale. Readings were taken to the nearest 0.1kg.

3.7.3 Mid Upper Arm Circumference (MUAC)

MUAC of the children was measured using MUAC tapes released by UNICEF in 2007. The respondents were asked to hold the children, and the tape was wrapped round upper arm of the less active hand, mostly the left hand. The trained assistants then took the reading at the arrow mark.

3.8 Pre-testing the questionnaire

Trained field assistants were involved in pre-testing the questionnaire in 14 households that were randomly sampled in Mombasa County. Care was taken not to include the households involved in pretesting in the actual survey. The pre-testing was helpful in identifying the appropriateness of the questionnaire in meeting the desired objectives and assessing the competence of the enumerators in carrying out the actual survey.

3.9 Data quality control

The quality of the data was controlled through proper training of the field assistants, close supervision of the field assistants during data collection by the principle investigator, daily checking of questionnaire to ensure that they were correctly and completely filled, and data cleaning i.e. extreme entries and wrong entries were removed.

3.10 Research tools and equipment

The main research tool was a semi-structured questionnaire, while the equipment that were used included Salter weighing scale, height boards, MUAC tapes, kitchen scales and measuring cylinders.

Data was collected through face to face administration of semi-structured questionnaires which had sections of socio-demographic characteristics of the study population, cassava production practices, food frequency questionnaire, 24 hour recall, morbidity and nutritional status assessment. Dietary assessment was done using the 24-hour recall method, food frequency questionnaire and dietary diversity scoring. Food portions were weighed using kitchen scale and measuring cylinder. Anthropometric assessment was done by measurement of weight and height, while clinical assessment involved looking out for physical signs of protein energy malnutrition.

3.11 Data analysis

Statistical Package for Social Scientists (SPSS) version 16 was used to compute descriptive statistics, establish correlations between different variables such as education level by sex and consumption of various cassava based products by County, and compare means such as average monthly income by County and care practices given to the children by County through analysis of variance (ANOVA). Energy and protein obtained from cassava-based diets were calculated using Nutri-survey. Intakes were then compared in terms of the Recommended Dietary Allowances (RDA) for age and sex to determine the percentage of requirement obtained from the diet. Nutritional status of the children was calculated using the Emergency Nutritional Assessment software (ENA for SMART).

3.12 Ethical consideration

Research permit was obtained from the National Commission for Science, Technology and Innovation. The respondents were informed on the purpose of the study, objectives, and possible benefits of the study. Each participant was requested to sign a consent form prior to the

interview to ensure that they were aware of the terms and conditions before they agree to participate in the interview.

CHAPTER FOUR

4.0 RESULTS

4.1 Demographic and socio-economic characteristics of the study population

The study population comprised of 45% males and 55% females. The average household size was 5 persons. About 52% of the study population was dependent, while age of 7% of the study population's was not known (Table 3).

Table 3: Distribution of the study population by age and dependency

Age category	% of population
0-14(dependent population)	51.6
15-64(productive population)	40.5
65+(dependent population)	0.5
Age not known	7

As shown in Figure1, education level of the study population was low and comprised 10% who had never gone to school, 40% who had not completed primary school, 14% who completed primary but did not proceed to secondary school, 3% who had gone to secondary school but did not complete, and only 5% who had completed secondary education. Only 2% of the respondents had tertiary education, this did not differ significantly ($P=0.566$) between Kwale, Mombasa and Kilifi Counties.

Although distribution of education level by sex showed that females had a generally lower level of education than their male counterparts, this difference was not statistically significant ($P=0.21$)

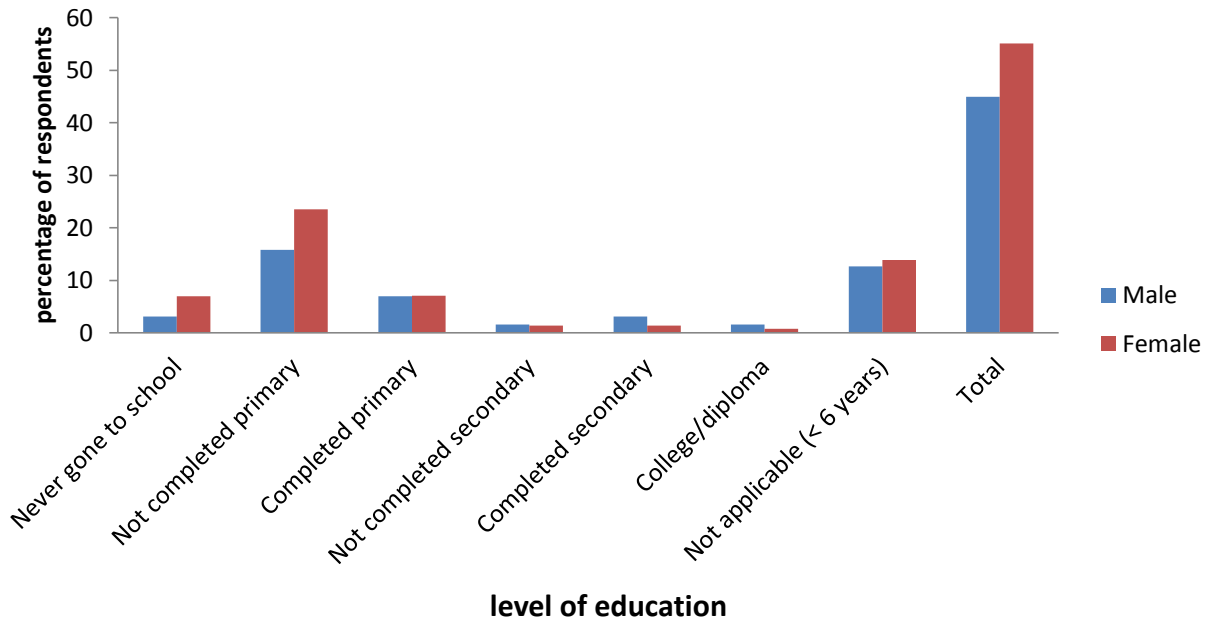


Figure 3: Distribution of education level of the study population by sex

Eighty eight (88) percent of the households were male headed with only 12% of the households female headed. Thirty (30) percent of the household heads were in formal employment, 29% were businesses persons, 27% worked as casual laborers while 14% were either unemployed or practicing farming.

The proportion of the household that derived their income mainly from employment was equal to those who derived their income mainly from business returns at 32% followed closely by casual labor at 22%. The primary source of income for 10% of the households was from sale of crops, while 4% derived their income from sale of other agricultural produces and remittances

The total monthly income of 29% of the households was below Ksh 5,000 per month, while 45% of the households earned between Ksh 5,001 and Ksh 10,000. Nineteen (19) percent of the households earned above Ksh 10,000 per month but below Ksh 25,000 with only 7% of the households earning above Ksh 25,000. Distribution of monthly income per County is as shown in Table 4.

Table 4: Distribution of average monthly income of the households by County

Income Level in Ksh.	County			Total
	Mombasa	Kilifi	Kwale	
5000 and below	5.4	11.8	10	27.2
between 5001 and 10000	17.7	15.4	12.7	45.8
between 10001 and 25000	4.5	9.5	3.6	17.6
above 25000	2.6	4.5	2.3	9.4
Total	30.2	41.2	28.6	100

4.2 Land ownership and crop cultivation practices

Sixty three (63) percent of households practiced farming, while 37% did not practice any form of agriculture. However, only a half (50%) of the study population owned land. Among those who own land, 50% were from Kwale County, 30% from Kilifi County and 20% from Mombasa County. The average land size was 2.5 acres.

Eighty six (86) percent of the farming households gave first priority to maize cultivation, with only 10% of the households indicating cassava as their first priority crop. However, cassava was produced as a second most preferred crop in 66% of the farming households. Kibanda Meno was the most preferred cassava variety and was grown solely by 60% of the households, and in combination with Kaleso variety by 16% of the households. Other varieties grown included Tajirika and Muhogo Mweupe among others, or a combination of more than one variety.

4.3 Source of Cassava and Cassava Consumption Patterns

Almost all(98%) the households including those that did not produce cassava consumed it, with 54% of the households preferring Kibanda Meno, 21% did not know the names of the varieties they consumed, while 16% were satisfied with any variety for example kaleso, tajirika, karembo etc. The sources of cassava for household consumption were found to be almost equal at 45% between own production and local open-air markets. Seven (7) percent and 3%of the households obtained their cassava from individual farmers or the supermarkets, respectively (Figure 2).

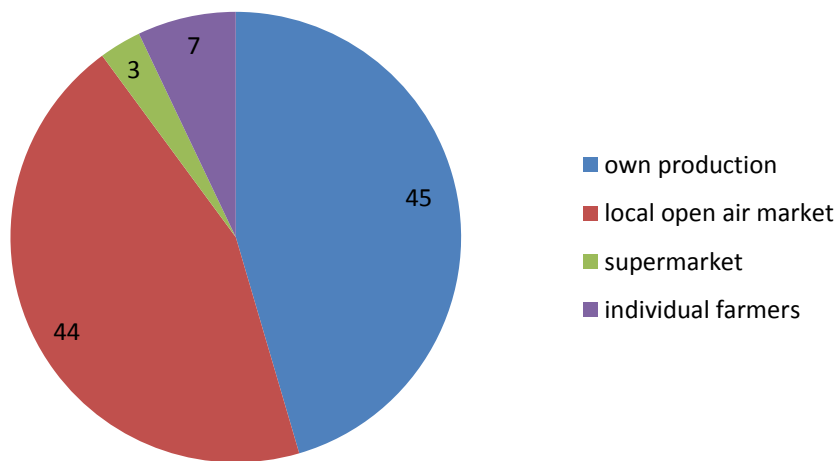


Figure 4: Sources of cassava for the households

Eighty nine (89) percent of the households obtained cassava in its unprocessed form. Cassava was mostly consumed in boiled form by 74% of the households. The rest of the households mostly preferred cassava chips (7.1%), cassava roots or leaves (7%), cassava crisps (4.5%), raw cassava (3.8%), or a combination of more than one form (2%). Distribution of the preference of cassava products per County is as shown in Table 5. The differences in preference of the products were not statistically significant ($P>0.05$).

Table 5: Most preferred forms of cassava consumption by the study population by county

Cassava product	% per County			Total
	Mombasa	Kilifi	Kwale	
boiled cassava	21	28.6	24.5	74.1
cassava leaves	0.5	1	0	1.5
cassava crisps	0.5	3	1	4.5
cassava chips	2.5	4.1	0.5	7.1
boiled cassava, crisps and chips	1	0.5	0.5	2
raw cassava	1.5	1.8	0.5	3.8
both leaves and roots	4	2	1	7
Total	32.0	39.2	28.8	100

At household level, cassava roots were cooked by first boiling in water (94%) for approximately half an hour. When the roots were almost ready to eat, 31% of the households added coconut milk while 69% consumed them without adding anything. However, 4% of the households preferred to shallow fry the cassava while 2% of the households preferred to make cassava ugali.

The frequency of consumption of cassava-based products was as shown in Table 6. Boiled cassava was the most frequently consumed, with 34% and 25% of household consuming boiled cassava once or twice per week and once per month or less, respectively.

Cassava fries, leaves and crisps were the second, third and fourth most consumed cassava based products, respectively. About 25% of the households consumed cassava fries once or twice per week, 30% once per month or less; while 16% consumed cassava leaves once or twice per week and 28% once per month or less; with 16% of household consuming crisps once or twice per week and 24% once per month or less. Cassava leaves were consumed more by the households earning between KES 5001 and 10000, and they mostly consumed the leaves once per month or less.

Cassava based *Ugali* and porridge were not very popular among the households, despite the fact that *ugali (sima)* and porridge from cereals are popular in Kenya. However, maize still remains the most important staple for people in coastal Kenya, followed by Irish potatoes.

Table 6: Frequency of consumption of cassava based products by children and their primary care givers in comparison with other starchy staples

Food Products	Frequency						
	More than once daily (%)	Once daily (%)	3-6 times per week (%)	Once or twice per week (%)	Once per month or less (%)	Never (%)	
Crisps	2	3	9	16	24	46	
Ugali	0	3	6	4	6	81	
Porridge	0	1	4	6	9	80	
Gari	0	1	2	4	9	83	
Boiled cassava	1	2	18	34	25	20	
Fries	0	2	11	25	30	31	
Leaves	1	1	9	16	28	45	
Maize	29	43	26	2	–	–	
Irish potatoes	9	19	33	24	10	5	
Rice	2	7	42	32	14	3	
Sweet potatoes	1	1	6	17	45	30	

The average amount of energy and proteins derived from cassava and cassava-based products by the households were as shown in Table 7. The average amounts of cassava-based products consumed by primary caregivers were higher than those consumed by children. Fries provided the highest amounts of energy for children (327.1 kcal), followed by boiled cassava (325.7kcal) and *gari* (269.4kcal) per any consumption time; while primary caregivers obtained higher amounts of energy from boiled cassava (700.9kcal), followed by *gari* (650 kcal), fries (494.7kcal) and crisps (446.6kcal).

Cassava based *ugali* and porridge yielded less energy for both primary caregivers and children at any consumption time compared to other cassava based products (Table 7). The *ugali* and porridge were made from composite flours comprising 50% maize and 50% cassava flour. The leaves provide least amount of energy but highest amount of protein for both primary caregivers and children at any consumption time compared to other cassava based products.

Table 7: Average amount of energy and protein derived from cassava by children 2-5 years and their primary care givers

Cassava Products	Average Amounts of Energy (kcal) and Protein (g) consumed							
	Average amount consumed by primary care				Average amount consumed by child			
	Energy (kcal)	% of RDA (2500kcal)	Protein (g)	% of RDA (46g)	Energy (kcal)	% RDA (1500kcal)	Protein (g)	% of RDA(15g)
Crisps	446.6	17.8%	3.3	7%	130.6	8.7%	0.9	6%
Ugali	423.0	16.9%	3.1	6.7%	134.7	9%	1.0	6.7%
Porridge	344.9	13.8%	2.5	5.4%	156.7	10.4%	1.1	7.3%
Gari	650.0	26%	4.7	10.2%	269.4	17.9%	2.0	13.3%
Boiled cassava	700.9	28%	5.1	11%	325.7	21.7%	2.4	16%
Fries	494.7	19.8%	3.6	7.8%	327.1	21.8%	2.4	16%
Leaves	69.4	2.8%	10.2	22.2%	29.3	1.9%	4.3	28.7%

4.3.1 Differences in consumption of cassava and its products among three Counties in Coastal Kenya

The quantities of some cassava based products consumed by children and primary care givers differed significantly ($P < 0.05$) between the three Counties as shown in (Table8).

Table 8: Cassava based products consumption in relation to the Counties

Cassava based product	F value	P value	Order of consumption by County (highest to lowest)
Cassava crisps-Children	F(2,38)=3.494	0.040	1,2,3
Boiled cassava-Children	F(2,78)=3.542	0.034	1,3,2
Cassava crisps-Primary Caregivers	F(2,33)=4.472	0.019	1,2,3
Boiled cassava-Primary Caregivers	F(2,81)=10.387	0.000	1,3,2
Cassava leaves-Primary Caregivers	F(2,59)=6.555	0.003	1,3,2

1=Kwale, 2=Mombasa, 3= Kilifi

4.4 Frequency of consumption of protein rich foods by children 2-5 years

Majority of the households provided their under-5 years old children with protein rich foods as shown in Table 9. Fish, milk and its products and pulses were consumed more than three times in a week by more than half of the children studied. Chicken and other fowls were among the least frequently consumed protein rich foods by the study children.

Table 9: Frequency of consumption of protein rich foods by children 2-5 years

Food item	More than once (%)	than daily (%)	Once daily (%)	3-6 times per week (%)	Once or twice week (%)	or per month (%)	Never (%)
Eggs	1		5	17	38	25	14
Fish	4		20	38	27	8	3
Chicken or other fowl	1		3	4	25	54	13
Meats	1		3	11	36	32	16
Milk and its products	14		25	20	18	12	11
Pulses	9		18	34	26	10	3

4.4.1 Dietary diversity of children 2-5 years in the study region

Dietary diversity was analyzed out of 8 food groups. Food groups consumed by the 2-5 years children in 24 hours preceding the study are shown in Table 10. The mean dietary diversity score (DDS) of the children was 5.2 with a standard deviation of 1.45. About 12.3% of the children had a mean dietary diversity score of less than 3 food groups. However, only 2% of the children had consumed food from all the 8 food groups. DDS did not differ significantly ($P=0.491$) between the three counties. There was a weak but significant positive correlation between DDS and household's average monthly income ($r=0.216, P=0.002$).

Table 10: Foods Consumed by 2-5 years Children over 24-Hour period per County

Food Group	% Consumption in the past 24hours							
	CONSUMED				NOT CONSUMED			
	Kwale	Mombasa	Kilifi	Total	Kwale	Mombasa	Kilifi	Total
Starchy staples	100	100	100	100	0	0	0	0
Vegetables	84	92	89	89	16	8	11	11
Fruits	69	77	60	67	31	23	40	33
Meats	61	67	73	68	39	33	27	32
Eggs	13	16	13	14	87	84	87	86
Milk and its products	45	58	49	51	55	42	51	49
Oils and fats	85	86	70	79	15	14	30	21
Legumes	55	48	66	58	45	52	33	42

4.5 Effects of boiling on protein and cyanide content of selected cassava varieties

Cassava leaves had higher protein and cyanide content than the roots, with Kibanda Meno (local variety) leaves having the highest (11.56mg/100g) amount of protein (Table 11) and cyanide (4.84mg/100g) as indicated in Table 12. However, during boiling Kibanda Meno leaves lost highest amount (70.1%) of protein and cyanide (50%), indicating that the common practice of boiling the leaves in this region results in protein loss and cyanide reduction.

Table 11: Protein content (Percentage wet weight basis) of raw and cooked samples

Sample	Raw samples		Cooked samples		% protein loss	
	Roots	Leaves	Roots	Leaves	Roots	Leaves
Tajirika	2.71±0.11	4.33±0.24	1.07±0.05	1.33±0.18	60.5	69.2
Kibanda Meno	4.36±0.09	11.56±0.88	1.94±0.1	3.46±0.23	55.5	70.1

Protein losses were statistically significant at $p < 0.05$

Table 12: Cyanide content (mg/kg wet weight) of Tajirika and Kibanda Meno raw and cooked samples

Sample	Raw samples		Cooked samples		% cyanide loss	
	Roots	Leaves	Roots	Leaves	Roots	Leaves
Tajirika	32.2±5.3	48.0±4	23.7±3.8	21.5±2.1	26.4	55.2
KibandaMeno	35.1±2.3	48.4±0.1	18.9±2.2	24.2±3.3	46.2	50

4.6 Morbidity experience of the children

Ninety four (94) percent of the children had received all the necessary immunizations, 45% of these were confirmed from the clinic cards issued at the Health Centers while 49% were as confirmed by their mothers. Only 6% of the children had not received all the necessary immunization. Majority of the children (52%) were found to have been sick two weeks prior to the study. The illnesses found to be most common among the children were coughs and upper respiratory tract infections (27%), fever (22%), malaria (17%), diarrhea (14%) or a combination of more than one of these illnesses. Most of the mothers (57%) took their sick children to

hospital for treatment, 28% bought drugs over the counter while 15% just observed the children at home.

The distribution of childcare practices is as shown in Table 13. The differences in proportion of all care practices between the three Counties were statistically significant (P=0.007)

Table 13: Care practices (percentage respondents) given to sick children by County

Child Care Practice	Mombasa	Kilifi	Kwale	Total
Observed at home	3.5	10.4	1.7	15.6
Bought drugs over the counter	9.6	11.4	6.1	27.1
Took child to a health facility	13.0	19.1	25.2	57.3
Total	26.1	40.9	33	100.0

4.7 Nutritional status of the children

4.7.1 Height for Age (Stunting)

The prevalence of stunting indicated that approximately 7% of the children were severely stunted, 22% were moderately stunted while 71% of the children had normal height for age. Prevalence of stunting by age groups is shown in Figure3. The levels of stunting in the three counties are as shown in Table 14. Differences in stunting status between the three counties were statistically significant (P=0.003)

Table 14: Stunting levels of children 2-5 years old per County

Nutritional Status	Mombasa(%)	Kilifi (%)	Kwale (%)	Total (%)
Severe stunting (≤ -3 Z-scores)	1.1	1.3	5	7.4
Moderate stunting (≥ -3 to ≤ -2 Z-scores)	7.8	2.3	11.4	21.5
Normal (≥ -2 Z-scores)	26.6	19.5	25	71.1
Total	35.5	23.1	41.4	100

4.7.2 Weight for Age (Underweight)

Cases of severely underweight among the study children were not observed. About 8% of the children were, however, moderately underweight while 92% of the children had normal weight for age (Figure 4). This did not differ significantly ($P=0.248$) between the three Counties.

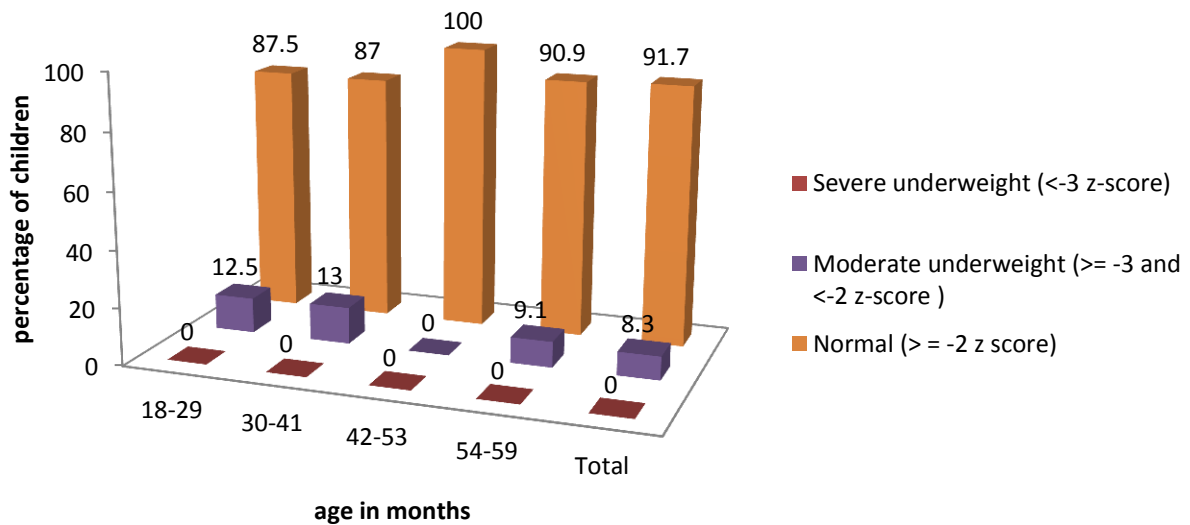


Figure 5: Weight for Age (Underweight) among the children 2-5 years

The level of underweight among the children 2-5 years in the three counties is as shown in Table 15.

Table 15: Distribution of underweight among children 2-5 years old by County

Level of underweight	Mombasa (%)	Kilifi (%)	Kwale(%)	Total (%)
Severe underweight(<-3Z scores)	0	0	4	4
Moderate underweight(>-3 to<-2 Z scores)	6	10	6	7
Normal(>-2 Z scores)	94	90	90	89

4.7.3 Weight for Height (Wasting)

Severe wasting was not very common among the studied children. Only 3% of the children aged 18-29 months were seen to have cases of severe wasting. This represented about 0.7% of the children studied. About 8% were moderately wasted while 90% of the children had normal weight for height (Figure5).A weak positive correlation ($P=0.03$) existed between consumption of cassava leaves with level of wasting, but no correlation was noted with other cassava based products. The differences in wasting levels between the three counties were as shown in table 16 below. However the differences in the wasting levels between the three counties were not statistically significant ($P=0.304$)

Table 16:Distribution of wasting among children 2-5 years old by County

Level of wasting	Mombasa (%)	Kilifi (%)	Kwale (%)	Total (%)
Severe wasting(<-3Z scores)	0	2	2	1
Moderate wasting (>-3 to<-2 Z scores)	5	14	8	10
Normal (>-2 Z scores)	95	84	90	89

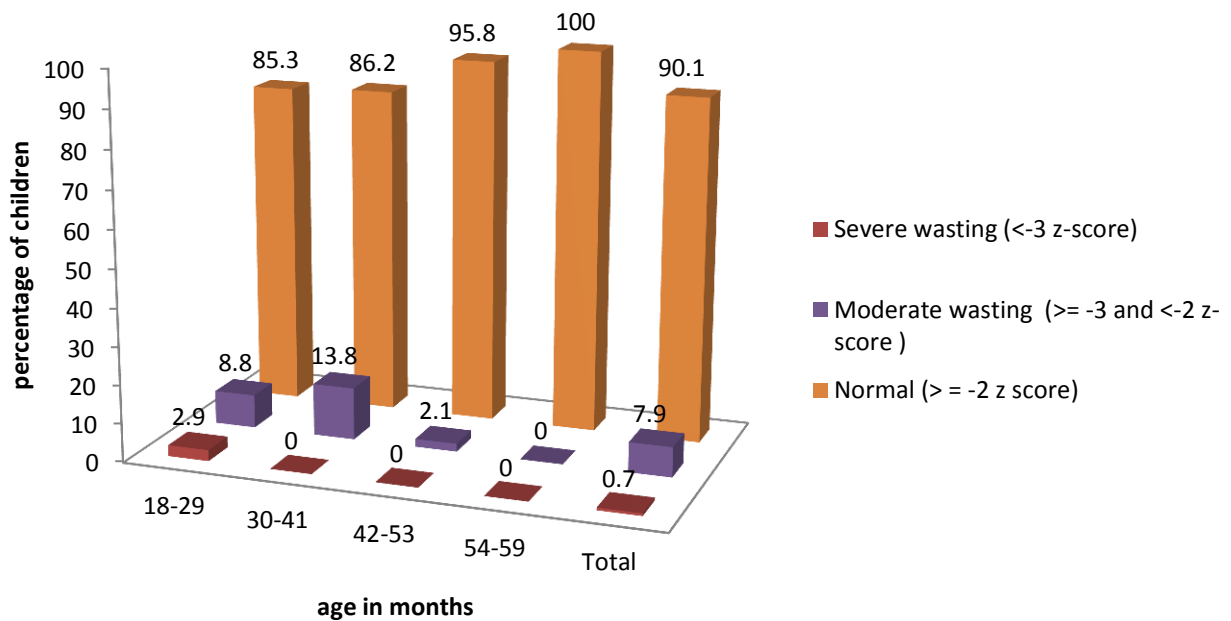


Figure 6: Weight for Height (Wasting) among children 2-5 years

4.7.4 MUAC

The mean MUAC of the children studied was 15.4 cm with an SD of 1.7cm. Using MUAC, no cases of severe malnutrition were identified. Only 5% of the children were moderately malnourished while 95% of the children had normal MUAC ranges. No significant differences (P=0.233) were noted between the three Counties.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Socio-demographic characteristics of the study population

Majority of the study population was below 15 years of age with a dependency ratio of 1.3. A dependency ratio of above a unit indicates that the proportion of population in need of support exceeds the working population, and this often puts economic strain on the households (CBS, 2004). The age-sex composition where females slightly out-number the males and where the proportion of the youthful population exceeds the adults and aged population are similar to the country findings of CBS (1999, 2004)

The mean household size in the study area was 5, which did not differ significantly between the three counties. This is slightly higher than the Kenyan national average household size of 4.6. Large household size puts pressure on the limited resources for meeting health and nutritional requirements (CBS, 2004). A household also tends to become food insecure when all potential resources are strained or threatened (GOK/UNICEF, 1998).

Education level of the study population was generally low, with majority of the population having not completed primary school. Women were slightly lesser educated than the males, which may imply that the girl child is still neglected and resources channeled more towards the boy child in the study region. This may have far-reaching implications in terms of employment opportunities and economic dependence. Lower education usually limits mothers' exposure to general information on nutrition and compromise food choices. KDHS 2008-2009 reported that children of mothers with higher levels of education were better nourished than those of mothers with lower levels, suggesting that most of them were more aware of the nutritional needs of the household members, and were more careful on what they fed their children on.

Males head most of the households (88%), while females head only 12%. Nationally, women head 32% of the households (KDHS, 2003). However, the head of the household, male or female has no effect on food availability since most households have similar economic activities.

5.1.1 Socio-economic characteristics of the study population

Majority of the households earned about a dollar per day. This is below the recommended poverty cut-off of 1 US dollar per person per day (WHO, 1996). This meant that most of the study households were at risk of inadequate access to food. However, since majority of them practiced agriculture for subsistence purposes, it is possible that they were able to obtain most of their dietary needs through own production.

Only 63% of the population practiced agriculture, while 37% of the population did not engage themselves in any agricultural activity. The number of people who engaged in agriculture differed significantly between Mombasa, Kilifi and Kwale, with Mombasa having the lowest percentage (22%) and Kwale the highest percentage (42%). In Kilifi, those who engaged in agriculture formed 36% of the study population. This could be attributed to the land ownership differences, as more people from Kwale County owned land, followed by Kilifi County and the lowest number of people who owned land were from Mombasa County. The skewed land ownership is likely to be as a result of the population density as it decreases from Mombasa, followed by Kilifi and Kwale is the least populous among the three Counties.

Though majority of the households practiced agriculture, it did not serve as the main source of income for the coastal households. Lack of land to practice agriculture could be a factor that would cause some households not to engage in agricultural activities. However, there are other possible reasons such as poor climate for agricultural productivity in coastal region and in-

conducive environment for people to engage in farm activities. This therefore makes cassava an appropriate crop to grow in the coast since it is a drought resistant crop, its perennial and it can stay for long periods in the fields (Tchacondo et al., 2011)

5.2 Food consumption patterns of the study population

5.2.1 Cassava utilization by the study population

Approximately 98% of the households studied consume cassava. This shows that cassava is a highly accepted crop in the coastal region and it has a great potential of increasing household food security. The possibility of processing cassava into various products could enable households to create variety with cassava based products (Kiura et al.,2005). Both roots and leaves are consumed by majority of the population, with consumption of the leaves at 76%. This shows that the population is utilizing cassava appropriately, since the leaves are known to be even more nutritious than the roots (Montaghac et al.,2009) .

The frequency of consumption of cassava based products shows that boiled cassava roots is the most commonly consumed cassava product in the coastal region, while utilization of some cassava based products such as cassava porridge, *ugali* and *gari* is still low. This is probably because most farmers were found to be likely to stick to selling fresh cassava roots due to poor buying prices of chips (Kiura et al.,2005), which could not cover the cost of cassava production and processing. Majority of the consumers were in turn also likely to be consuming the fresh roots in their boiled form.

Consumption of cassava-based products that have not undergone intensive processing was highest in Kwale, followed by Kilifi and the lowest consumption was from Mombasa County. This is probably due to the fact that Kwale County comprised of rural population that owned

larger pieces of land and engaged more in Agriculture. Kilifi County was the second highest in agricultural engagement and in land ownership while Mombasa County was the least engaged in Agriculture and the lowest in land ownership. The consumption pattern could also be as an influence of the poverty levels, which according to KNBS (2014) shows that more people live below the poverty level in Kwale, Kilifi and Mombasa Counties respectively. Since over the years cassava has been viewed as a poor man's crop, this could result to more poor people consuming higher amounts of cassava as compared to their rich counterparts. However, consumption of cassava crisps was higher in Mombasa than Kilifi County, though Kwale County retained the lead. This shows that with more value addition, cassava based products utilization in urban areas is likely to increase.

Most (54%) of the households preferred Kibanda Meno, because of its sweetness and ease in cooking. However, 21% did not know the names of the varieties they consumed, while 16% were satisfied with any variety. This indicates that despite the fact that research institutions are making a lot of effort to develop varieties that are either superior nutritionally or in terms of adaptability, households are not so much informed on this genotypic characteristics of the different varieties and do not make their decisions of consumption based on them, hence more education needs to be done.

Households mostly obtained cassava from own production and local open-air markets. Other households sourced their cassava from individual farmers or from supermarkets. This could imply that cassava production is not a major factor influencing consumption, since own farm is as good a source of cassava as local open-air markets. This therefore could be an indicator of a high potential for commercialization of cassava in the region, as those that did not produce cassava were willing to buy in order to sustain consumption.

5.2.2 Consumption of protein rich foods by 2-5 years old children

The survey based on 24-hour recall data found that over half of the children received adequate amount of protein. With RDA for protein for children 2-3 years and 3-5 years being 22g and 25g respectively (FAO et al., 2004), majority of the children in this region are able to obtain adequate amount of proteins from their diets. This therefore could explain why majority of the children studied had normal parameters for the three indicators of malnutrition, which were well comparable to the findings of KDHS (2008).

5.3 Effect of cooking on Cyanide and protein content of cassava roots and leaves

It was established that cassava roots and leaves had a higher protein and cyanide content while raw than after cooking, with the leaves having the higher content of both protein and cyanide than the roots, both before and after cooking. These findings are in agreement with the findings of the study by Tchacando et al (2011), which identified an almost similar margin of decrease in protein and cyanide content in cassava cultivars with boiling.

Kibanda Meno leaves were found to have higher contents of both protein and cyanide than Tajirika leaves. However, boiling reduced the cyanide content of these leaves by 50%. The decrease in CN can be explained by the formation of HCN under the action of linamarase on the cyanogenic glycoside especially at the beginning of the cooking when the temperature is still low to inactivate enzymes. Part of the cyanide could also have been lost through evaporation (Bradbury and Denton, 2010). Reduction in protein content after boiling could be as a result of leaching in boiling water, since the water was poured off after the product was well cooked (Bradbury and Denton, 2010).

5.4 Nutritional status of the children 2-5 years

Poor nutrition usually results from a combination of several factors such as poverty, ignorance, diseases, poor feeding practices, poor hygiene and sanitation among others. To understand the nutritional status of a population, one usually studies the nutritional status of the under-fives. This is because they are the most vulnerable members in the community.

Stunting is an indicator of chronic malnutrition. The KDHS (2008) preliminary findings indicate that the 35% of Kenyan children under 5 are stunted. The rate of stunting at the time of the study was 29%, of which 7% of the children were severely stunted. This indicates long periods of food insecurity in Coastal region. More levels of stunting were found in Kwale County, which could be associated with lower income levels of study population from this county compared to Kilifi and Mombasa.

The number of children who were underweight at the time of the survey was 12.6%. These children were moderately underweight; no cases of severe underweight were noted. This is close but lower than the national figure of underweight indicated to be at 16% (KDHS, 2008). Underweight being an indicator of acute malnutrition, can be a result of acute food shortage or illness (GOK/UNICEF, 1998). In the case of the current study, this could have been as a result of illnesses, considering that 52% of the children had suffered some illnesses two prior to the study, majority having suffered from upper respiratory tract infections and fever, which did not differ significantly between the counties.

Wasting represents failure to receive adequate nutrition in the period immediately preceding the survey. Children whose weight for height is below minus two standard deviations (-2 SD) from the median of the reference population are considered wasted. Levels of wasting were lower than

that of stunting and underweight. Only 10% of the children were wasted, out of which only 0.7% were severely wasted. The level of wasting at the time of the study was lower than the regional figure of wasting which is at 13.7% for moderate wasting and 3.5% for severe wasting (KDHS, 2008), which can be attributed to the appropriate dietary habits and child feeding practices identified from the survey. A weak positive Pearson correlation between the amount of cassava leaves consumed, and degree of wasting was however noted. This could be attributed to the lower levels of incomes reported by households consuming more cassava leaves, which limited the ability of the households to meet the dietary needs of the children adequately.

5.5 Morbidity experience

Majority of the children had received all the necessary immunizations. However, it was observed that most mothers did not continue taking their children to health clinics for growth monitoring and other advices after the necessary immunizations were obtained, but only visited the clinics when the children were ill, which shows poor understanding of need for growth monitoring programmes and hence low uptake of nutritional information.

Majority of the children had been sick two weeks prior to the survey. The illnesses found to be most common among the children were coughs and upper respiratory tract infections, fever, malaria and diarrhea respectively, or a combination of more than one of these illnesses. This could be associated with the weather patterns at the time of the study, as the region was in its rainy season, which is associated with most of these illnesses. Malaria and acute respiratory tract infections are listed in the Kenya Demographic Health Survey 2003 as being among the major illnesses affecting children in Kenya. More children had been sick two weeks prior to the survey in Kilifi County compared to Kwale and Mombasa. In addition to the cold weather in the region,

Kilifi County could have experienced more cases of child illnesses due to the occurrence of flash floods related to poor drainage.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The population in Coastal Kenya comprises of large households, with 46% of the households earning approximately 3 dollars per day. The main sources of income are business returns and employment.

Dietary diversification in the region is generally appropriate, with majority of the children consuming food from more than half of the food groups per day.

Cassava is consumed by almost all the households in Coastal Kenya, mainly in form of boiled roots. Primary care-givers obtained up to 28% of their daily energy requirement from cassava every consumption time, while children obtained approximately 22% of their energy requirement from cassava. Cassava leaves were the major source of proteins for the primary care-givers and children among the cassava based products that were assessed. The leaves provided the primary care-givers with 22.2% of their daily protein requirements and children with about 28.7% of their daily protein needs.

The common practice of boiling cassava roots and leaves and pouring off excess water leads to significant reduction in level of protein and cyanide content of cassava.

The levels of malnutrition among the children are of mild form. Majority of the children are normal for the three indicators of malnutrition measured. However, morbidity experience of the children is quite high.

6.2 RECOMMENDATIONS

There is need for increased promotion efforts to increase the frequency of consumption of the leaves and some cassava based products. For example, consumption of the fermented cassava based product *gari* was found to be quite low, regardless of the fact that fermentation process increases the bioavailability of nutrients and is beneficial to the health of the gastro- intestinal tract.

Inclusion of leaves in cassava root-based products should be considered, since it would increase both protein and energy intake, thus reducing protein energy malnutrition associated with communities that consume cassava roots as a staple food.

Alternative methods of preparing cassava-based products to ensure reduced cyanide level and retain as much proteins as possible should be considered. This includes for example chopping the products into small pieces and exposing them in the sun for a few hours, soaking in water before cooking, or fermentation.

Food processors should also consider fortification of cassava flour with some nutrients, as is the case with maize and wheat flour in order to increase the nutrient density. They should also consider increasing availability of these products to consumers especially those in urban areas, and continue creating awareness on the products through advertisements and in social media.

More research also needs to be carried out to develop a cassava variety, which is rich in most of the nutrients of public health importance such as proteins. This should however be done with caution to ensure that traditional traits of cassava that makes it acceptable to consumers are maintained, so that the desire for the crop is not lost.

REFERENCES

- Akinpelu, A.O., Amamgbo, L.E.F., Olojede, A.O. and Oyekale, A.S. (2011). Health implications of cassava production and consumption. *Journal of Agriculture and Social Research (JASR)* 11(1): 118-125.
- Ayankunbi, M.A., Keshinro, O.O. and Egele, P. (1991). Effects of methods of preparation on the nutrient composition of some cassava products-Garri (eba), Lafun, and fufu. *Journal of Food Chemistry* 41(3): 349-354.
- Ayodeji, O.F. (2005). Nutrient composition and processing effects on cassava leaf. *Pakistan Journal of Nutrition* 4(1): 37-42.
- Battistini, N., Caselli, D., Bedogni, G. and Gatti, G. (1992). Food intake in University students and its impact on nutritional status. *Nutrition Research* 12: 222-233.
- Bernard, R. H. (2006). *Research methods in anthropology: Qualitative and quantitative approaches*. AltaMira Press, US. pp 58-196.
- Black, R.E., Morris, S.S. and Bryce, J. (2003). Where and why are 10 million children dying every year? *Lancet* 361:2226–2234.
- Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., de Onis, M. and Ezzati, M. (2008). Maternal and Child Undernutrition Study Group. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* 371:243–260.
- Central Bureau of Statistics (CBS), Ministry of Health (MOH) and ORC Macro. (2004). *Kenya Demographic and Health Survey 2003*. Government Printer, Nairobi, Kenya. pp 112-204.
- Central Bureau of Statistics (CBS), Government of Kenya (GoK). (1999). *Kenya Population and Housing Census 2*. Government Printer, Nairobi, Kenya. pp 68-154
- Chaudhury, R.H. (1986). Determinants of nutrient adequacy in a rural area of Bangladesh. *Food and Nutrition Bulletin* 8: 24-30.
- Church S. (2009). Food composition explained. *Nutrition Bulletin* 7(34): 250-272.
- Claude, F. and Denis, F. (1990). African cassava mosaic virus: Etiology, epidemiology, and control-plant disease. Accessed on 8th Jan 2015, at www.academia.edu/7520288/African.
- Cliff, J., Muquingue, H., Nhassico, D., Nzwalo, H. and Bradbury, J.H. (2011). Konzo and continuing cyanide intoxication from cassava in Mozambique. *Food and Chemical Toxicology* 49(3): 631-635.
- Colombani, P.C. (2011). The origins of food composition tables. *Journal of Food Composition Analysis* 24: 732-737.

Cupples., Janet, L., Cobb., Ernst, S., Donald, R., Miller and Ralph B. (1992). Comparison of techniques for estimating nutrient intake: The framingham study. *Journal of Epidemiology* 3(2):171-177.

Curran, S., Anderson, L., Gugerty, M. and Cook, J. (2009). Gender and cropping: cassava in sub-Saharan Africa. *EPAR Brief* 32: 20-99.

denHartog, A.P., Wija, A., Vanctaveren, S. and Inge, D.B. (2006). Food habits and consumption in developing countries. *Manual for social surveys*. pp 103-110.

Egesi, C.N., Ilona, P., Ogbe, F.O., Akoroda, M. and Dixon, A. (2007). Genetic variation and genotype \times environment interaction for yield and other agronomic traits in cassava in Nigeria. *American Society of Agronomy* 99(4): 1137-1142.

FEWS NET, (2006). Understanding nutrition data and the causes of malnutrition in Kenya. Accessed on 23rd June 2014, at www.fews.net/sites/default/files/documents/reports/Kenya.

Food and Agriculture Organization of the United Nations. (2009). Cassava. Accessed on 18th Sept. 2014, at www.fao.org/fileadmin/templates/est/AAACP/estafrica/FAO.

Food and Agriculture organization of the United Nations. (2000). Dynamics of change – The dividends of food security. Accessed on 26th August 2014, at www.fao.org/docrep/x8200e/x8200e00.htm.

Food and Agriculture Organization of the United Nations. (1995). Dimensions of need: An atlas of food and agriculture. Accessed on 2nd Feb 2015, at www.fao.org/docrep/U8480E/.htm.

Food and Agriculture Organization of the United Nations. (1990). Roots, tubers, plantains and bananas in human nutrition. Accessed on 29th Jan 2015, at www.fao.org/docrep/T0207E/T0207E01.htm

Food and Agriculture organization of the United Nations. (1986). The dynamics of rural poverty. Accessed on 3rd April 2014, at <http://www.amazon.com/The-Dynamics-Rural-Poverty-F3054/dp/925102488X>.

FAOSTAT. (2009). Comparison of potential staple crops. Accessed on 22nd October 2014, at <http://faostat.fao.org/site/567/DesktopDefault.aspx.PageID=567#ancor>.

FAO/WHO/UNU., Hall, K.D., Sacks, G., Chandramohan, D., Chow, C.C., Wang, Y.C, Gortmaker, S.L., Swinburn, B.A. (2004). Quantification of the effect of energy imbalance on bodyweight. *Lancet* 2011: 826-837.

Gaffney, A., Kpaka, C., Slakie, E., Anderson, C.L. (2012). Cassava Integrated Value Chain. Accessed on 9th December 2013, at www.linkedin.com/in/elysiaslakie.

Gethi, J.G., Muli, M.B., Saha, H.M. and Muinga, R.W. (2008). Technical report for the second year: Dissemination, promotion and maintenance of new cassava varieties in coastal and dry mid-altitude areas of Kenya. KARI Headquarters, Nairobi, Kenya.

Gibson, R.S. (2005). Principles of nutritional assessment, 2nd edition. Oxford University Press. pp 27-100.

Goel, M.K., Mishra, R., Gaur, D.R., Das, A. (2007). Nutrition surveillance in 1–6 years old children in urban slums of a city in northern India. *Journal of Epidemiology* 5(1): 1-8.

GOK/UNICEF. (1998). The right to household food security: In situation analysis of children and women in Kenya. Government of Kenya and the UNICEF Country Office, Nairobi, Kenya.

Harvestplus. (2012). Vitamin A Cassava. Available at: Accessed on 22nd October 2014, at <http://www.harvestplus.org/content/vitamin-cassava>.

Intergovernmental Panel on Climate Change (IPCC). (2007). Fourth Assessment Report. Cambridge University Press.

Kenya Agricultural Research Institute (KARI) Mtwapa. (2009). Cassava value addition activities at KARI Mtwapa annual report. KARI Headquarters, Nairobi, Kenya.

Kenya National Bureau of Statistics (KNBS), Ministry of Planning, National Development and Vision 2030. (2009). Kenya population and housing census. Government Press, Nairobi, Kenya.

Kenyon, L., Anandajayasekeram, P. and Ochieng, C. (2006). A synthesis/ lesson learning study of the research carried out on roots and tuber crops commissioned through the DFIDB RNRRS research programmes between 1995 and 2005. pp 1-52.

Kiura, J.N., Mutegi, C.K., Kibet, P. and Danda, M.K. (2005). Cassava production, utilization and marketing in coastal Kenya. A report of a survey on cassava enterprise conducted between July and October 2003 in Kwale, Kilifi, Mombasa and Malindi Districts. Internal Report No. 35, KARI-Mtwapa. KARI Headquarters, Nairobi, Kenya.

Lobell, D.B. and Field, C.B. (2007). Global scale climate-crop yield relationships and the impacts of recent warming. *American Journal of Climate Change* 3(3): 1-7.

Lobell, D.B., Schlenker, W. and Costa-Roberts, J. (2011a). Climate trends and global crop production since 1980. Accessed on 15th March 2014, at biblio-climat.fr/wp-content/uploads/2014/01/69_Lobell.

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G. and Fawzi, W. (2008). Tanzanian food composition table. Tanzania Food and Nutrition Centre (TFNC), Dares Salaam, Tanzania.

Munga, T.L. (2000). Root and tuber crops. KARI-Mtwapa annual report. KARI Headquarters, Nairobi, Kenya.

Mwango'mbe, A.W., Mbugua, S.K., Olubayo, F.O., Ngugi, E.K., Mwinga, R., Munga, T., Muiru, W.M. (2013). Challenges and opportunities in cassava production among the rural households in Kilifi County in the Coastal region of Kenya. *Journal of Biology, Agriculture and Healthcare* 3(10): 30-34.

My Expert Africa. (2012). Kenya Coast. Accessed on 9th September 2014, at www.expertafrica.com/kenya/kenya-coast/reference-map.

Nambisan, B. (2011). Strategies for elimination of cyanogens from cassava for reducing toxicity and improving food safety. *Food Chemical Toxicology* 49:690-693.

Nelson, G.C. and Rosegrant, M.W. (2009). *Climate change: Impact on agriculture and costs of adaptation*. Washington, D.C.

Parry, M., Evans, A., Rosegrant, M.W. and Wheeler, T. (2009). *Climate change and hunger: Responding to the challenge*. Rome, Italy.

Rey Chrissie. (2006). Improvement of cassava for social and economic benefits. Southern African Society for Plant Pathology, Witwatersrand, South Africa.

Rocha-e-Silva, R.C., Cordeiro, L.A. and Soto-Blanco, B. (2010). Cyanide toxicity and interference with diet selection in quail (*Coturnixcoturnix*). *Composition, Biochemistry Physiology Toxicology and Pharmacology* 151: 294-297.

Sanni, L.O., Onadipe, O.O., Ilona, P., Mussagy, M.D., Abass, A. and Dixon, A.G.O. (2009). Successes and challenges of cassava enterprise in West Africa: a case study in Nigeria, Benin and Sierra Leone. Accessed on 16th May 2014, at books.google.com.ng/books/about/Successes_and_challenges.

Schmidhuber, J. and Tubiello, F.N. (2007). Global food security under climate change. Accessed on 19th Feb 2015, at www.ncbi.nlm.nih.gov/pubmed/18077404.

Stephenson, K., Rachel, A., Sally, M., Rhoda, N., Busie, M.D., Simon, G., Ada, M. and Mark, M. (2010). Consuming cassava as a staple food places children 2-5 years old at risk for inadequate intake, an observation study in Kenya and Nigeria. *Nutrition journal* 9(9): 1-6.

Stupak, M., Vanderschuren, H., Gruissem, W., Zhang, P. (2006). Biotechnological approaches to cassava protein improvement. *Trends Food Science and Technology* 17:634–641.

Tchacando, T., Karou, S.D., Osseyi, E., Agban, A., Bawa L.M., Atcha, A.R., Soumana K., Assignon, K., Kpemoua, A., Desouza, C. (2011). Effects of harvest and cook processing on cyanides content of cassava cultivars and cassava based dough consumed. Lome, Togo.

United Nations Children's Fund (UNICEF). (2009). *The state of the world's children, special edition: celebrating 20 years of the convention on the rights of the child*. New York. pp 92-99.

Williams, A.P. and Funk, C. (2010). A westward extension of the warm pool intensifies the Walker Circulation, drying Eastern Africa. *U.S. Geological Survey Open-File Report*. pp 2010–2119.

World Bank. (1986). *Poverty and Hunger: Issues and options for food security in developing countries*. A World Bank policy study.

World Health Organization (WHO). (1996). Current population reports: Consumer income. United States. pp 60-198.

Appendix 2: Research Questionnaire

General Information on the Study population

1. Questionnaire No. _____ 2. Household No. _____
3. Date of the study _____
4. Constituency/district _____
5. Location _____
6. Sub-location _____
7. Village _____

Section 1: DEMOGRAPHIC PROFILE

Person No.	Name	Age	Sex	Marital Status	Rship to HH Head	Education Level	Occupation	Contribution to HH Income	Current Weight
1									
2									
3									
4									
5									
6									
7									
8									

Codes

SEX Marital Status

- 1=male
2=female

Relationship to the Household Head

- 1=married
2=never been married
3=separated
4=divorced
5=widowed
6=others (specify) _____
- 1=Household head
2=spouse
3=son/daughter
4=relative
5=employee

6=Not applicable (<14 years)

Education level income

- 1=never gone to school
2=not completed primary
3=completed primary
4=not completed secondary
5=college/diploma
99=Not applicable(<6 years)

Occupation

- 1=formal employment
2=Business
3=Farming
4=Casual laborer
5=unemployed
6=student
99= others (specify)

Contributes to household

- 1=yes
2=no

Section 2: Household economic activities

1. What is your main livelihood activity?
 - 1=employment
 - 2=crop farming
 - 3=livestock rearing
 - 4=self employed/business
 - 5=others (specify)_____
2. What is your main source of income?
 - 1=employment
 - 2=sale of crops
 - 3= sale of livestock and their produces
 - 4=business returns
 - 5= casual labor
 - 6=others (specify)_____
3. What is your average monthly income, all sources combined?
 - 1= 5,000 and below
 - 2=between 5,000 and 10,000
 - 3=between 10,000 and 25,000
 - 4=above 25,000
4. Does your household own any land?
 - 1=yes
 - 2=no

(If no, proceed to 3)
5. if yes, what is the approximate size of this land? _____ *(record the units too)*
6. Does your household practice any form of agriculture?
 - 1=yes
 - 2=no
7. If yes, which agricultural practice do you engage in?
 - 1=crop production
 - 2=livestock rearing
 - 3=both
8. *(if the household grows crops)*, which are the major crops that you produce(*list*)
 - 1=
 - 2=
 - 3=
 - 4=
 - 5=
 - 6=

(If cassava is not on the list, probe if they produce and include on the list if they do)
(If no cassava is produced at all, proceed to question 7)

9. If cassava is produced, which variety(s)/genotype do you normally produce?

1=_____

2=_____

3=_____

Section 3: Household cassava consumption practices

10. Does your household consume cassava?

1=yes

2=no *(if no, proceed to question 14)*

11. If yes, where do you normally obtain the cassava you consume from?

1=own production

2=local open air market

3=super market

4=Other sources (specify)_____

12. In which form do you normally obtain and consume the cassava?

1=unprocessed cassava (either roots or leaves)

2=Processed cassava products (specify product and name) _____

4=Other forms (specify)_____

13. Which cassava variety/genotype(s) do you normally consume?

14. Has your household ever consumed cassava?

1=yes

2=no

15. If yes, why did you stop consuming cassava? *(can give more than one response)*

1=_____

2=_____

3=_____

16. Have you ever consumed cassava leaves?

1=yes

2=no

17. If yes, how do you normally prepare the leaves for consumption

Meal name:_____

Preparation method: _____

_____ I

If no, are you aware that they are edible (they can be eaten)?

1=yes

2=no(*if no proceed to 20*)

18. If yes, why don't you eat them?

1= _____

2= _____

3= _____ -

19. If no, would you eat the leaves now that you know they are edible?

1=yes

2=no

20. If no, kindly let me know why you still cannot eat them

1= _____

2= _____

3= _____

21. If cassava is consumed, kindly describe the most commonly followed method of preparation, and the name of the final product /meal

Meal name: _____

Preparation
method _____

Section 4: Food frequency questionnaire

For each food item below, kindly let me the category that best describes the frequency with which your child usually eats that particular food item (<i>enumerator to indicate with a check mark</i>)							
Food item	more than once daily	Once per day	3-6 times per week	Once or twice per week	Once per month or less	Never	Estimated amounts at every consumption time(mls)
Maize meal							
Irishpotatoes							
Dark green leafy vegetables							
Sweet potatoes							
Pumpkin							
Spinach							
Ripe papaya							
Eggs							
Fish (liver intact)							
Chicken or other fowl							
Beef (sheep/goat meat)							
Milk and its products							
Beans							
Cassava crisps, Fries boiled Leaves							
Rice							
Cookedbananas							
Sorghum							

5:24 HOUR DIETARY DIVERSITY SCORE

Kindly let me know the foods your child consumed in the past 24 hours

Qstn NUMBER	FOOD GROUP	EXAMPLE	1 = YES 0=NO
1.	Cereals	Maize, wheat, rice, millet, sorghum and any other grains or foods made from these (e.g bread, spaghetti, noodles, porridge, ugali, muthokoi/githeri	
2.	Roots and tubers	Irish potatoes, yams, cassava, or other foods made from these (e.g. chips/French fries,	
3.	Vitamin A rich vegetables and tubers	Pumpkin, carrots, squash, orange-fleshed sweet potato, other locally available vitamin A vegetables e.g. red sweet pepper,	
4.	Dark green-leafy vegetables	Dark green-leafy vegetables including wild forms and locally available vitamin A rich leaves such as amaranth, cassava leaves, kales, spinach e.t.c	
5.	Other vegetables	Other vegetables e.g. tomato, onion, egg plant, green bananas and any other locally available vegetable	
6.	Vitamin A rich fruits	Ripe mango, apricots, ripe pawpaw, ripe banana, avocado, 100% fruit juice and any other locally available vitamin A rich fruits	
7.	Other fruits	Including wild fruits, 100% fruit juice made from this.	
8.	Organ meat	Liver, kidney, heart and other organ meats and blood-based foods.	
9.	Flesh meats	Beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds and insects.	
10.	Eggs	From chicken, duck, guinea fowl or any other eggs.	
11.	Fish and sea food	Fresh or dried fish	
12.	Legumes, nuts and seeds	Dried beans, dried peas, lentils, nuts, green grams, or food made from these e.g. peanut butter	
13.	Milk and milk products	Milk, cheese, mala, yogurt.	
14.	Oils and fats	Oils, fats, margarine or butter added to foods or used for cooking	
15.	Sweets	Sugar, honey, sweetened soda, sugar cane sweetened juice drinks, sugary foods such as chocolate, candies, cookies and cakes,	
16.	Spices, condiments and beverages.	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, fermented beverages.	

SECTION 6.DIETARY INTAKE-24 hour recall

Please describe the foods and drinks taken during the last 24 hours from morning to night time whether at home or outside the home.

(Researcher to list all foods mentioned, where composite meals are mentioned probe for the ingredients, when respondent is through probe for any meal that might not have been mentioned.)

Match the meal according to time given by the respondent. NB: where the household has more than one child 2-5 years old, randomly select one.

Time (Breakfast, midmorning snack, lunch etc.)	Dish	Ingredients	Amount	Total volume of food prepared	Unit in grams	Amount served to the child (2-5 years)	Amount left over	Amount consumed

Section 7: Nutritional status of the child

26. Age (months) =

27. Weight=

28. Height=

29. Presence of physical signs of protein energy malnutrition

1=yes

2=no

NB: check for the following symptoms and indicate with a tick the signs observed

1. Edema

2. Dry/peeling skin

3. Hair discoloration

4. Abdominal distention

5. Excessive loss of muscle and tissue

6. Loss of appetite

7. Loose skin