CONSUMER KNOWLEDGE, ATTITUDES AND PRACTICES ON FOOD FORTIFICATION IN KENYA

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Consumer Knowledge, Attitudes And Practices on Food Fortification in Kenya

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DECLARATION

This dissertation is my original work and has not been submitted or presented for a degree in any other university.

Signature……Date…….

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This thesis has been submitted for examination with our approval as university supervisors.

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DEDICATION

To my parents, Joshua and Praxedes, for teaching me the construct of life and hard work, to my Uncle, Bernard Ogot, for the mentorship and support in my life. To my brothers, Eric, the late Joseph, Moses and Michael and sisters, Linette, Lorraine, Lavina, Gloria and Catherine, for your cooperation, understanding, encouragement and support.

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OPERATIONAL DEFINITION OF TERMS

Attitude A person's feeling or opinion towards an idea e.g. nutritional ideas.

Catchment area It is a large area from which the institution attracts a population that uses its services e.g. regions or counties.

Dietary practices The food choices preferred by individuals in terms of frequency and patterns for the overall health and wellness.

Enumeration areas Are the cluster areas drawn from the supervision areas e.g. sub locations or the villages/estates.

Food fortification Is the process of adding key vitamins and minerals such as Vitamin A and iron to staple foods such as rice to improve its nutritional content which aims to reduce nutritional deficiencies in a population.

Mandatory fortification Is when food manufacturers are required by the national food law to add certain vitamins or minerals to a specified food or foods.

Micronutrient Deficiencies Are also known as micronutrient malnutrition or hidden hunger. It occurs when a person lacks enough of essential vitamins or minerals for optimal health.

Nutrition knowledge Refers to understanding of processes and concepts related to general health of an individual.

Supervision areas Are the cluster areas drawn from the catchment areas e.g. the sub-counties

Voluntary fortification Is when food manufacturers freely choose to fortify foods they produce.

Ugali A type of stiff porridge made by mixing corn meal with boiling water

Uji A type of thin porridge typically eaten for breakfast made from maize flour

LIST OF ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
AOR	Adjusted Odds Ratio
B_6	Pyridoxine
B_{12}	Folate/ Folic acid
C.As	Catchment areas
CHVs	Community Health Volunteers
CHWs	Community Health Workers
CI	Confidence Interval
COFEK	Consumer Federation of Kenya
COR	Crude Odds Ratio
CRSP	Collaborative Research Study Project
DALYs	Disability Adjusted Life Years
DNA	Deoxyribonucleic Acid
DSM	Dutch State Mines
E. As	Enumeration areas
FAO	Food and Agricultural Organization
Fe	Iron
GHI	Global Hunger Index

GNP	Global Nutrition Report
GoK	Government of Kenya
GRAS	Generally Recognized as Safe
Hcy	Homocysteine
HHDs	Households
HIV	Human Immunodeficiency Virus
ID	Iron Deficiency
IDA	Iron Deficiency Anaemia
IDD	Iodine Deficiency Disorders
IFAS	Iron and folic acid supplementation
IYC	Infant and Young Children
IZiNCG	International Zinc Nutrition Consultative Group
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KAP	Knowledge Attitude and Practices
KASA	Knowledge Attitudes Skills and Aspiration
KBC	Kenya Broadcasting Corporation
KDHS	Kenya National Demographic Health Survey
KDP	Kenya Demographic Profile
KEBs	Kenya Bureau of Standards

KFSSG	Kenya Food Security Steering Group
KNMS	Kenya National Micronutrient Survey
Ksh	Kenya Shilling
KTN	Kenya Television Network
LC-LQAS	Large Country-Lot Quality Assurance Sampling
LMIC	Low- and Middle-Income Countries
MMA	Methylmalonic Acid
MNDs	Micronutrient deficiencies
MNM	Micronutrient malnutrition
MoH	Ministry of Health
MPHS	Master of Population Health Sciences
N/A	Not Applicable
NaFeEDTA	Sodium iron (iii) ethylene diamine tetra acetic acid
NTDs	Neural Tube Defects
NTV	National Television
ODK	Open Data Kit
PSC	Preschool children
RDAs	Recommended Dietary Allowances
RMS	Royal Media Services

RNA	Ribonucleic acid
S. As	Supervision areas
TV	Television
USI	Universal Salt Iodization
UOR	Unadjusted Odds Ratio
Umol/L	Micromoles/Litre
VAD	Vitamin A Deficiency
WHO	World Health Organization
WFP	World Food Programme

ABSTRACT

Micronutrient malnutrition (MNM) is widespread in the industrialized nations, but even more so in the developing regions of the world. Food fortification is considered as an important strategy to address micronutrient malnutrition, which is a key challenge in most developing countries. Kenya has made great strides in food fortification. However, lack of empirical information on consumers' awareness, preference and demand for fortified foods remains the barrier to the uptake of fortified foods. This study was therefore designed to assess consumer knowledge, attitudes and practices on food fortification in Kenya. A cross-sectional descriptive study was done in 13 counties namely; Kakamega, Kisumu, Uasin Gishu, Trans-Nzoia, Nakuru, Nyandarua, Narok, Nairobi, Mombasa, Kilifi, Kitui Meru and Garissa. Structured questionnaires were used to interview 1435 consumers in the households. The information collected included socio-demographic characteristics, awareness of food fortification, knowledge of food fortification, attitudes and practices of fortified foods in Kenya. The data was analyzed using STATA version 14.0 with the p value for statistical significance set at $p < 0.05$. Relationship of variables was done using binary logistic regression analysis. In more than half (59%) of the households, the wives were the ones responsible for most of the grocery shopping decisions. About one-third (32.9%) of the respondents were knowledgeable about food fortification. Furthermore, food fortification knowledge was significantly associated with respondents who had attained tertiary ($p=0.04$) and secondary ($p=0.02$) education. More than two-thirds (72%) of the respondents were not aware of the term "food fortification". Awareness of food fortification was significantly associated with female respondents ($p=0.02$), respondents aged 18-24 years ($p=0.02$) and greater than 50 years ($p=0.03$), respondents with secondary and tertiary education ($p<0.00$), households with more than 7 dependents ($p=0.01$) and respondents in formal employment ($p<0.00$). About half (46%) of the respondents had a positive perception towards food fortification. However, two-thirds (66%) of the respondents expressed those fortified foods could be more expensive than non-fortified ones. While more than 80% of the respondents stated to have purchased foodstuffs used as fortification vehicles in Kenya, less than 20% of them stated that they purchased the respective foodstuffs for their added vitamins and minerals. Price was considered the most important factor when making purchase among 30% of the respondents. The study concluded that although Kenyan consumers have considerably limited knowledge and awareness about fortified foods, they demonstrated a positive attitude towards food fortification. Consumption of foods that currently require mandatory fortification was high, probably due to availability of such products in the market. These findings suggest that there is a high potential of food fortification program in Kenya but price seems to be a limiting factor of consuming fortified foods. Moreover, these findings offer useful insights for the Government of Kenya through the Ministry of Health and partners to develop consumer preference-based food fortification information programs in Kenya.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Micronutrient deficiency, or "hidden hunger", is regarded a significant contributor to the global burden of disease. It is estimated that about 2 billion people in the world today are micronutrient deficient particularly vitamin A, iron, iodine, folate and zinc (Cesare, 2019). In Kenya, like other developing countries, malnutrition continues to raise morbidity and mortality concerns. More than half of the morbidity and mortality cases especially among children are as a result of zinc, iron, and vitamin A deficiencies (KNMS, 2011).

According to the Kenya's state of nutrition report, Kenya is home to more than 40 million people, 80% of whom live in rural areas and rely almost entirely on agriculture (Kamenwa, 2017). In the same report, about 80% of the land area is arid and semi-arid, mainly in the northern and eastern regions. Furthermore, areas identified with good agricultural potential represent only about 18% of the territory but support 80% of the population (Kamenwa, 2017). Thus, micronutrient malnutrition is certain to exist due to food shortages and is likely to be common where diets lack diversity. Kenya's food security and nutrition needs are further complicated by prolonged drought, floods, inflation in food and fuel prices and environmental degradation due to over-exploitation of natural resources (Momanyi *et al.*, 2019).

In recognition that micronutrient deficiency remains an obstacle to the overall national development, the Government of Kenya (GoK) developed the Food and Nutrition Security Policy in 2012 (Yolanda and Suarez, 2015). The key strategic interventions related to nutrition include; dietary diversity, supplementation of children with vitamin A, public health measures such as deworming and food fortification. Although all these interventions are complementary, food fortification was considered an important cost effective strategy for addressing micronutrient malnutrition. Therefore, an amendment of cap 264 of the Food, Drug and Substances

act and further gazettement of the legal notice 62 in 2012 which made law for all commercial maize and wheat flours, salt, sugar and edible oils to be fortified according to the set legal standards (Pambo, 2014). Fortification of foods is considered effective because it increases access to micronutrients of public health significance without need for drastic changes in consumption patterns (Darnton-hill and Nalubola, 2018). However, most of these fortified flours are beyond reach of resource-poor households that consume insignificant amount of processed foods, limiting the use of food fortification among the targeted population (WFP, 2016). This is because more than 70% of the Kenyan population purchase flour or grind grain at the medium and small scale mills who have limited capacity to fortify flours (WFP, 2016). This justifies the need to explore small and medium scale maize flour fortification program in Kenya since maize is the basic staple of the Kenyan diet. It's mainly consumed as flour cooked into a thick porridge (*Ugali*) that is usually eaten with vegetables or meat stew, or simply accompanied with fresh or fermented milk. To encourage public adaptation, however, it is important to address any public concerns about food fortification.

Consumers are one of the determinants of successful food fortification programs. Their perception of fortified foods and consumption of these fortified products however may depend on their knowledge on nutritional issues (Pounis et al., 2011). Generally, there is vast literature on consumers' acceptance or rejection of fortified foods in other parts of the world (Bishai, 2003; Rowland *et al.,* 2010 ; Schwab, 2012; Health and Learning, 2015). These studies found that consumers' attitudes and consumption of fortified foods were positive. This was attributed to high levels of knowledge and awareness among consumers that food manufacturers were able to fortify some foods. These studies, however, are based on the developed country context and in most cases where food fortification has already been commercialized. The literature on consumer knowledge, attitudes and practices on food fortification in developing countries including Kenya is still scanty. This makes it important to understand barriers to demand and consumption of fortified foods that relate to consumer knowledge and facts of awareness about importance of micronutrients (Alibabi *et al.,* 2016). Thus, the aim of this study was to assess consumers' knowledge, attitudes and practices on food fortification in Kenya.

1.2 Statement of the problem

Micronutrient deficiency is a public health problem in Kenya due to persistent food insecurity. Seasonal food production due to overreliance on rain-fed agriculture is the main cause of food insecurity in Kenya (Kamenwa, 2017). Poor dietary diversity especially among the resource-poor communities also contributes to micronutrient malnutrition (Fungo, 2013). Women and children are the most vulnerable to micronutrient deficiencies due to inadequate dietary intake, lack of knowledge about the importance of dietary diversity and inequitable distribution of food within households (Harika and Faber, 2015). The main forms of micronutrient deficiencies in Kenya include vitamin A, iron, folate, vitamin B_{12}, iodine and zinc deficiencies (Pambo *et al.,* 2014). According to the Kenya National Micronutrient Survey 2011 report, 83.3% of pre-school children are Zinc deficient. Iron deficiency is at 36.1% in pregnant women and 21.8% in under 5 years old children. The national prevalence of vitamin A deficiency (VAD) is 4.1% and a 24.4% margin of the population are at risk of suffering from VAD. Notably, the margin at risk for under 5 children stands at 52.6%. National folate deficiency is at 32.1% in pregnant women and 30.9% in non-pregnant women. Finally, it is estimated that 22.1% of school aged children are iodine deficient (KNMS, 2011).

Food fortification is one of the strategies that have been safely and effectively used to prevent vitamin and mineral deficiencies (WHO, 2014). Developing countries are increasingly recognizing food fortification as an effective medium to long-term approach to improving the micronutrient status of large populations following fortification success stories in industrialized countries (Battalwar and Syed, 2017). Fortification is credited with the successful control of deficiencies of vitamins A and D, several B vitamins, iodine and iron among populations through commonly consumed foods such as salt, sugar, wheat flour, and edible oils (Garrett, 2018b). Universally, 87 nations have a bill that makes it compulsory to fortify at least one cereal grain that is milled in the industry, eleven of these nations fortify more than 50% of at least one cereal grain that is milled in the industry, eight of them fortify wheat flour while 3 fortify maize flour (DSM, 2017). Kenya has made great strides in Food fortification. The Kenya's Ministry of Health shared a report by Maize Flour

Fortification Landscape Kenya which stated that 40% of maize flour in Kenya is fortified (Groote and Kimenju, 2012; Samira *et al.,* 2020). So far 37 mills fortify maize flour, 23 large mills certified by the Kenya Bureau of Standards (KEBS) distribute their flour to retail shops and supermarkets country wide and 12 certified medium mills distribute to schools, hospitals and other institutions (WFP, 2016; Samira et al., 2020). Moreover, two small mills not certified but are assisted by the WFP provide flour for 21 schools in Kakuma refugee camp feeding 73,000 learners.

The Kenya national food fortification strategic plan 2018-2022 stated that one of the programmatic challenge experienced in food fortification is health service providers and general population lacking sufficient information on the importance of micronutrients (Food Fortification Resource Centre, 2017). Hence a strategic objective was developed to reduce the occurrence of micronutrient malnutrition in the population. One of the priority areas was to advocate and create awareness on food fortification. Unfortunately, public awareness of fortified maize flour by the Ministry of Health (MoH) and millers was still a challenge. It was recommended that creating awareness on the existence and importance of fortified maize flour would help build confidence and preference and consequently increase consumption of the product (Food Fortification Resource Centre, 2017).

Currently, only a few studies in Kenya have assessed consumer awareness and utilization of fortified food products (for example Groote and Kimenju, 2012; Pambo *et al.,* 2014; and Samira *et al.,* 2020). However, these studies are mainly based in one or two counties, focusing on a single fortified product. Therefore, a significant knowledge gap worthy of conducting investigation exists particularly regarding awareness, knowledge, perceptions and consumption practices of fortified foods among Kenyan consumers. Understanding the Kenyan consumers' awareness, knowledge, attitudes and practices for fortified foods provides useful insights on the potential of the Kenyan market for fortified foods. The study also offers useful information for addressing micronutrient deficiencies among the Kenyan population.

1.3 Justification of the study

Food fortification has played a major role in the health of the populations in several developed and developing countries including Kenya. Current reduced levels of micronutrient deficiencies in Kenya are attributable to fortified sources (Mannar, 2017). The results of this study will be relevant for the Government of Kenya and food industries in Kenya, as it provides avenues for value addition. For instance, many stakeholders involved, including small and medium scale millers may use this information to make decisions on whether or not to produce fortified maize flours. This is because maize is the staple food in Kenya with the availability unrelated to socio-economic status if compared to the other food staples that are mandatorily fortified in Kenya. Thus, this would enable them to become consumer-driven flour producers.

Consumer federation of Kenya have also expressed concerns related to consumer choice of food products due to lack of awareness and knowledge of their potential health benefits (Njuguna, 2015). Furthermore, uncertainties about consumer acceptance however has increased in many parts of the world, partly due to differing attitudes (Fletcher, 2018). Communication to consumers is often overlooked yet it is an essential part of effective fortification interventions. Thus, this study will not only help program implementers with information to make informed decisions regarding food fortification programs but also in designing of food fortification education programs for micronutrient and food enrichment promotion in the country. Promotion of nutrition knowledge plays a key role in enhancing positive attitudes with focus to influence demand and consequently improve the nutritional status of the targeted population.

Food fortification being a multi-stakeholder proposition, information from this study will be useful to develop a multi-sectoral partnership between national government, industry, international agencies, expert groups and other players to work closely on issues relating to technology development, quality assurance, food processing and marketing, social communication and demand creation. This would translate to effective and sustainable fortification initiatives.

1.4 Objectives

1.4.1 General objective

The main aim of the study was to assess consumer awareness, knowledge and attitudes towards food fortification and consumption practices of fortified foods in Kenya.

1.4.2 Specific objectives

1. To determine socio-demographic characteristics of the Kenyan consumers.
2. To assess awareness levels of consumers on food fortification in Kenya.
3. To evaluate knowledge on food fortification among Kenyan consumers.
4. To assess attitudes towards food fortification among Kenyan Consumers.
5. To determine the consumption patterns of fortified foods in Kenya.

1.5 Research questions

1. What is the socio-demographic characteristics of the Kenyan consumers?
2. What is the level of awareness on food fortification in Kenya?
3. What are the levels of consumer knowledge about food fortification in Kenya?
4. What are the attitudes of consumers towards food fortification in Kenya?
5. What are the consumer practices of fortified foods in Kenya?

1.6 Limitations of the study

The study is limited by how well the participants in the study represent the entire Kenyan population. Also, the results of the study are limited by the honesty of the participants, or their nonbiased participation. This is because the researcher considered all the information given by the respondents to be accurate.

1.7 Conceptual Framework

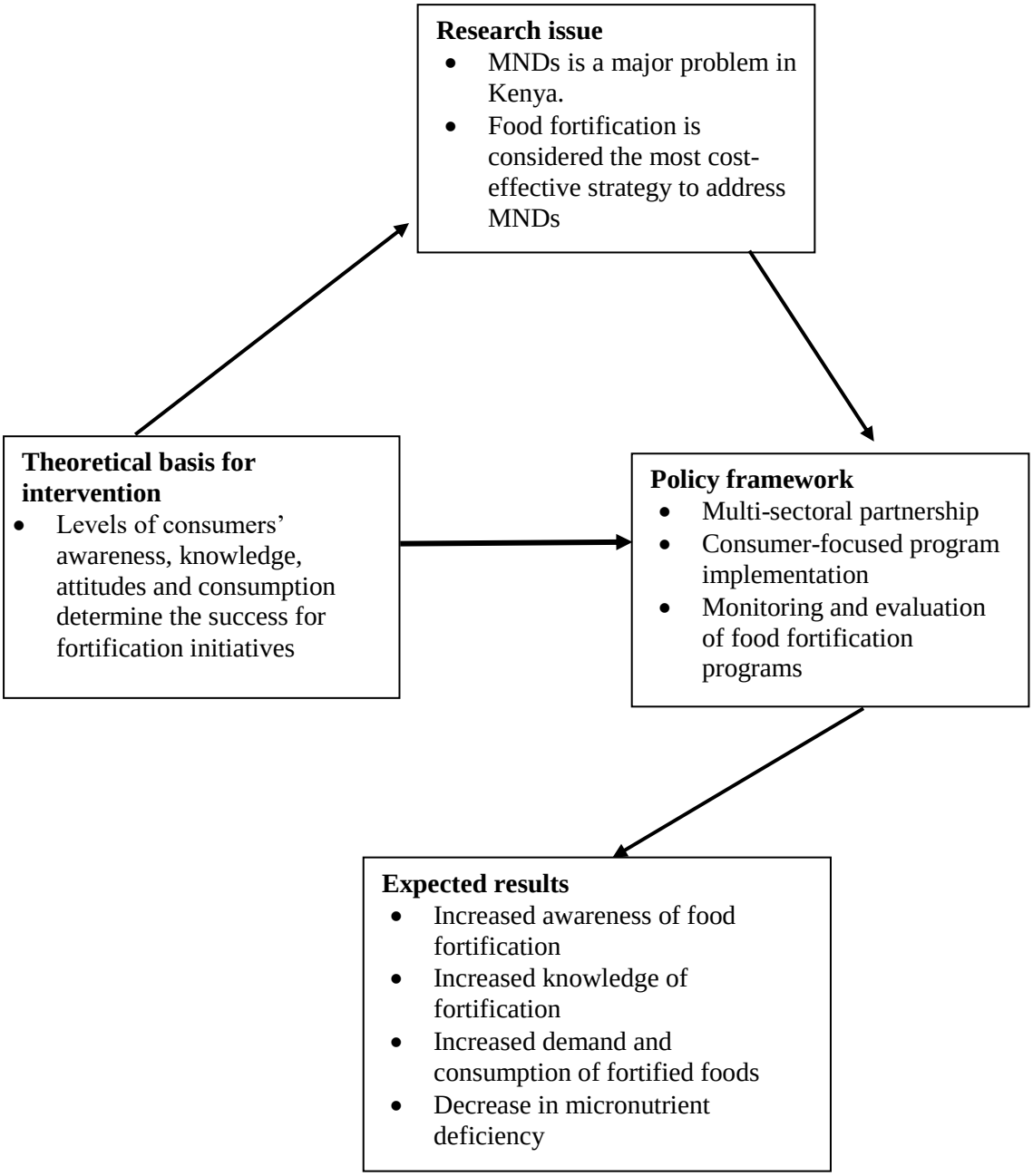

Figure 1.1: Conceptual Framework

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Micronutrient malnutrition is not only an urgent global health issue, but also an impediment to productivity, economic growth and poverty eradication (Motadi et al., 2016). The focus of food fortification relies on commonly consumed food vehicles (i.e., staple foods) to deliver micronutrients to as much of the general population as possible while also trying to include a large proportion of members of vulnerable population groups who would stand to benefit most from additional micronutrients (Aaron *et al.,* 2017). This approach to delivering micronutrients has a long history of success to address inadequate dietary intake of essential nutrients in higher-resource countries, and is increasingly used in low and middle-income countries to address a range of micronutrient deficiencies (Aaron *et al.,* 2017). For instance, mandatory wheat flour fortification was introduced in Jordan in 2002, after the country's first nationally representative survey on micronutrient status revealed that low micronutrient intake was a major public health concern (DSM, 2017). Flour was initially fortified with iron and folic acid, although fortification with zinc, niacin and vitamins A, B and D followed shortly after. A follow up survey in 2010 showed that the roll-out of the program in Jordan had been a huge success, with wheat flour products now routinely fortified with a wide range of essential micronutrients (DSM, 2017).

In Venezuela, a study showed a significant reduction in iron deficiency and anemia by 59% and 47% respectively by fortifying wheat flour and pre-cooked corn flour since the late nineties (Kasankala *et al.,* 2018). Similarly, iron deficiency anemia got reduced by 72%, vitamin A by 58%, vitamin B2 by 64%, and vitamin B6 by 91% as a result of flour fortification in India (Ahuja and Sheth, 2021). Various studies have also undertaken clinical trials and have reported similar findings as of these researchers, thus providing a significant evidence of the potential that food fortification holds for improving global health (DSM, 2017; Kasankala *et al.,* 2018 and Garrett, 2018b).

2.2 Micronutrient malnutrition

Micronutrient malnutrition is also known as micronutrient deficiencies or “hidden hunger”. This occurs when the body does not have sufficient amounts of vitamins or minerals due to inadequate food intake, insufficient absorption and suboptimal utilization, or an age- or disease-related increased need of micronutrients within the body resulting in impairment of the immune system and have a negative impact on organ function (Future and Relations, 2014).

In developed nations, micronutrient deficiencies are widespread but even more so in the developing regions of the world. It can affect all age groups, but infant, young children and women of reproductive age tend to be among those most at risk of developing micronutrient malnutrition (Allen *et al.,* 2006). People suffering from hidden hunger are often from the poor segment who cannot afford foods that are more nutritious or lack access to these foods maybe due to restricted food distribution system making them rely on own-grown or locally produced staple foods (WHO, 2014) .

Around the world, at least 2 billion people live with micronutrient deficiencies (GNP, 2017). Previous studies have shown that hidden hunger is a risk factor for many diseases which contribute to high rates of morbidity and even mortality (WHO, 2015). It has been estimated that micronutrient deficiencies account for about 7.3% of the global burden of disease, with iron and vitamin A deficiency ranking among the 15 leading causes of the global disease burden (Allen *et al.,* 2006). According to Global Nutrition Report (2019), around 0.8 million deaths (1.5% of the total) can be attributed to iron deficiency each year, and a similar number to vitamin A deficiency. In terms of the loss of healthy life, expressed in disability-adjusted life years (DALYs), iron-deficiency anemia results in 25 million DALYs lost (or 2.4% of the global total), vitamin A deficiency in 18 million DALYs lost (or 1.8% of the global total) and iodine deficiency in 2.5 million DALYs lost (or 0.2% of the global total) (Cesare, 2019).

Micronutrient deficiency has long-ranging adverse effects on human health, learning ability and productivity (Food *et al.,* 2011). In addition to the direct health effects,

the existence of "hidden hunger" leads to high social and public costs, reduced work capacity in populations due to high rates of illness and disability, and tragic loss of human potential (Global Report, 2009). Overcoming micronutrient malnutrition is a precondition for ensuring rapid and appropriate development.

2.3 Factors influencing consumer knowledge, attitudes and practices on fortified foods

The efficacy of food fortification has been demonstrated consistently for different micronutrients and different food vehicles (Osendarp *et al.,* 2018). As a result, it is now well accepted that micronutrient fortification of foods has the potential to significantly increase serum micronutrient concentrations and reduce clinical and physiological manifestations of deficiencies (Osendarp *et al.,* 2018). However, the effectiveness of fortification programs is not only determined by the biological efficacy of the fortified foods but also by involving consumers for sustainable implementation (Pambo *et al.,* 2014). Understanding consumers' awareness and knowledge, opinions and demand for fortified foods is important to address any public concerns about food fortification, which have been reported to exist among consumers in many parts of the world (Verbeke, 2005; Municipality, 2018; Garg, 2020; Ahuja and Sheth, 2021). Some of the key factors identified to influence consumer acceptance of the concept of fortified foods are;

2.3.1 Socio-demographic determinants

Consensus is reached by most studies that female consumers are the most likely users of fortified foods given that they are more reflective about food and health issues compared to their male counterparts (Arganini *et al.,* 2012; Pambo *et al.,* 2014; Rowland *et al.,* 2010 and Tariq *et al.,* 2020). They also have the primary responsibility for food purchase decisions in most households. Furthermore, this is supported by Verbeke, (2005) findings based on a review of quantitative studies in the U.S whereby it was reported that functional foods including fortified food consumers were females, well educated, higher income class reflecting a higher willingness to pay a premium price as well as better knowledge and higher awareness among consumers who are in a broad 35-55 age group.

A study conducted in Kenya on consumer preference for Vitamin-A fortified sugar showed that consumers in the urban area (Nairobi) were willing to pay more for the product than their rural counterparts in Kakamega (Pambo *et al.,* 2017). This difference in willingness to pay was attributed to lack of awareness on food fortification and higher incidence of poverty which limits their purchasing ability.

Presence of the sick and young children in the household impact food choice and acceptability because of its potential association with higher food risk aversion (Verbeke, 2005). The same author (Verbeke, 2005) reported that parenting also triggers focus on nutrition which results in nurturing benefits through provision of wholesome foods that lay a strong health foundation for the family or household members.

The socio-economic constraints faced by consumers when fortified foods are being promoted, and the likely benefits of food fortification, are now being increasingly recognized as critical factors in gaining public and private sector commitment to, and eventually the success of a fortification program (Darnton-hill and Nalubola, 2018). These factors need to be addressed earlier enough otherwise ignoring them has been shown to contribute to failure of the programs (Mannar, 2017). Nevertheless, even with the best social marketing, price can remain a constraint especially in very poor households where there is very little price elasticity, and even a minimal increase can discourage the buying of fortified foods (Groote and Kimenju, 2012).

2.3.2 Awareness levels of consumers on fortification

Awareness is the forefront of defense against fraud and deception that is rampant in the food industry, hence a powerful tool of progress in a society (Pambo, 2014). As a matter of fact, it is important in enabling consumers make rational choices and informed decisions before spending money on any product (Pambo *et al.*, 2014).

The importance of advocacy of food fortification should be emphasized at the political level as well as raising consumer awareness regarding the magnitude and effects of micronutrient deficiencies. Otherwise, the sustainability and role of food fortification as a complementary approach is at risk (Darnton-hill and Nalubola,

2018). Also, the success, impact and long term sustainability of food fortification like other interventions such as biofortification rest with educating consumers, developing consumer demand and demonstrating impact (Darnton-hill and Nalubola, 2018).

Social mobilization and social marketing activities has also been recommended to be adopted as a national preventive strategy to prevent micronutrient deficiencies (Wang *et al., 2008)*. A study conducted in China to promote NaFeEDTA-fortified soya sauce in an iron-deficient population demonstrated successful implementation of fortification activities by engaging representatives from the Ministry of Health, and officials from the local county governments in social communication (Wang *et al.,* 2008). In the same report, school children and volunteers were also mobilized in distribution of information, education communication materials in their households and the culture and sports centers respectively to achieve awareness (Wang *et al.,* 2008).

A study conducted in Kenya on consumer awareness of vitamin A fortified sugar reported that a number of studies have revealed that access and use of mobile phones in Kenya is high (Pambo *et al.,* 2011). Thus, dissemination of nutritional information through mobile phones (short messages) should be considered. In the same study, consumers residing in urban areas had higher awareness levels compared to their rural counterparts. The study also established the fact that purchasing sugar from supermarket, age of the consumer, reading of newspapers and household having infant member(s) significantly increases consumers' awareness of sugar fortification. The study suggested that nutrition education as well as formation of nutrition clubs in both primary and secondary schools should be introduced to enhance awareness. Finally, in this same study, females were less likely to be aware of food fortification compared to males, particularly those in rural areas. The finding implied that nutrition programs should be packaged with activities that promote gender roles (Pambo *et al.,* 2011).

The use of groups in the society such as women groups, churches and other non-profit organizations are recommended to supplement media sources and increase awareness on micronutrient health benefits and related micronutrient deficiencies. Public awareness campaign has to be seriously adopted to inform consumers about fortified foods. Also, utilization of mass media, particularly on the radio in the vernacular stations has to be used to convince consumers the need and benefits of food fortification (Groote and Kimenju, 2012).

2.3.3 Knowledge levels of consumers on food fortification

Nutrition knowledge is broadly defined as knowledge of concepts and processes related to nutrition and health including knowledge of diet and health, diet and disease, foods representing major sources of nutrients, and dietary guidelines and recommendations (Soederberg and Cassady, 2015). A study done on the effect of nutrition knowledge on food label use in California found that besides socio-demographics, nutrition knowledge is important for dietary choices by having positive influence on food choice without the use food labels (Soederberg and Cassady, 2015).

Another study done on consumer perception and use of iron fortified foods associated with their knowledge of nutritional issues in Greece found that increasing nutrition knowledge improves the perception that iron fortified foods have a positive role in human diet (Pounis *et al.*, 2011). However, high levels of education among study participants were negatively associated with the positive attitude for iron fortified foods. This finding implied that the formal education they had was not nutrition related.

It has also been shown that younger women have better knowledge about dietary iron compared to older women in a study done in Croatia on the level of nutrition knowledge and dietary intake of Bosnian women (Alibabi *et al.*, 2016). In the same study, pregnant women knew more facts about the investigated topic compared to other women who were in reproductive age but not pregnant. This was attributed to nutrition education provided at the health facilities during antenatal and post-natal visits.

Nutrition information on food labels has also been shown to be a cost-effective method of communicating nutrition information to consumers because the information appears at the point of sale for most packaged foods (Campos *et al.*, 2011). The model (see in figure 2.1) suggests that nutrition knowledge supports healthy food choices through information processing associated with food labels. For instance, consumers pay attention to nutrition information on a food label, allowing more accurate information to be stored in memory and used in decision making when purchasing food. However, cognitive literature reveals that knowledge could play a broader role in food choice by supporting dietary intake regardless of use of food labels (Soederberg and Cassady, 2015).

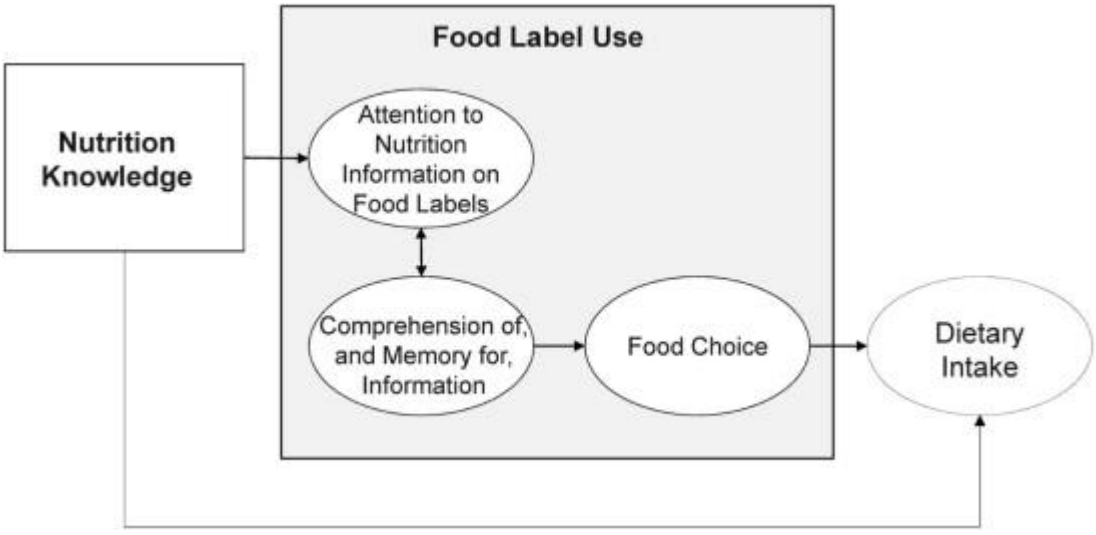

Figure 2.1: Cognitive process underlying use of food labels

Source: (Soederberg and Cassady, 2015)

In conclusion, nutrition knowledge is associated with positive consumer beliefs and attitudes, and consumption of these fortified products (Pounis *et al.*, 2011) . This highlights the importance of nutrition education focused on consumer informed choices about fortified foods.

2.3.4 Attitudes and practices of consumers on fortified foods

For successful functional food expansion, consumer acceptance of the concept of functional foods, and a better understanding of its determinants, are key success factors for market orientation, development and successfully negotiating market opportunities (Annunziata and Vecchio, 2010). Annunziata and Vecchio, (2010) report further explained that most of studies done on food attitudes and practices have demonstrated that cognitive, motivational and attitudinal determinants of consumer acceptance of functional foods vary considerably in different countries. Findings in a study done on consumer acceptance of functional foods in Belgium indicates that age, gender, education, presence of young children, and presence of ill family members emerge as socio-demographic determinants of functional food acceptance (Verbeke, 2005).

Figure 2.2 shows a model of normative eating behavior. Norms of appropriate eating are set by the behavior of other people, shared cultural experiences, as well as environmental cues such as package size that imply socially prescriptive consumption (Higgs and Thomas, 2016). People engage in social comparison to the norm referent to decide if the apparent norm is relevant to them, taking into account their similarity to and strength of identification with the norm referent. If a norm is relevant, then there may be matching of behavior to the norm but this will depend on other contextual factors such as the attention paid to the norm, concerns about behaving in a socially appropriate manner and other competing norms such as personal norms (habitual intakes) (Higgs and Thomas, 2016). The process of behavioral adjustment may involve processes such as synchronization of eating patterns, consumption monitoring and changes in preference for a type of food. Matching to the norm however reinforces the norm (Higgs and Thomas, 2016).

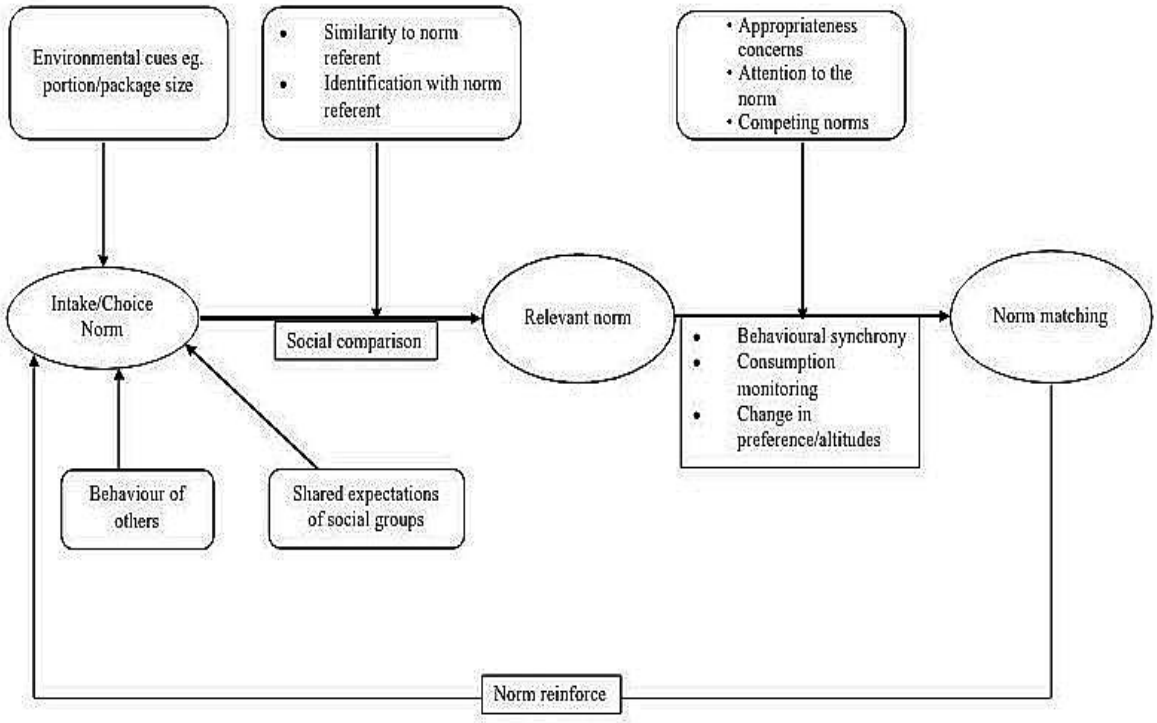

Figure 2.2: Current opinion in food behavior

Source: (Higgs and Thomas, 2016)

Figure 2.2 above can therefore be coupled with the results of Groote and Chege, (2008) on consumer preference for color and nutritional quality for bio fortified maize in Kenya. Whereby, the findings indicated that consumer preferences for color of bio-fortified maize is influenced by consumers' socioeconomic and cultural background, in particular income, education, and ethnic group. The researchers add that surprisingly education does not have an effect on the preference for bio-fortified maize. Ethnic background plays a role such that people from western Kenya had the strongest preference for yellow maize while consumers from central Kenya group had a significant negative preference.

In terms of taste, findings by Pounis *et al.* (2011) showed that low consumption of iron fortified food reported by the participants is as a result of sensory properties of iron fortified products. These findings are in line with recent reports that suggest taste as the main determinant of a food choice. Intense studies on iron fortified foods have to be focused so as to improve the sensory characteristics of these foods (Pounis

et al., 2011). It is also important for food manufacturers to build consumer trust for food fortification process through effective communication channel.

A study done on consumer awareness, attitudes and behaviors on food fortification in New Zealand demonstrated a large proportion of study participants that viewed food fortification as a strategy not supported by the scientific community. Instead, it was generally perceived as a way for food producers to market their products "as healthy" (Rowland *et al.,* 2010). Evidence that fortification has been used effectively and safely in the longer term may prove more convincing to such individuals. In the same study, most participants expressed a negative attitude towards mandatory fortification of some foods. This is because they perceived the process will impact their freedom, as choice of non-fortified foods will be restricted under mandatory fortification regulations.

Lastly, consumer education and knowledge of health benefits of fortified products increases acceptability scores (Pambo *et al.,* 2014). Health benefit information of a fortified product enhances acceptability and increased frequency of consumption of that particular product (Pambo, 2014). This is evident in a study done in Kenya on consumer awareness on sugar fortified with vitamin A. Kenyan consumers that were aware of the importance of vitamin A in the diet demonstrated increased demand and consumption of sugar fortified with vitamin A (Pambo, 2014).

2.4 Risk factors for micronutrient malnutrition

Apart from low dietary intake, other risk factors identified to expose vulnerable populations to micronutrient malnutrition include; Monotonous diet resulting in low micronutrient intake and poor bioavailability of minerals, low intake of animal source foods, suboptimal breastfeeding practices, low micronutrient density of complementary foods, increased physiological demands for growth during pregnancy and lactation, increased demand due to acute infection (especially if infection episodes are frequent), or chronic infection (e.g. tuberculosis, malaria and HIV/AIDS) and disease (e.g. cancer) (Allen *et al.,* 2006). Poor general nutritional status, in particular, protein energy malnutrition, malabsorption due to diarrhea or the presence of intestinal parasites (e.g. hookworms), increased excretion (e.g. due to

schistosomiasis), seasonal variations in food availability, food shortages, social deprivation, illiteracy, low education and poor economic status and poverty were also identified as preconditions for micronutrient deficiencies (Allen *et al.*, 2006).

The prevalence of micronutrient malnutrition is especially high in Southeast Asia and sub-Saharan Africa, and young children and pregnant women are at greatest risk (WHO, 2015). Recent estimates indicate that globally over two billion people are at risk for vitamin A, iodine, and iron deficiency (Bhutta and Salam, 2015). In spite of recent efforts in the control and prevention of these deficiencies, other micronutrient deficiencies of public health concern include zinc, folate, and the B vitamins (Underwood, 2015). However, there is limited data on the actual prevalence of these deficiencies suggesting the need for simple public health approaches that evaluate and address multiple micronutrient malnutrition.

Figure 2.3 shows Bennett's hierarchy model that is usually used to tailor education programs. It is often shown as a stair case with inputs (the beginning) on the bottom and impact (the end) at the top. The idea being as you move to the top, the outcomes are stronger and further reaching (Radhakrishna and Bowen, 2010).

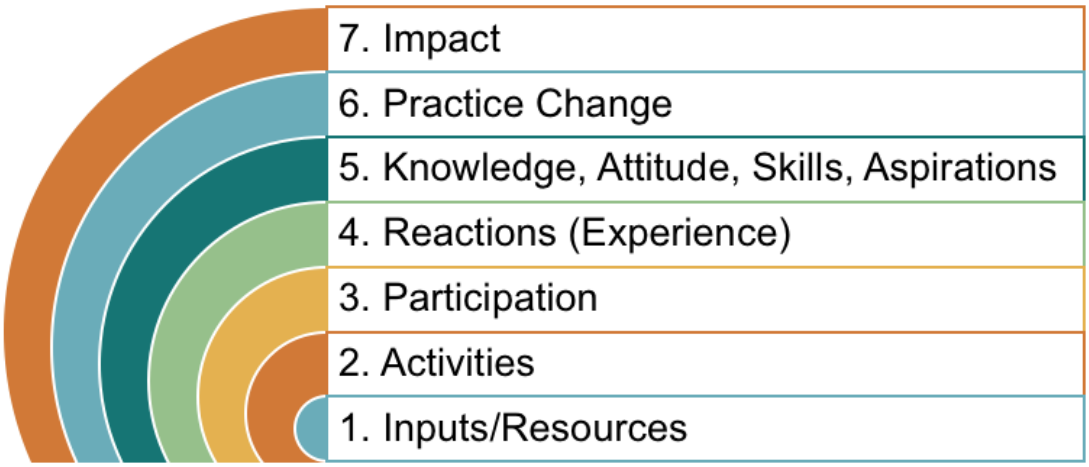

Figure 2.3: A Conceptual framework of Bennett's change model related to the current study.

Source: (Radhakrishna and Bowen, 2010)

1. **Inputs:** These are the resources to be used for the program
2. **Activities:** This is a description of what you will be doing.
3. **Participation:** This is a description of two things. First, who is the target audience? Second, how many people are participating, for how long and how often.
4. **Reactions:** This is a description of what the participants' immediate reactions should be to the program. Did they find the program interesting, enjoyable, and informative?
5. **KASA:** KASA is the most distinctive part of Bennett's Hierarchy. It asserts that to achieve a "practice change" (the next step), participants should have prior changes in four areas. **Knowledge**: what they know. **Attitude**: how they feel. **Skill**: what they can do. **Aspiration**: What they want.
6. **Practice Change:** The goal of an educational program is for participants to apply what they learn to their lives. This is practice change. It describes what participants do differently. At this point in the hierarchy, the educational program has let go and hopes that the activities it did and the KASAs it produced results in something.
7. **Impact:** This is the end results of the practice change. What did it add up to for society?

2.5. Micronutrient deficiencies

2.5.1 Vitamin A deficiency (VAD)

Vitamin A deficiency is a serious worldwide public health problem in poor societies especially in low income countries that particularly affects preschool-age children (KNMS, 2011). It has been estimated to cause about 70 percent of cases of preventable, severe, visual impairment and childhood blindness worldwide, a major contributor to morbidity and mortality from infections (KNMS, 2011).

Recent estimates indicate that globally, 12 billion people are at risk for vitamin A, iodine, and/or iron deficiency, in spite of recent efforts in the prevention and control of these deficiencies (WHO, 2015). Clinical vitamin A deficiency (VAD) affects at least 2.8 million preschool children in 160 countries, and subclinical VAD is

considered a problem for at least 251 million, including school age children and pregnant women (Bhutta and Salam, 2015).

According to the 2011 Kenya National Micronutrient Survey report, the prevalence of vitamin A deficiency is at 4.1%. Preschool children (PSC) had the highest (9.2%) prevalence of vitamin A deficiency compared with all other groups. The marginal VAD (0.7 - <1.05 μmol/L) in PSC was 52.6%. Prevalence of overall marginal vitamin A deficiency was 24.4 percent (KNMS, 2011). The observed prevalence of VAD is also lower compared to the global estimates of 33.3 percent in pre-school children (KNMS, 2011). Vitamin A deficiency increases vulnerability to other disorders, including the risk of severe illness and death from common childhood infectious diseases. This situation is mainly aggravated by poor dietary intake of foods that lack this nutrient and also caused by a high prevalence of diseases and conditions that directly interact with an individual's vitamin A status, such as measles, malaria, HIV/AIDS, and other micronutrient deficiencies such as iron and zinc (KNMS, 2011). Delayed growth, especially stunting, has also been reported in children with clinical signs of VAD (Bhutta and Salam, 2015).

The initial signs of vitamin A deficiency are night blindness, impaired epidermal integrity manifested by hyperkeratosis and anemia (WHO, 2014) such that if night blindness is left untreated, it is followed by xerophthalmia, a disease associated with structural changes in the cornea. Several studies have shown that vitamin A supplementation after six months for children less than 5 years can drastically reduce the morbidity associated with measles among children (KNMS, 2011).

Vitamin A is an essential nutrient needed in small amounts for the normal functioning of the visual system, and maintenance of cell function for growth, epithelial integrity, reproduction and immunity (WHO, 2015). The dietary sources of vitamin A are preformed vitamin A which is found in foods of animal origin and provitamin A carotenoid which are found in yellow and orange-fleshed fruits and vegetables and in dark green leafy vegetables (Mwaniki, 2007). Palm oil is the universal source of pro- vitamin A for the pharmaceutical industry. Vitamin A interventions include promotion of breastfeeding, food fortification, dietary

supplementation of children with vitamin A and biofortification (KNMS, 2011). Though these interventions have had significant impact in projects where they are administered, the results have not been sustainable especially in resource-poor communities (T. Report *et al.,* 2018). This is because resource-poor households consume an insignificant amount of processed foods limiting the use of fortification (Ohanenye *et al., 2021).* In addition, they tend to be situated in remote areas characterized by poor infrastructure, inadequate health care, and insufficient public funds. This situation limits the use of supplementation as a sustainable intervention. Dietary diversification is still the best way to alleviate malnutrition (Lumole, 2013). It aims at ensuring that the available diet is adequate in every nutrient. Dietary diversification is a long-term objective although it provides useful insights that there is no single solution to combat "hidden hunger"(Ogechi and Chilezie, 2017). Several solutions such as fortification are not mutually exclusive but complement one another (Mannar, 2017).

The most common vitamin A fortificant for cereals is vitamin A palmitate, a dry form that is stable in flour (Schofield *et al.,* 2008). There is little evidence of sensory and physical incompatibility either in the flour or in wheat-based flour products. However, baking of flour products typically results in ~30% loss of the vitamin (Schofield *et al.,* 2008). Fortification of margarine and monosodium glutamate with vitamin A has been practiced in some European countries and North America for many years, while fortification of sugar has also been shown to be effective and sustainable in a number of Latin American countries (L. Allen *et al.,* 2006). Typical vitamin A fortification programs have sought to deliver 30% to 60% of the Recommended Dietary Allowances (RDAs) for specific target populations as long as they consume enough of the proposed food vehicle (Schofield et al., 2008). Vitamin A fortification of wheat and maize flour in commodity foods should be considered (Future and Relations, 2014) when fortification of more cost-effective food vehicles is not feasible and when the target population consumes enough of the staple flour to deliver sufficient amounts of vitamin A.

2.5.2 Iron deficiency anemia (IDA)

Iron deficiency is the most common and widespread nutritional disorder, affecting approximately two billion people globally (Sullivan *et al.,* 2012). It is prevalent in all age groups and thus a public health problem in most parts of the world. In Kenya, the highest prevalence of iron deficiency anemia, iron deficiency, and anemia was observed in pregnant women at 26%, 36.1% and 41.6% respectively, and lowest in men (2.9%, 3.6% and 9.3% respectively) (KNMS, 2011). Pre-school children have a higher prevalence of anaemia, iron deficiency and iron deficiency anaemia (26.3 percent, 21.8 percent, and 13.3 percent respectively) than school-age children (16.5%, 9.4% and 4.9% respectively). Non-pregnant women on the other hand have a prevalence of 21.9% for anaemia, 21.3% for iron deficiency and 14.0% for iron deficiency (KNMS, 2011).

Anemia is one of the major global nutrition concerns, caused not only by deficiency of iron, but is also associated with other nutrient deficiencies, such as riboflavin, vitamin A, B_{12} and B_6, and folic acid (Bhutta and Salam, 2015). Apart from the nutrient deficiencies, chronic and general infections, malaria and worm infestation also lead to anemia (Allen *et al.,* 2006). Anaemia has been shown in several studies to be a global public health problem (WHO, 2011; Sullivan *et al.,* 2012; García-casal, 2014 and Obasohan *et al.,* 2020). In developed countries, iron deficiency is a major cause of anemia coupled with anorexia, the use of reducing diets or vegetarian food habits (Bhutta *et al.,* 2008). On other hand, in developing countries particularly Africa and Asia, inadequate intakes of dietary iron and poor bioavailability of iron from plant-based diets are major causes of anemia. Besides, excessive iron losses due to menstruation (among women) and worm infestation are considered main risk factors for anemia (WHO, 2011).

Iron deficiency anemia is a severe stage of iron deficiency in which hemoglobin (hematocrit) falls below the standard cut-offs (WHO, 2015). Serum ferritin, transferrin receptor, transferrin saturation and erythrocyte protoporphyrin are indicators used as biochemical evidence for iron deficiency. Anaemia resulting from iron deficiency impacts the lives of millions of women and children contributing to

fatigue, poor cognitive and motor development, and low productivity (WHO, 2011). When it occurs during pregnancy, it may be associated with low birth weight and increased risk of maternal and perinatal mortality (WHO, 2015).

In Vietnam, fish sauce fortified with iron while in China, fortification of soy sauce with iron significantly improved the iron status and reduced anemia and iron deficiency among pregnant women and children respectively (Allen *et al.,* 2006). The effectiveness of iron fortification of infant formulas has also been demonstrated in many parts of the world which has been associated with fall in prevalence of anemia among children less than 5 years (Allen *et al.*, 2006; García-casal, 2014) and Ohanenye *et al.,* 2021).

In countries like Venezuela, wheat and maize flours have been fortified with iron (mixture of ferrous fumarate and elemental iron). A comparison of the prevalence of iron deficiency and anaemia pre and post-intervention showed a significant reduction in the prevalence of these conditions in children (Allen *et al.,* 2006). Also, in Chile, fortification of milk with iron produced a rapid reduction in the prevalence of iron deficiency among infants and young children (IYC) (Allen, 2006).

Interventions designed to prevent iron deficiency anemia include; dietary diversification, iron supplementation, fortification of foods with iron and public health measures such as deworming (Allen *et al.,* 2006). Food based interventions such as fortification of food vehicles with absorbable forms of iron is a highly desirable and cost-effective approach to controlling iron deficiency (WHO, 2015).

2.5.3 Zinc deficiency

Zinc is a vital micronutrient for body function at different statuses of body physiology. It is estimated that one third of the world population lives in countries with a high prevalence of zinc deficiency (Bhutta and Salam, 2015). According to the Kenya national micronutrient survey report, pre-school children had the highest prevalence of zinc deficiency (83.3%) among all the population subgroups. This was followed by non-pregnant women with a prevalence of 82.3 percent, school age children (80.2%), men (74.8%) and finally pregnant women (68.3%) with the lowest

prevalence (KNMS, 2011). High zinc deficiency levels is reported to be worsened due to diarrhea, pneumonia and malaria (WHO, 2014). It is estimated that two billion people are associated with zinc deficiencies in the developing world especially in south Asian developing countries (Wani *et al.,* 2017). For instance, India is having its soils 50 percent deficient in zinc which is estimated to rise to 63% by 2025, if the present trend continues. Moreover, it is estimated that 26% population in India is at a risk of zinc deficiency which account for 312 million people among a population of 1.2 billion (Tulchinsky, 2015).

Zinc is an important metallo-enzyme in the human body, involved in biochemical processes as diverse as enzymatic catalysis, lipid and carbohydrate metabolism, deoxyribonucleic acid (DNA) replication, RNA transcription, cellular signal transduction, and antioxidant defense mechanisms (Arbor, 2011). Even though zinc has enormous significance, the amount needed in the human body is about 2-4g (Wani *et al.,* 2017). In spite of having diverse functions in vivo, it has been difficult to develop a single biomarker of zinc status. Plasma zinc concentrations have been used, but this bio- marker is nonspecific (Bailey, 2015). The human body however has no long-term storage system for zinc, therefore consistent dietary intake is needed to sustain all of these functions and maintain the relatively small exchangeable zinc pool (Bailey, 2015). Zinc is primarily found in seafood and meat, while the zinc in plant-based diets containing fiber and phytochemicals is less-available (Ackland and Michalczyk, 2016). Although cereals and legumes can provide amounts of zinc similar to those found in animal tissues, dietary zinc bioavailability is reduced by phytates found in grains, nuts and seeds (Ackland and Michalczyk, 2016).

The available studies have found that zinc fortification can increase dietary zinc intake and total daily zinc absorption (Hess et al., 2011; Wani et al., 2017 and Ohanenye et al., 2021). In Kenya, mandatory flour fortification with zinc has been adopted as a strategy to increase zinc uptake among populations with elevated risk of zinc deficiency (KNMS, 2011). Different zinc fortificants meet "Generally Recognized as Safe" (GRAS) standards, though current evidence suggests that zinc

oxide is the most suitable fortificant due to its low cost and negligible effect on sensory characteristics of fortified flour and flour products (Hess and Brown, 2009).

2.5.4 Vitamin B_{12}/ folate deficiency

Folate is a form of vitamin B, which is important for making and repair of DNA and production of red blood cells (Liu *et al.,* 2016)**.** Vitamin B_{12} deficiency has been linked to poor pregnancy outcomes and increased risk of megaloblastic anemia, neurological disorders, sub-acute degeneration of the spinal cord and Neural Tube Defects (NTDs), delayed child development, abnormal cognitive function and elevated plasma homocysteine concentration (Schofield *et al.,* 2008). Folate is an essential vitamin for good health and women of childbearing age are among the population subgroups that have been shown to have low blood folate levels (Liu *et al.*, 2016). No good estimates of global folate deficiency exist for those considered to be at highest risk (women of reproductive age, pregnant females, and young children). Besides, only about 30% of women globally take folic acid supplements prior to conception (Mcdowell *et al.*, 2008). In Kenya, the national prevalence of folate deficiency in pregnant women stands at 32.1% and 30.9% in non-pregnant women (KNMS, 2011). The only natural rich source of vitamin B_{12} are animal sources thus the deficiency is prevalent among population groups that are vegans or the poor segments who can't afford animal food sources of this vitamin (Schofield *et al., 2008).*

Folate deficiency occur as a result of insufficient dietary intake or poor absorption of vitamin B_{12}. It can be determined by serum, plasma, or erythrocyte folate concentrations (Linabery and Kimberly, 2012). Folate deficiency causes megaloblastic or macrocytic anemia and increases the likelihood for pregnancies affected by neural tube defects (Bailey, 2015). Neural tube defects (NTDs) are structural birth defects of the central nervous system caused by the failure of the embryonic neural tube to close within the first 4 weeks after conception (Liu *et al.*, 2016). NTDs are the major cause of perinatal mortality, disabilities and child morbidity hence it is a worldwide public health burden (Bailey, 2015).

Several studies have also shown that folate deficiency is very low in countries that have adopted prenatal folic acid supplementation (Zimmerman and Andersson, 2012; Geoffry, 2015; Bailey, 2015 and Health and Learning, 2015). In addition, mandatory or voluntary folic acid fortification programs have had significant impact of reducing the prevalence of low serum folate in the population

Previous studies have also shown significant treatment of vitamin B_{12} deficiency by using a combination of vitamin B_{12} two active co-enzyme forms (methylcobalamin and adenosylcobalamin) (Benoist, 2008; Thakkar and Billa, 2015; Bailey, 2015 and Allen, 2018). Countries currently enforcing addition of folate to fortified flour should re-examine their requirements based on the standard recommendations regarding levels of folate fortification based on per capita consumption of "fortifiable" flour.

2.6 Food Fortification as a strategy to reduce micronutrient deficiencies

According to the 1991 Codex Alimentarius, fortification of foods refers to "The addition of one or more essential nutrients to a food, whether or not it is normally contained in the food, for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups (Future and Relations, 2014). In the first half of the 20th century, many vitamins and minerals were discovered, and it was possible to synthesize them on a large scale in order to restore vitamins and minerals lost in food processing (Allen *et al.*, 2006). Milk fortification with vitamin D commenced in the parts of the United States in efforts to eliminate rickets among children and osteoporosis among the elderly (especially the African Americans) (Future and Relations, 2014).

Fortification of foods began more than 100 years ago, when Switzerland and the United States began adding iodine to salt to prevent goiter among school children (Allen *et al.*, 2006). Food fortification was first specifically mentioned in the 1992 International Conference on Nutrition declaration as a valid technology to adopt (Future and Relations, 2014). It was recognized as a cost-effective food-based approach and a tool to fight MNDs if existing food supplies and limited access fail to provide adequate levels of nutrients (Future and Relations, 2014).

The fortification of cereal products with B vitamins and flour with iron has also been widely practiced. Since the 1940s, the B group vitamins have been used to enrich processed foods due to widespread public health problems such as pellagra, Beriberi, anaemia and riboflavin deficiency (Allen *et al.,* 2006). The success of fortification programs such as Universal Salt Iodization (USI) in many developed countries is attributed to large-scale, centralized food processing plants with the equipment and expertise needed to add nutrients to foods in a safe, consistent and cost-effective way (Future and Relations, 2014).

2.7. Forms of food fortification

Food can be fortified at three levels; mass or universal; targeted; or household and may be mandatory or voluntary (Future and Relations, 2014). Mass fortification is the preferred approach when a majority of the population is at risk of a particular nutrient deficiency, whereas targeted fortification is designed for defined subpopulation groups for example, fortification of complementary foods for children (Allen *et al.,* 2006). Commercial or market-driven fortification is whereby the manufacturer takes a business-oriented initiative to add specific amounts of one or more nutrients to a processed food. It is more common in developed countries, though its predicted to rise in less-regulated, low-income countries causing concern due to the potential disruption to traditional dietary patterns (Future and Relations, 2014).

Home fortification and biofortification are more recent approaches, with evaluations still underway as to their effectiveness (Mannar, 2017). Home fortification also referred to as household or community fortification, is a combination of supplementation and fortification, in particular for complementary foods for young children to be delivered at the household level. Different products, such as micronutrient-based powders (“sprinkles”) and micronutrient-rich spreads, are added to weaning foods and porridges (Allen *et al.,* 2006).

Biofortification on the other hand is the process of generating genetically improved food crops that are rich in bioavailable micronutrients through conventional breeding for example the orange fleshed sweet potatoes (Osendarp *et al.,* 2018). These three

forms of fortification can either be mandatory or voluntary fortification. Mandatory fortification is when food manufacturers are required by the national food law to add certain vitamins or minerals to a specified food or foods (wheat flour and cooking oils). Whereas, voluntary fortification involves the practice by which food manufacturers freely chooses to add different concentrations of vitamins, minerals and other nutrients to processed foods such as juices "enriched with vitamin C" (Future and Relations, 2014).

2.8 Basic principles of food fortification

According to Future and Relations, (2014) report, the public health impact of food fortification depends on a number of parameters which include; how widely and regularly a fortified food is consumed, constant consumption pattern of a fortified food with low risk of excess consumption, good stability during storage, a relatively low-cost product, centrally processed with minimal stratification of the fortificant and no interactions between the fortificant and the carrier food. The fortified/ carrier food should be contained in most meals, with the availability unrelated to socio-economic status and also linked to energy intake (Future and Relations, 2014). Thus, the major food vehicles used for fortification include cereals, condiments, fats, oils and margarines, dairy products and value-added products.

2.9 Advantages of food fortification

Food fortification offers a number of advantages over other interventions aimed at preventing and controlling MNDs. In most settings, the delivery system for fortified foods is already in place, generally through the private sector. It is usually possible to add one or several micronutrients without adding substantially to the total cost of the food product at the point of manufacture (Allen *et al.,* 2006). This affords many countries the opportunity to develop effective strategies to combat MNDs based on the fortification of centrally-processed dietary staples that once would have reached only a very small proportion of the population (Allen *et al.,* 2006).

Fortification generally aims to supply micronutrients in amounts that approximate to those provided by a good, well-balanced diet. Consequently, fortified staple foods contain "natural" or near natural levels of micronutrients, which may not be the case with supplements (Allen *et al.,* 2006). Multiple micronutrient deficiencies often coexist in a population that has a poor diet. It follows that multiple micronutrient fortification is frequently desirable. In most cases, it is feasible to fortify foods with several micronutrients simultaneously (Tulchinsky, 2015).

Fortification of widely distributed and widely consumed foods has the potential to improve the nutritional status of a large proportion of the population, both the rich and the poor (Zimmermann and Andersson, 2012). If consumed on a regular and frequent basis, fortified foods maintain body stores of nutrients more efficiently and more effectively than will intermittently supplements. Fortified foods are also better at lowering the risk of the multiple deficiencies that can result from seasonal deficits in the food supply or a poor-quality diet (Bailey, 2015). Additionally, fortification requires neither changes in existing food patterns nor individual compliance (Darnton-hill and Nalubola, 2018). Thus, it is often more cost-effective than other strategies, especially if the technology already exists and an appropriate food distribution system is in place (Darnton-hill and Nalubola, 2018). Finally, when properly regulated, fortification carries a minimal risk of chronic toxicity (Darnton-hill and Nalubola, 2018).

2.10 Limitations of food fortification

Although it is recognized that food fortification can have an enormous positive impact on public health, there are however some limitations to this strategy for MNDs control (Allen *et al.,* 2006). First and foremost, fortified foods are not a substitute for a good quality diet that supplies adequate amounts of protein, energy, essential fats and other food constituents required for optimal health (Mwaniki, 2007). For instance, infants and young children who consume relatively small amounts of food, are less likely to be able to obtain their recommended intakes of all micronutrients from universally fortified staples or condiments alone (Black *et al.,* 2008).

Secondly, a specific fortified foodstuff might not be consumed by all members of a target population. Fortified foods often fail to reach the poorest segments of the general population who are at the greatest risk of micronutrient deficiency. This is because such groups often have restricted access to fortified foods due to low purchasing power and an underdeveloped distribution channel (Mwaniki, 2007). It is also likely that in many locations fortified foods will not supply adequate amounts of some micronutrients, such as iron for pregnant women, in which case supplements will still be needed to satisfy the requirements of selected population groups (Bhutta *et al.,* 2008).

Thirdly, it is generally possible to add a mixture of vitamins and minerals to relatively inert and dry foods. Interactions can occur between fortificant nutrients that adversely affect the organoleptic qualities of the food or the stability of the nutrients (Iles *et al.,* 2017). For example, some iron fortificants change the color and flavor of many foods to which they are added, and can cause the destruction of fortificant vitamin A and iodine (Allen *et al.,* 2006). Technological issues relating to food fortification have yet to be fully resolved, especially with regard to appropriate levels of nutrients, stability of fortificants, nutrient interactions, physical properties, as well as acceptability by consumers including cooking properties and taste (Fungo, 2009).

Lastly, although food fortification is a more cost-effective than other strategies, there are nevertheless significant costs associated with the food fortification process, which might limit the implementation and effectiveness of food fortification programs (Groote *et al.,* 2011).

2.11 Summary of the literature

Food fortification is a technologically and economically effective intervention to promote micronutrient intake by the targeted populations (Darnton-hill and Nalubola, 2018). In some instances, food producers choose to fortify foods voluntarily whereas, in others, governments enforce mandatory fortification (Future and Relations, 2014). Mandatory fortification is assured through legislation and enforcement with little or no change in the knowledge and behavior of the targeted population (Garrett, 2018b).

Starting in the 20th century, fortification has been used in different parts of the world to target specific health conditions: goiter with iodized salt; rickets with vitamin D-fortified milk; beriberi, pellagra and anemia with B-vitamins and Fe-enriched cereals or flour (Pandey and Saroshe, 2015). Likewise, Kenya has made great strides in food fortification. Furthermore, consumer responses towards food nutritional enrichment have gained importance in the country due to the increase in the production of nutritionally enhanced foods, both bio-fortified and industrially-fortified food products (Groote and Kimenju, 2012). Recently, Kenyan mass media covered debates on the adverse health effects of food enrichments, but with lacking scientific data (Ministry of Health, 2022). In the same report, it was stated that health care providers, millers and the general population lack sufficient information on the importance of micronutrients (Ministry of Health, 2022). Consumers may adopt misleading information emanating from such negative debates without discretion if they have low levels of awareness and knowledge of nutrition information-making them more skeptical to food fortification. This calls for the need to assess consumer awareness and knowledge, attitudes and practices on food fortification in Kenya. The findings from this study are expected to provide insights to policy makers and other stakeholders with a better understanding of consumer levels of awareness, knowledge, attitudes and demand for fortified foods. It can also serve to guide strategies for micronutrient promotion and food enrichment education programs in the country.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study location

The study was undertaken in households during the months of November 2017 and January 2018 in Kakamega, Kisumu, Uasin Gishu, Trans-Nzoia, Nakuru, Nyandarua, Narok, Nairobi, Mombasa, Kilifi, Kitui, Meru and Garissa counties. This was done in order to gather information from a representative population of all the regions of Kenya. Every region was represented by sampling one or two counties.

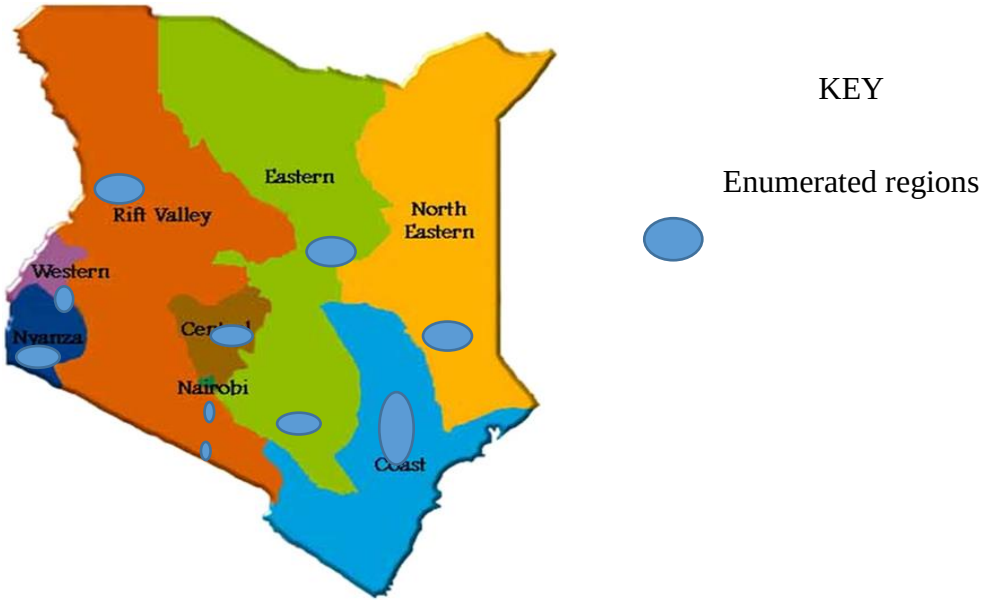

Figure 3.1: Geographical distribution of counties surveyed across the country

3.2 Study design

A cross sectional descriptive study was undertaken in order to ascertain and describe the characteristics of the variables of interest in the study. This design was used because it provided a snapshot of the frequency of the consumption practices of fortified foods and characteristics of the status of the study population at a particular point in time. In addition, findings from cross-sectional studies are useful for nutrition program planning (Setia, 2016). Data collection is also a one-off activity,

and it is relatively inexpensive and takes up a little time to conduct which is appropriate for a thesis.

3.3 Target population

This study targeted a household member responsible for food purchase in his/her household. A household member who met the inclusion criteria and consented was included in the study.

3.3.1 Inclusion criteria

- A household head or a household member who is 15 years of age and above.
- Permanent residents-They involved respondents that had stayed in the enumerated area for more than three months. This was considered a criterion to ensure reliability and validity of the study outcomes.
- Respondents that consented to participate in the study.

3.3.2 Exclusion criteria

- Household member below 15 years of age.
- Temporary residents-They involved respondents that had stayed in the enumerated area for less than three months. This criterion was left out to throw doubt on the reliability of the study results.
- Respondents who did not consent to participate in the study.

3.4 Sampling techniques and sample size determination

3.4.1 Sample size determination

The sample size was determined using Large Country-Lot Quality Assurance Sampling (LC-LQAS) method (Hedt *et al.,* 2008). LQAS is used to estimate coverage at an aggregate level. It uses small samples typically 19 per area to make an accurate and reliable classification. Samples larger than 19 have practically the same statistical precision as 19 thus it will not result in better findings either. On the other

hand, sample sizes less than 19 have shown rapid deterioration in the precision of the measure.

Additionally, supervision areas (S. As) which are the smaller administrative units in the catchment areas (C.A) are not supposed to be less than 4 although 5 is also preferred. In this study, supervision areas were the sub locations in the selected counties and were more than 4 in each catchment area. A total of 67 supervision areas were selected using simple random sampling technique. All the supervision areas had equal chances of being selected for the study.

LC-LQS sample size Formulae:

The formulae below are the standard LQAS analysis method used to calculate supervision areas as having reached a standard or target.

$$n = N(1+(m-1)\widehat{\rho})\left\{\left[\left(\frac{\ell_{max}N^{*}_{cen}}{1.96}\right)^{2}\left(\frac{(m-1)(1-\widehat{\rho})}{N\overline{M^{2}}}\right)+m\widehat{\rho}\right]\right\}^{-1}$$

Where:

m =the number of samples collected in each Supervision areas (SA) =19

N =the total number of SAs in a catchment area=13

N^{*}_{cen} =the total population in the catchment area (usually based on a national census) = 1,130,958(At the time of the study)

$\overline{M^{2}}$ = the average square of supervision area population= 57,354,228,804

$\hat{\rho}$ =an estimate of the intra class correlation (if no estimates, one can turn to ICC estimates based on design effects from other multistage surveys in the area) =0.087

ℓ_{max}, = the maximum desired length for the confidence interval, has a value of 0.2.

n=13(1+(19-1)0.087){[0.2(1,130,958)/1.96]^2[(19-1)(1-.087)/13*57,354,228,804 + 19*0.087]}$^{-1}$

n=4.69

Minimum number of supervision areas to sample (n) = 5

Seventy-six enumeration areas (villages and estates) were selected from the 67 supervision areas. The study selected 19 respondents from each supervision area, which gave a total (n) of 1273 (19x67) respondents as shown in **Appendix V.** The study also added 15% of the sample size calculated to cater for non-responses.

This was calculated as shown below.

(15/100) x n

(15/100) x 1273 = 190.95

New sample size (n_0) = 1273 + 191

n_0 = 1464

A total of 1464 respondents were targeted for the survey. Only 1435 respondents participated in the survey. A response rate of 98% (100 x 1435/1464) was achieved.

3.4.2 Sampling procedure

Multistage cluster random sampling method was done to group the Kenyan population into the 9 regions divided based on the old provinces of Kenya which included; Nairobi, Central, Coast, Western, Eastern, North Eastern, Nyanza, North Rift and South Rift regions. Simple random sampling technique was then adopted to select 13 cluster counties from the 9 regions namely; Nairobi, Nyandarua, Mombasa, Kilifi, Kakamega, Kitui, Meru, Garissa, Kisumu, Nakuru, Narok, Uasin Gishu and Trans-Nzoia counties. Within the counties, simple random sampling was used to select 67 sub-counties, 67 wards, 67 locations and 67 sub-locations.

From the 67 sub-locations, a total of 76 villages (in rural areas) and estates (in urban areas) were randomly selected to achieve the desired sample size using a systematic sampling technique. Finally, the primary sampling units which were the households

were also selected using simple random sampling technique. A list of households in each village/estate was obtained and a simple random sampling technique was used to identify a representative sample of households from each village/estate. All households had equal chances of being selected for the study.

A summary of respondents' county of residence included in the study is as shown in Table 3.1 below.

Table 3.1: Respondents' County of residence selected in the study

County of residence	Frequency (n= 1435)	Percentage
Kakamega	84	5.9
Kilifi	106	7.4
Kisumu	120	8.4
Mombasa	85	5.9
Nakuru	78	5.4
Narok	57	4.0
Trans-Nzoia	131	9.1
Uasin-Gishu	40	2.7
Nairobi	157	10.9
Nyandarua	120	8.4
Meru	154	10.7
Kitui	142	9.9
Garissa	161	11.2

3.5 Data collection tool

A pretested, tablet-based questionnaire was used to collect information on socio demographic characteristics, awareness, knowledge, attitudes and consumption practices of fortified foods and use of maize flour products among Kenyan consumers **(Appendix 1).**

3.6 Study variables

The dependent variables for this study comprised of awareness, knowledge, attitudes and practices of the studied participants towards food fortification.

The independent variables included socio-demographic characteristics of the study participants. These characteristics comprised of age, gender, household composition, marital and occupation status, education level and respondents' place of residence.

3.7 Quality Control

3.7.1 Recruitment and training of research assistants

The research assistants recruited were holders of Bachelor's degree in social sciences, fluent in written and spoken English and Kiswahili, good communication skills, teamwork and outgoing personality. The research assistants were trained for one day on various aspects of data collection exercise in order to ensure accuracy and competence.

The training topics involved the purpose of the study and its objectives, data collection method and materials, code of conduct and work schedule in the field. They were also trained on how to accurately enter, save and send the data entered on the tablets.

3.7.2 Validity of the research instrument

In order to ascertain the content validity of the research instrument, questions were formulated to address all the variables as included in the conceptual framework and ensured logical flow of the content. After pre-testing, the questionnaire was reviewed by seeking an independent opinion on the quality of the instrument from the supervisors who are nutrition experts. The instrument was then adjusted accordingly.

3.7.3 Reliability of the research instrument

In order to ascertain the ability of the questionnaire in producing consistent results, the questionnaires on the mobile data platform were designed such that one can't move to the next page without proper filling of the data. This ensured completeness of the filled questionnaires before they were sent to the server.

3.7.4 Pretesting of the questionnaire

The pretest of the research instruments was carried out a week prior to the main survey. This ensured that there was time to address issues identified during pretesting. The exercise was carried out at Jomo Kenyatta University of Agriculture and Technology (JKUAT) main campus during training of enumerators with enumerator participation. Questionnaires were drafted and coded into a tablet version. Open Data Kit (ODK) tool version on Samsung tablets was used. The purpose of the pre-testing was to identify/increase the efficacy of the research instruments. The results of pretest guided in setting the actual field data collection logistics.

3.8 Ethical consideration

A letter of approval (Appendix VI) to carry out research was obtained from the Ministry of Health (MoH) with the reference number MOH/ADM/1/1. Permission to conduct household interviews was obtained from the county officials in the respective counties. Ward administrators and village elders who served as guides during household interviews were contacted in the respective enumerated areas as well. Finally, the primary survey respondent also gave consent to be interviewed. To ensure authenticity of the results, the respondents were assured of confidentiality of all the information given. The research team assured to keep the identities of those who participated strictly confidential. A signed informed consent was sought from interviewee before administering the interview (Appendix 1). Participation was purely voluntary and no pressure or inducement of any kind was applied to encourage an individual to participate in the research.

3.9 Data management and analysis

All the data that was not captured during the initial stages of data coding process was coded into computers as variables after which it was entered, cleaned and analyzed using STATA version 14.0. Descriptive statistics such as frequencies were used in describing socio-demographic characteristics, awareness and knowledge levels, attitudes and consumption practices of fortified foods among consumers. Binary

logistic regression analyses were performed to determine the association between socio-demographic variables and the main outcome variables. Statistical significance was set at $p<0.05$.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

In this section, the results of the study are described. These include the socio-demographic characteristics of the study participants, status of awareness, knowledge, attitudes and practices on food fortification among Kenyan consumers.

4.2 The Socio-demographic characteristics

A total of 1435 respondents were interviewed in this study. A response rate of 98% (100x1435/1464) was achieved. The distribution of the respondents by gender, age, level of education and occupation status is shown in Table 4.1. More females were interviewed (76%) than males (24%). The median age of the respondents was 35 years. A high proportion (65.2%) of the respondents were aged between 25 to 49 years and about half (49.3%) had attained primary education. The majority of the respondents (73%) were married. Regarding the household composition, 34.7% of the households had about 3-4 dependents. Self- employment was the major occupation among 40% of the respondents.

Majority of the households (76%) were male-headed households. About 44.7% of the household heads had achieved primary education. Self-employment was the major occupation for about 41% of the household heads. The “other” forms of occupation comprised of construction workers, caretakers, gardeners, cooks, quarrymen, cow/swineherds and farm workers. More than half (59%) of the respondents also reported that the wives were the ones responsible for most of the grocery shopping decisions in the households.

Table 4.1: Socio-demographic characteristics of the respondents

Characteristic	Overall n=1435 n (%)	Female n (%)	Male n (%)
Age (yrs.)			
15-17	18(1.3)	14(1.0)	4(0.3)
18-24	207(14.4)	164(11.4)	43(3.0)
25-34	472(32.9)	383(26.7)	89(6.2)
35-49	464(32.3)	352(24.5)	112(7.8)
>50	274(19.1)	184(12.8)	90(6.3)
Level of education			
No formal education	145(10.1)	100(7.0)	45(3.1)
Primary	707(49.3)	539(37.6)	168(11.7)
Secondary	436(30.4)	349(24.3)	87(6.1)
Tertiary	147(10.2)	109(7.6)	38(2.6)
Marital status			
Married	1057(73.7)	968(67.5)	89(6.2)
Divorced/Separated	67(4.7)	14(1.0)	53(3.7)
Widowed	116(8.1)	16(1.1)	100(7.0)
Single	195(13.6)	99(6.9)	96(6.7)
Size of household			
1-2 dependents	150(10.5)	-	-
3-4 dependents	498(34.7)	-	-
5-6 dependents	409(28.5)	-	-
>7 dependents	378(26.3)	-	-
Occupation of the respondent			
Self-employed	574(40.0)	420(29.3)	154(10.7)
Formal employment	124(8.6)	93(6.5)	31(2.1)
Casual labor	208(14.5)	139(9.7)	69(4.8)
House wife/husband	331(23.1)	289(20.1)	42(3.0)
Other	198(13.8)	156(10.9)	42(2.9)
House head gender	1435(100)	344(24.0)	1091(76.0)
House head education level			
No formal education	147(10.2)	61(4.2)	86(6.0)
Primary	642(44.7)	169(11.7)	473(33.0)
Secondary	457(31.9)	76(5.3)	381(26.6)
Tertiary	189(13.2)	32(2.3)	157(10.9)
Occupation of the house head			
Self employed	588(41.0)	158(11.0)	430(30.0)
Formal employed	256(17.8)	29(2.0)	227(15.8)
Casual labour	340(23.7)	66(4.6)	274(19.1)
Housewife/husband	100(7.0)	42(3.0)	58(4.0)
Other	151(10.5)	43(3.0)	108(7.5)

In more than half (59%) of the households, wives were the ones responsible for most of the shopping decisions. This result is consistent with a previous study done on attitudes and purchase behavior of Green products among consumers in food choice in South Africa that showed food-related activities such as shopping, cooking and eating are conventionally presented to be female-centered (Anvar, 2014). Females bear a heavy responsibility in terms of household food purchase decisions and preparation thus they should be targeted for food fortification information programs.

A previous study done in Kenya on consumer awareness of vitamin A fortified sugar showed that consumers between the ages of 25-49 years tend to have better knowledge of the investigated topic due to their accumulated experience in shopping activities (Pambo *et al.,* 2017). Besides, it is expected that younger people may also be exposed to numerous modern technology-based channels of information dissemination including phones and media. Thus, this could influence younger people to be aware of food fortification information.

Household composition has long been associated with the health status of the household (KDHS, 2008). Larger households tend to be crowded leading to health problems compared to smaller households (KDHS, 2008). The distribution of respondents' household composition in this study shows a pattern similar to that seen in the KDHS, (2008/2009) report, with almost a third (32.3%) of the households having about 3-4 dependents.

Marital status is associated with various demographic behaviors. Pambo *et al.,* (2011) showed that marriage is a formal institution with an established structure of information flow. Thus, households headed by individuals in formal marriages in the study were identified to be likely more aware of fortification information.

Education is a key determinant of the lifestyle and status an individual enjoys in a society. In addition, educational attainment has a strong effect on health behaviors and attitudes (KDHS, 2008/2009). In this study, almost half of the respondents (49.3%) and household heads (44.7%) had attained primary education. This characteristic might have influenced 40% and 41% of the respondents and householdes to engage in self-employment activities. These results are similar with

the KDHS, (2008/2009) report that demonstrated respondents who attained primary education tend to engage in self-employment activities which translates to low income especially in rural areas.

The proportion of male-headed households (76%) in this study was higher than that of female-headed households (24%). This result is similar with the KNMS, (2011) report that indicated 72.4% of Kenyan households are male headed. Household heads are the determinants of household's ability to access adequate quantity and quality of food. For instance, households headed by women have been reported to be typically poorer and food insecure than those households headed by men (KDHS, 2008). Thus, access to fortified foods is likely to be a challenge in female-headed households due to limited economic resources influenced by their reported occupation (self employment and casual labour).

4.3 Knowledge on food fortification

4.3.1 Consumers' knowledge of food fortification

Food fortification is the process of adding micronutrients to food products in efforts to reduce or prevent a demonstrated micronutrient deficiency. Only a third (32.9%) of the respondents understood what food fortification entails (Table 4.2). Knowledge level on food fortification among Kenyan consumers was low, with 61.3% of the respondents indicating that they did not know what was meant by food fortification.

Table 4.2: Knowledge on food fortification (expressed as a percentage of respondents)

Statement	False	True	Didn't know
Fortification is adding micronutrients to food products	5.8	32.9	61.3
Fortification is adding vitamins only to food products	23	13.7	63.3
Fortification is adding minerals only to food products	23.8	12.2	64
Fortification is adding proteins to food products	16	20	64

Table 4.3 shows the association of respondents' level of education and knowledge of food fortification. There was a statistical significance association between food fortification knowledge and respondents who had attained secondary (p=0.02) and tertiary education (p=0.03). They were 3 times more likely to be knowledgeable than those with no formal education. In addition, respondents with primary education were 2 times more likely to be knowledgeable than those with no formal education although the result was not statistically significant (p=0.08). This finding contrasts with a previous study on the level of nutrition knowledge and its association with fat consumption among college students in Michigan that reported knowledge of nutrition is not acquired through formal education (Yahia *et al.,* 2016). This could be presumed that the formal education acquired from the previous study was not nutrition related.

Table 4.3: Association of the level of education and knowledge of food fortification

Highest level of education	N	Knowledge of food fortification (%)	Crude OR (95% CI)	p-value
No formal education	145	10.3	1	1
Primary	707	25.9	2.37(0.90 - 6.23)	0.080
Secondary	436	44.3	3.22(1.21 - 8.58)	0.020*
Tertiary	147	55.1	3.15(1.07 - 9.30)	0.038*

COR= Crude odds ratio, CI= Confidence Interval, (*) = statistically significant at 5%, N=number of people in the sample.

4.3.2 Knowledge on mandatory fortification of some foods.

More than two-thirds (71%) of the respondents stated that they did not know that the government of Kenya (GoK) has made it compulsory for food manufacturers to add vitamins or minerals to some foods (Appendix II). Additionally, almost two thirds (64%) of the respondents did not have a way to determine whether vitamins and minerals in a product were naturally occurring or a result of fortification (Appendix II). Food labels are more explicit in communicating nutrition and health benefits of a

product because the information appears at the point of sale for most packaged foods. However, a previous study on the effects of nutrition knowledge on food label use in California, USA shows that food labels have been typically underutilized by consumers (Soederberg and Cassady, 2015). Nutrition knowledge play a key role in food choice by supporting dietary intake regardless of use of food labels (Campos *et al.*, 2011). Thus, these results could be attributed to lack of knowledge and improper use of information sources on fortified foods among the consumers.

The respondents were also asked if they know the types of food vehicles used for mandatory fortification in Kenya. As illustrated in Figure 4.1, about 20%, 15%, 8% and 6% of the respondents were knowledgeable about maize flour, wheat flour, oils and fats, and salt are required to be fortified by law respectively. In addition, about 3% of the respondents mentioned some juices are fortified for example with vitamin C.

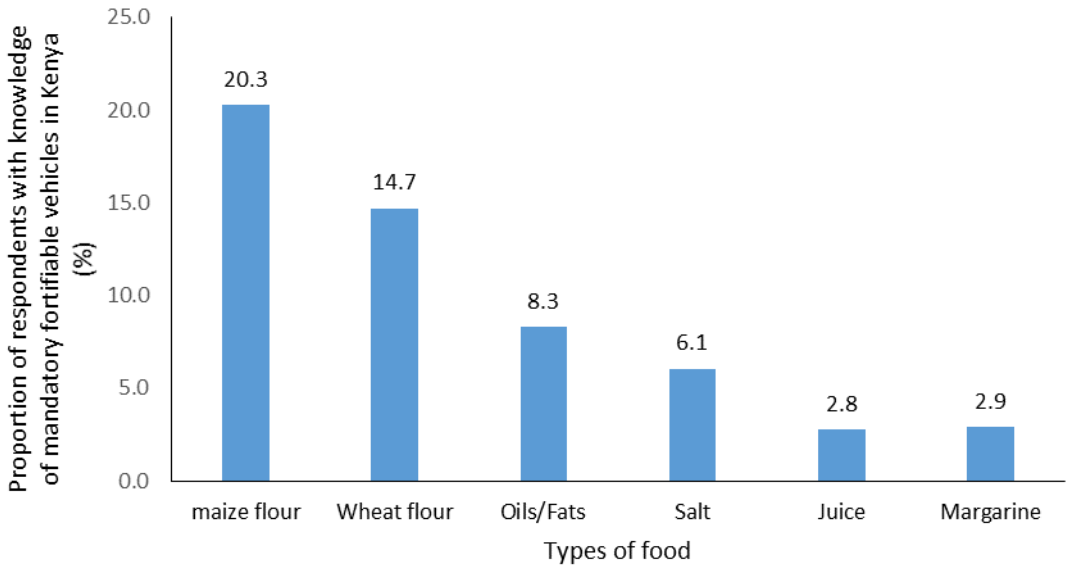

Figure 4.1: Respondents' knowledge of mandatory fortifiable vehicles in Kenya

According to the Global Fortification Impacts and Trends report, (2018), Kenya's large-scale mandatory food fortification included; wheat flour, maize flour and vegetable oils. The project was established in June 2012 and by 2015, there were over 150 brands of certified products for wheat flour, maize flour, salt and edible oils

and fats in the Kenyan market (Garrett, 2018a). Juices and cereal-based food products such as weetabix are voluntarily fortified by the manufacturers. Voluntary fortification is when a food industry is permitted to add micronutrients to a processed food as long as it is within a framework of specifications (Mannar, 2017). Thus, the respondents who mentioned juices as mandatory fortifiable vehicle could be the few consumers who pay attention to advertisements and food labels when making food purchase decisions. This result is similar to a study done in India where the study participants identified juices, bread, biscuits and milk and milk products as mandatory fortifiable foods when they are actually voluntary fortified in India (Battalwar and Syed, 2017).

4.3.3 Knowledge on the existence of mandatory maize flour fortification law in Kenya

Less than a quarter (23%) of the respondents knew that maize flour fortification is enforced by law (Figure 4.2). This result might have been influenced by limited knowledge on food fortification and reported low levels of education by the respondents. A previous study in Greece had shown that nutrition knowledge supports comprehension of and memory for information (Soederberg and Cassady, 2015). Furthermore, attainment of higher education has also been reported to enhance grasping of information (Pambo *et al.,* 2017). Thus, focused information on food fortification should be provided to consumers through specially developed educational tools that will incorporate and benefit everyone.

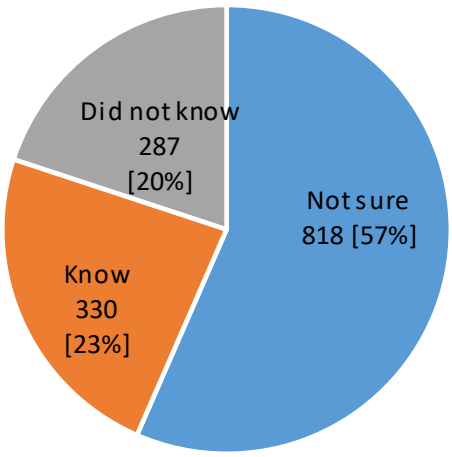

Figure 4.2: Respondents' knowledge of mandatory maize flour fortification law enforcement in Kenya (n=1435)

4.4 Awareness on food fortification

More than two-thirds (72%) of the respondents were not aware of the term 'food fortification.' Table 4.4 shows the association of respondents' socio-demographic characteristics and awareness of food fortification. In the binary logistic analysis, there were statistical significant associations between awareness of food fortification and female respondents (p=0.02), respondents aged 18-24 years (p=0.03) and greater than 50 years (p=0.03), respondents with secondary and tertiary education (p< 0.00), households with more than 7 dependents (p=0.01) and respondents in formal employment (p<0.00).

Table 4.4: Association of the respondents'socio-demographic characteristics and awareness of food fortification

	Respondents aware n(%)	Respondents not aware n(%)	COR (CI 95%)	p-value	AOR (CI 95%)	p-value
Gender						
Male	107 (32.9)	218 (67.1)	Ref		Ref	
Female	294 (26.5)	816 (73.5)	0.7(0.6 - 1.0)	**0.023**	0.8 (0.6 - 1.1)	0.198
Age category						
15-18	8 (44.4)	10 (55.6)	Ref		Ref	
18–24	52 (25.1)	155 (74.9)	0.4 (0.2 - 1.1)	0.083	0.3 (0.1 - 0.9)	**0.025**
25–34	154 (32.6)	318 (67.4)	0.6 (0.2 - 1.6)	0.300	0.5 (0.2 - 1.3)	0.146
35–49	128 (27.6)	336 (72.4)	0.5 (0.2 - 0.9)	0.127	0.4 (0.2 - 1.2)	0.107
>50	59 (21.5)	215 (78.5)	0.3 (0.1 - 0.9)	**0.031**	0.3 (0.1 - 0.9)	**0.042**
Education level						
No formal education	24 (16.6)	121 (83.5)	Ref		Ref	
Primary	159 (22.5)	548 (77.5)	1.5 (0.9 - 2.3)	0.114	1.3 (0.8 - 2.1)	0.270
Secondary	152 (34.9)	284 (65.1)	2.7 (1.7 - 4.4)	**<0.0001**	2.3 (1.4 - 3.8)	**0.002**
Tertiary	66 (44.9)	81 (55.1)	4.1 (2.4 - 7.1)	**<0.0001**	3.2 (1.7 - 5.8)	**<0.0001**
Marital status						
Single	57 (29.2)	138 (70.8)	Ref		Ref	
Married	305 (28.9)	752 (71.1)	1.0(0.7 - 1.4)	0.915	1.2 (0.8 - 1.9)	0.294
Divorced/Separated	12 (17.9)	55 (82.1)	0.5(0.3 - 1.1)	0.073	0.7 (0.3 - 1.5)	0.330
Widowed	27 (23.3)	89 (76.7)	0.7(0.4 - 1.2)	0.254	1.3 (0.7 - 2.4)	0.443
Size of Household						
1 - 2 dependents	47 (31.3)	103 (68.7)	Ref		Ref	
3 - 4 dependents	145 (29.1)	353 (70.9)	0.9 (0.6 - 1.3)	0.602	0.9 (0.6 - 1.4)	0.593
5 - 6 dependents	130 (31.8)	279 (68.2)	1.0 (0.7 - 1.5)	0.919	1.0 (0.7 - 1.6)	0.867
>7 dependents	79 (20.9)	299 (79.1)	0.6 (0.4 - 0.9)	**0.012**	0.7 (0.4 - 1.1)	0.100
Occupation						
Housewife/Husband	83 (25.1)	248 (74.9)	Ref		Ref	
Self-employed	156 (27.2)	418 (72.8)	1.1 (0.8 - 1.5)	0.490	1.0 (0.7 - 1.3)	0.827
Formal employment	53 (42.7)	71 (57.3)	2.2(1.4 - 3.4)	**<0.0001**	1.3 (0.8 - 2.1)	0.312
Casual labor	51 (24.5)	157 (75.5)	1.0(0.6 - 1.5)	0.884	1.0 (0.7 - 1.5)	0.861
Other	58 (29.3)	140 (70.7)	1.2 (0.8 - 1.8)	0.289	1.2 (0.7 - 1.8)	0.519

COR=Crude odds ratio, CI=Confidence Interval, n= number of people in the sample (1435), AOR=Adjusted odds ratio, (*)= Significant association at 5%

The term ‘fortification’ seemed to be a new word to the majority (72%) of the respondents during interviews. This is consistent with a study done in Tanzania that reported recognition of the term ‘fortification’ was very low among caregivers although the concept of adding micronutrients to foods was generally known (Kasankala *et al.,* 2018). The effect of gender and age on consumer awareness of nutritional issues is empirical. The authors of gender differences in food choice and dietary intake in modern societies argue that women engage in health promoting information and have healthier lifestyle patterns to a greater degree than men who often show skepticism and resistance to nutrition education message (Arganini *et al.,* 2011).

Older consumers have been shown to be more aware of nutrition information due to their precision during purchase as well as accumulated experience in food purchase activities (Pambo *et al.,* 2014). Another study done among New Zealanders and Australian consumers also found out that older consumers tend to check the nutritional content of a food such as sodium and fat content. This was attributed to the fact that they could be experiencing life style diseases which made them to be keen on food label use which consequently promotes awareness on fortified food products (Rowland *et al.*, 2010). On the other hand, it is expected that younger people may also be exposed to numerous modern technology-based channels of information dissemination including phones and media (Kennedy and David, 2014). Therefore, respondents between the ages of 15 to 24 years were included in the study.

Formal education has been demonstrated to be effective in dissemination of nutrition education since it enhances grasp (Pambo *et al.,* 2016). This result supports a previous finding by Pambo *et al.,* (2016) that reported consumers with secondary and tertiary education were able to understand, pronounce and memorize the term fortification easily while those with primary and no education had difficulty pronouncing and even remembering the term. Thus, attainment of higher education increases the ability to understand and store nutrition information long enough as memory and later use it in decision making when purchasing food (Soederberg and Cassady, 2015).

Households with dependents are also expected to be more aware of food fortification initiatives. The expectation is informed by the findings of Rowland *et al.,* (2010) who reported that the presence of dependents especially young children in the household positively impacts on food choices. This is because parenting triggers focus on nutrition and quality consciousness of foods. Therefore, shoppers with children are likely to be more aware of food fortification which influences them to look for healthy foods when making purchase decisions.

Formal employment is an indicator of good socio-economic status and the association varies with educational attainment (Oddo *et al.,* 2017). Formally employed respondents who are well educated may have preference for nutritious foods. These results share a number of similarities with Verbeke, (2005) who reported besides age, gender and presence of young children, higher education attainment reinforces the idea of a cognitive-oriented decision making process, including active reasoning for functional foods. In addition, some places of work e.g the Kenya Medical Training College highlights the importance of workplace initiatives by providing nutrition and wellness information to its employees (K. Report, 2015). Thus, consumers who are formally employed are likely to be more aware of nutritional issues compared to their counterparts who are unemployed.

4.4.1 Sources of information on food fortification

Respondents who had heard or read something about food fortification were also asked about the source of that information. Of these respondents, 27% reported having received the information through radio (Figure 4.3). This was followed by the Ministry of Health and television mentioned by 19% and 13.6% of the respondents respectively. Other sources of information identified by the respondents included; tertiary institutions, women groups, food labels on packaging material, newspapers, friends and conferences/seminars.

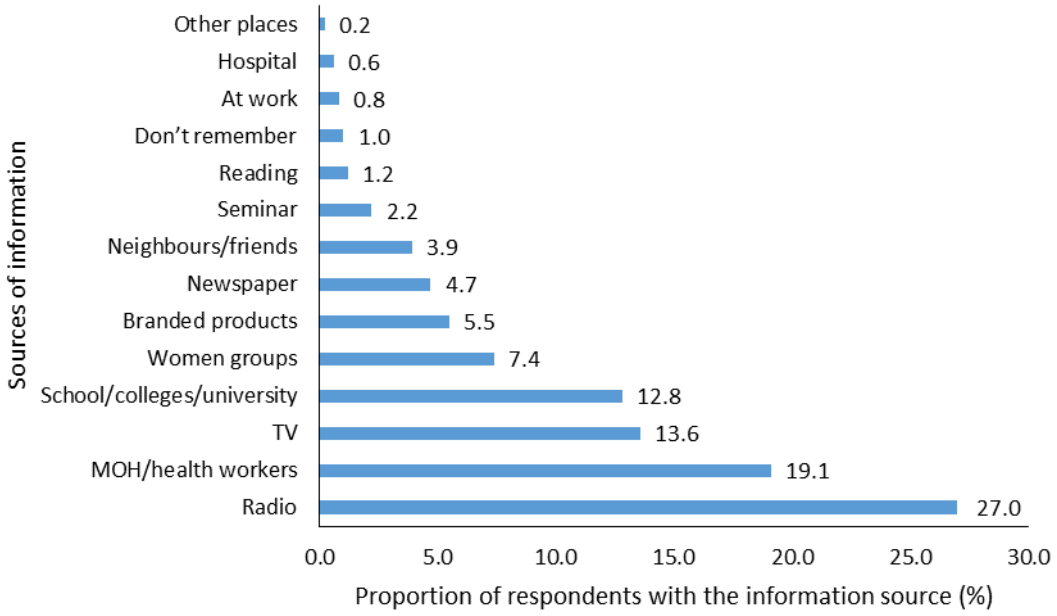

Figure 4.3: Sources of information on food fortification

This result is consistent with Groote and Kimenju, (2012) who reported radio as one of the most important sources of information (79% of their respondents listened to radio daily). It is very likely that radio can be an effective channel for communicating food fortification information (Groote and Kimenju, 2012). Besides, Community Health Volunteers (CHVs) also play a major role in disseminating health and nutrition information in the community. Thus, they form an effective source of information on food fortification.

4.4.2 Preferred channels for communicating food fortification

Vernacular radio was listened to by 24.9% of the respondents (Figure 4.4). This was followed by citizen television (14.6%) and the 'other sources' (11%) which were identified by respondents as friends, churches, short message services, agricultural extension officers, conferences and seminars. Besides, tertiary institutions (0.6%) and newspapers such as the standard (0.4%) and the star (0.2%) were the least preferred channels for communicating food fortification information.

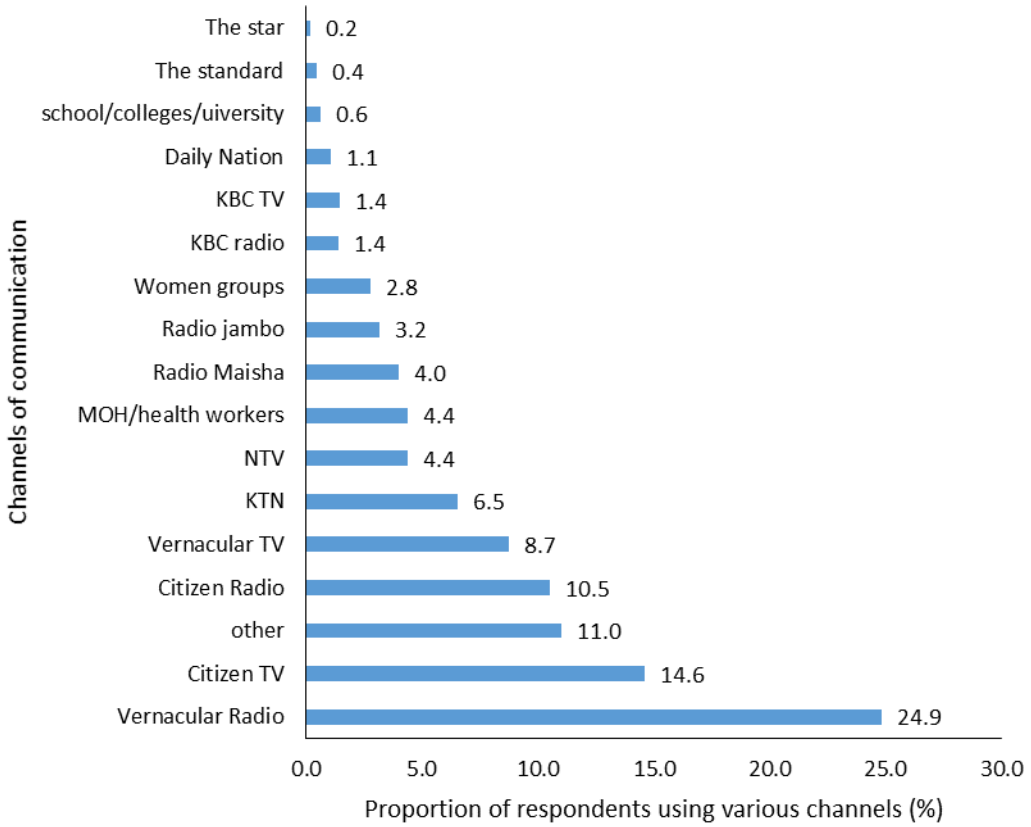

Figure 4.4: Respondents' preferred channels for communicating food fortification

The current findings are consistent with a previous study on consumer awareness of food fortification in Kenya that revealed the main source of information on food fortification reported by consumers was broadcast media sources (Kennedy and David, 2014). In addition, Groote and Kimenju, (2012) findings further explains that people with a secondary or tertiary education tend to listen to English language programs whereas people with primary education listen more to Kiswahili or vernacular language programs. In this study, preference for vernacular radio (24.9%) stations could be attributed by low levels of among respondents. For this reason, educational materials should be carefully and specially designed for creating awareness on food fortification among Kenyan consumers.

4.4.3 Awareness of micronutrients and health risks associated with their deficiencies

Less than half (37.1%) of the respondents were neither aware of vitamins nor minerals. Almost a third (32%) and about 1.5% of the respondents were aware of vitamins and minerals respectively (Appendix II). Awareness of both vitamins and minerals was reasonably low. Respondents who were aware of vitamins mentioned vitamins A, B, C, D, E and K and milk, vegetables such as spinach and fruits to be the best sources of these vitamins. Also, respondents who were aware of minerals stated calcium, iodine, iron, phosphorous, zinc and potassium. Some gave the sources of these minerals (Salt, fish, fruits and vegetables such as cabbages). Furthermore, most (76%) respondents acknowledged that there are health risks associated with consuming insufficient amounts of vitamins and minerals (Appendix II). Of these respondents, about 37% mentioned the risk of infection (Figure 4.5). Slow growth and development and anemia were reported by 26.8 and 20.7 percent of the respondents respectively.

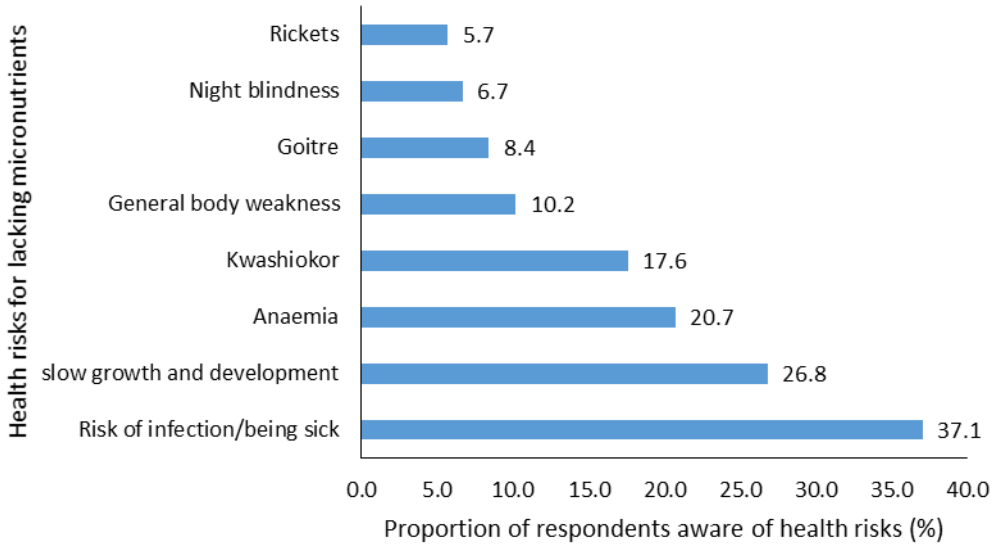

Figure 4.5: Respondents' awareness of health risks for lacking micronutrients

These results are in agreement with a study done in Australia that showed that awareness of vitamins and minerals among consumers was considerably low. The

Australian consumers stated that vitamins C, B-group, D and minerals (calcium and iron) are the most important micronutrients to consume (Rowland *et al.,* 2010). Also, the Australian consumers identified fresh foods, including fruits and vegetables, meats, dairy products and cereals as the best sources of vitamins and minerals.

Despite the low levels of education, majority (76%) of the respondents acknowledged that there are health risks associated with lacking these micronutrients. Verbeke, (2005) reported that Belgian respondents with lower education levels revealed their experience with their relatives who had micronutrient deficiencies and the financial burden for treatment acted as an incentive to adopt healthier lifestyle patterns.

4.5 Consumer attitudes on food fortification

Table 4.5 shows consumers' attitudes towards food fortification. Almost half (46%) of the respondents had a positive response towards food fortification. More than one-third (38%) of the respondents believe that there are no restrictions on food fortification, with almost half (48%) of them having expressed their concern about manufacturers fortifying foods. About 63% and 60% of the households interviewed believe that natural foods provide sufficient amounts of micronutrients and preferred getting them naturally from fruits and vegetables respectively.

Majority (70%) of the respondents considered eating fortified foods would help them with a healthier personal diet. However, more than half (52.2%) of the respondents did not know that adding folic acid to maize flour reduces birth defects. Eating fortified foods was viewed as unnecessary when taking balanced diets in almost half (49%) of the households. Regarding the effects of fortification, majority (70%) of the respondents thought that maize flour fortification promotes health. About half (50%) of the respondents believe fortification enhances the flavor of maize flour. Improved color and shelf-life of maize flour as a result of fortification were perceived by 35% and 37% of the respondents respectively.

Again, with regards to risks associated with food fortification, more than one-third (39%) of the households regarded fortification as an unnatural process. Furthermore,

almost half (45%) were of the opinion that fortification has the potential of causing negative side effects. More than half (60%) of the respondents acknowledged that consuming high amounts of micronutrients could be harmful to one's health. The vast majority (72%) of the respondents believe that everyone is at risk of micronutrient deficiencies. Moreover, more than three-quarters (78%) of the households identified that there are health risks to families lacking or consuming insufficient amounts of micronutrients.

Most (90%) respondents need more information concerning food fortification. The benefits of fortified foods seemed to be confusing among 59% of the respondents. Almost two-thirds (62%) of the respondents expressed that they trusted health claims made about fortified foods. Preference for buying fortified foods was stated by more than half (59%) of the respondents. As a result, about 63% stated that they wouldn't avoid buying fortified foods. However, two-thirds (66%) of the respondents believe that fortified foods could be more expensive than non-fortified ones.

Table 4.5: Attitudes on food fortification among Kenyan consumers (n=1435)

Type of perception	Statement	Agree n (%)	Disagree n(%)	Didn't know n(%)
Overall assessment	No food should have micronutrients added	522(36.4)	655(45.6)	258(18.0)
	There are no restrictions on food fortification	542(37.8)	497(34.6)	396(27.6)
	Not concerned with manufacturers fortifying foods	403(28.1)	693(48.3)	339(23.6)
	Natural foods provide sufficient amounts of micronutrients	904(63.0)	301(21.0)	230(16.0)
	I prefer micronutrients from natural foods only	863(60.0)	372(26.0)	200(14.0)
	Fortified foods taste better	631(43.9)	403(28.1)	401(28.0)
Benefits	Fortified foods make one healthier	1009(70.3)	218(15.2)	208(14.5)
	Fortified foods are unnecessary when taking balanced diets	709(49.4)	461(32.1)	265(18.5)
	Added folic acid to maize flour reduces birth defects	456(31.8)	230(16.0)	749(52.2)
Effects of fortification on maize flour	Promote health	1011(70.5)	198(13.8)	226(15.7)
	Improve flavor	725(50.5)	323(22.5)	387(27.0)
	Improve color	506(35.3)	503(35.1)	426(29.6)
	Improve shelf life	539(37.6)	411(28.1)	485(33.8)
Risks	Fortification is artificial	564(39.3)	570(39.7)	301(21.0)
	Fortification has potential negative effects	643(44.8)	472(32.9)	320(22.3)
	Everyone is at risk of lacking one or more micronutrient(s)	1038(72.3)	187(13.1)	210(14.6)
	There are health risks for lacking micronutrients	1121(78.1)	140(9.8)	174(12.1)
	Large quantities of micronutrients could be harmful	860(59.9)	333(23.2)	242(16.9)
Information	More information is needed on fortification	1293(90.1)	63(4.4)	79(5.5)
	The benefits of fortified foods are confusing	854(59.5)	370(25.8)	211(14.7)
	Mistrust of health claims made about fortified foods	287(20.0)	897(62.5)	251(17.5)
Intention to purchase fortified foods	Preference for a type of food specifically because it is fortified	851(59.3)	362(25.2)	222(15.5)
	Avoidance of buying a fortified food	330(23.0)	907(63.2)	198(13.8)
	Fortified foods are more expensive	945(65.9)	209(14.5)	281(19.6)

In the present study, almost half (45.6%) of the respondents had a positive response towards food fortification. This finding is consistent with a previous study on consumer attitudes and perception of functional foods that showed consumers expressed positive responses regarding foods and beverages with added health and wellness benefits (Kapsak *et al.,* 2011). Micronutrients tend to be part of the health and wellness benefits added to foods that undoubtedly enhance the nutritional benefit of a food product. Also, a study done in New Zealand found about 46% of the participants had positive attitudes towards food fortification as a component for providing health benefits and preventing neural tubes defects which was always occurring in the society (Health and Learning, 2015).

More than one-third (38%) of the respondents expressed that there are no restrictions on food fortification. This result is barely distinguishable from Rowland *et al.* (2010) findings whereby 34% of the participants expressed mistrust in the motivations of food producers in including vitamins and minerals in foods, and fortification used as a technique to market unhealthy foods as healthy. It is important to consider what consumers know today about food and continuously inform them about the roles the government chemists and public health officials play in ensuring safety standards of food fortification technology are put in place. Almost half (48%) of the respondents expressed concern about manufacturers fortifying foods. This is consistent with a study done among American consumers whereby 59% of the Americans stated that they are concerned about manufacturers attempting to make changes to improve the healthfulness of their diets which consequently improve their overall well-being (Kapsak *et al.,* 2011). This reveals that Kenyan consumers are also conscious and concerned about their overall well-being and the healthiness of the processed foods they purchase for consumption.

More than half (60%) of the respondents thought that natural foods could meet all the micronutrient needs of an individual. Most probably, this perception might have influenced almost half (49%) of the respondents to indicate that consuming fortified foods is unnecessary when taking balanced diets. These findings agree with the Health and Learning, (2015) report whereby New Zealanders expressed that

fortification was ineffective and unnecessary since it is an artificial process absorbed with safety concerns.

More than half (60%) of the respondents expressed their preference for fresh natural foods. This finding is consistent with a study done among Australians and New Zealanders which reported that the most commonly mentioned and most highly endorsed method of consuming vitamins and minerals was to eat fresh foods, particularly fruit and vegetables (Rowland *et al.,* 2010). Besides, more than two thirds (70%) of the respondents believe that fortified foods enhance a healthier personal diet, with almost half (44%) of the respondents having indicated that fortified foods would taste better than non-fortified foods. These results agree with Rowland *et al.* (2010) who reported that Australian and New Zealand consumers perceived that the ingredients added to foods including micronutrients may enhance the healthiness or the nutritional value as well as taste quality of a type of food.

Less than a third (31.8%) of the respondents believed that fortification of maize flour with folic acid would reduce birth defects among newborns. Awareness of folic acid, its sources, health benefits and the subsequent effect of lacking the mineral were considerably low among the respondents. For this reason, more than half (52.2%) of the respondents ended up providing 'unsure' responses to this statement. These results have a number of similarities with (Rowland *et al.,* 2010) findings that showed awareness of folate was generally low among participants, except among women that were currently or had been pregnant.

Respondents had also positive perceptions concerning the effects of maize flour fortification on health, flavor, color and shelf-life. Majority (70%) of the respondents stated that maize flour fortification would promote health. This result coincides with the findings of Kasankala *et al.* (2018) who reported that despite the low levels of awareness and knowledge on food fortification, Tanzanian consumers were able to identify the health benefits of fortification which included; improved immunity and school performance among children, prevented physical deformity and pregnancy complications (Kasankala *et al.,* 2018). According to Mannar, (2017), vitamins and minerals added to foods are specifically intended to promote health by preventing a

demonstrated deficiency of one or more nutrients in the population or specific population groups.

About half (50.5%) of the respondents thought that fortification could improve the flavor of maize flour while 35.3% of respondents believed that fortification improves the color of maize flour. This result confirms the findings of Groote and Kimenju, 2012 who reported that flavor and color were the main reasons Kenyan consumers preferred fortified maize flour to the hammer-milled maize flour. Our study finding is also similar to another study done among female adults of Mumbai in India where a majority of the subjects agreed that fortification has changed the taste, texture and appearance of the food products (Battalwar and Syed, 2017). Our result could also be influenced by the virtue of having the majority of women as study participants. A previous study had also shown that women are more likely to embrace suggested dietary changes such as flavor and color to a greater degree than men (Arganini *et al.,* 2012). More than one-third (37.6%) of the respondents thought that fortification would improve the shelf life of maize four. This finding could be true as explained in a previous study on consumer preferences for maize products in urban Kenya whereby it was identified that the industrially processed fortified maize flour is usually degermed and sifted, which reduces the oil content and increases storability (Groote and Kimenju, 2012).

Regarding fortification risks, less than half (39.3%) of the respondents indicated that food fortification is an unnatural process of enriching food. Furthermore, fortification was also perceived to have the potential to cause negative effects by almost half (45%) of the respondents. These results corroborate the findings of a study done on the barriers and enablers of uptake of folic acid fortified bread in New Zealand whereby 25% of the study participants strongly disagreed with fortification since it is an “artificial” or “unnatural” process which comes along with an occurrence of safety concerns (Health and Learning, 2015). Thus, facts about the origins of these micronutrients added to foods is important in convincing people, especially those opposed to artificial processing.

Most (72%) households reported that everyone is at risk of lacking one or more micronutrient(s), with greater than three-quarters (78%) of them agreeing that families which consume diets deficient in micronutrients are at a greater risk of micronutrient deficiencies. These results are in agreement with Rowland *et al.*(2010) findings who reported that most study participants in New Zealand acknowledged 'everyone' in the population is at risk and thus required sufficient intake of vitamins and minerals in order to maintain good health and prevent illness. Besides, a majority (60%) of the respondents in our study believe that consuming large quantities of micronutrients could be harmful. While levels of knowledge about sensitivity or toxicity are low, most respondents believed that it is possible to consume an unhealthy amount of vitamins and minerals.

An overwhelming majority (90%) needed more information concerning food fortification. This result is inconsistent with a previous study done in New Zealand where about 80% of the consumers had fortification information, with 75% having reported to have sought the information online (Health and Learning, 2015). Our finding could be attributed to low levels of education, acquired education that is not nutrition related and/ or poverty which limits an individual to seek for fortification information.

The benefits of food fortification seemed to be confusing to more than a half (59%) of the respondents. This result is similar to Rowland *et al.* (2010) who reported that most participants found the labels provided about food fortification benefits were confusing to consumers who were unable to determine whether vitamins and minerals in foods were added or naturally occurring. Thus, providing nutrition education with a component of food fortification information is very important to create demand among consumers when they are making food purchase decisions.

Interestingly, the vast majority (62.5%) of the respondents also expressed trust in health claims made about fortified foods in spite of their expressed mistrust of food manufacturers labeling foods as 'fortified' when they are not really fortified. A study done in Greece, reported that prior knowledge of food fortification influences

consumers to trust in nutrient claims indicated on packaged fortified foods (Soederberg and Cassady, 2015). This is in contrast with these results.

Preference for a type of food specifically because it is fortified was mentioned by more than a half (59.3%) of the respondents. A study done in Tanzania found that despite low income and education levels, lack of adequate awareness and knowledge of health benefits of food fortification did not have a negative influence on consumers' likeness/preference for fortified foods (Kasankala *et al.,* 2018). These characteristics are similar to our study participants.

A high proportion of respondents (63.2%) stated that they wouldn't avoid buying fortified foods. This result is in agreement with a previous study done on folic acid fortified bread whereby the vast majority (75%) reported that they would not avoid buying folic acid fortified bread or would not change their purchasing behavior if they found the bread they intended to buy was fortified (Health and Learning, 2015). Two-thirds (66%) of the respondents also expressed concerns that fortified foods would be more expensive. Previous studies have also reported of most consumers who expressed that fortified foods are more expensive than their non-fortified equivalents (Rowland *et al.*, 2010; FSANZ, 2013; Pambo et al., 2014; Groote and Kimenju, 2012). Program implementers who target small scale flour fortification should therefore consider price subsidization of fortified flour products due to the small price elasticity that exists among the low-income groups who at the bottom line are the targeted population for food fortification initiatives.

4.5.1 Persons at risk of Micronutrient deficiencies

Figure 4.6 shows subpopulation groups identified by respondents to be at a greater risk of micronutrient deficiencies. Children were mentioned to be at risk of micronutrient deficiencies by about 41% of the respondents. Slightly above one-third (34.4%) of the respondents mentioned that everyone is at risk. Other persons identified were the elderly, pregnant women, the sick and lactating women.

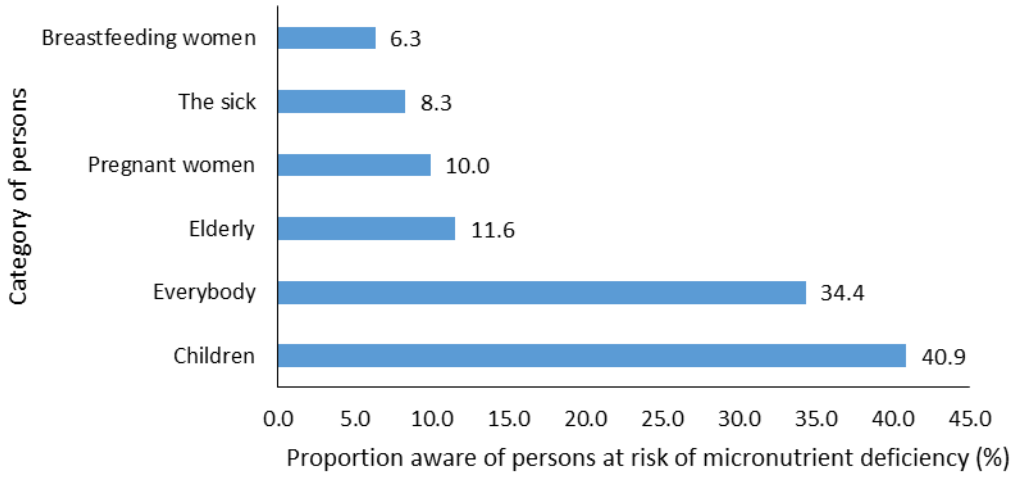

Figure 4.6: Persons identified to be at risk of micronutrient deficiencies

According to World Health organization, (2018) report, young children, pregnant women, the elderly and the sick are at a greater risk of micronutrient deficiencies. This is similar to results reported in this study. A systematic review of data in Kenya, Nigeria and South Africa further explains that women and children are the most vulnerable to micronutrient deficiencies due to inadequate dietary intake, lack of knowledge about the importance of dietary diversity and inequitable distribution of food within the household (Harika and Faber, 2015).

4.5.2 Preference for fortified foods

Respondents showed a positive preference for fortified foods. Most (70%) respondents indicated that they would choose fortified foods over their non-fortified food equivalents (Figure 4.7). However, a few respondents (3.8%) were not sure of their preference between fortified and non- fortified foods. Respondents further indicated that if they found out the flour, they were thinking of buying was fortified, 74% of them reported that they would consider purchasing it.

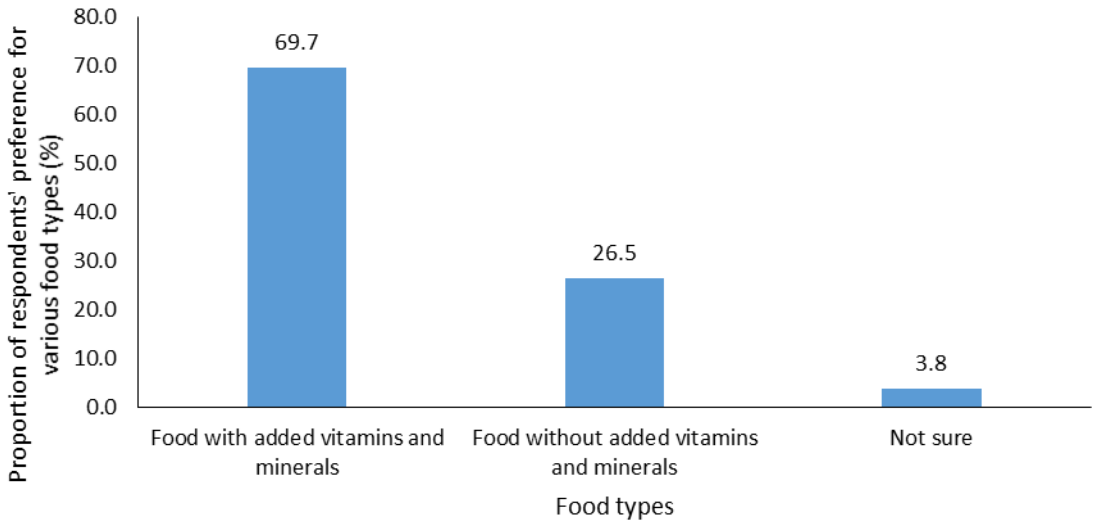

Figure 4.7: Respondents' preference for fortified foods

These findings imply that respondents had positive attitudes on the health benefits of fortified foods despite their suspicion on the unnatural ingredients added to processed foods. According to WHO, (2015), fortified foods are known for their nutritional and health benefits. Thus, the health benefit attribute could have influenced respondents' preference and decision of considering fortified foods over the non-fortified ones.

4.5.3 Effect of fortification on purchasing behavior

The results shown on Table 4.6 indicate that there were statistical significant associations of respondents' likeliness to purchase maize flour ($p=0.00$) and wheat flour ($p<0.00$) they intended to if they found it fortified. Respondents with a preference for fortified foods were 2 times more likely to purchase fortified maize flour. They were also 3 times more likely to purchase wheat flour because it is fortified compared to their counterparts that did not prefer purchasing flour they intended to if they found it fortified.

Table 4.6: Association of respondents' likelihood to purchase fortified flour and purchasing maize and wheat flours because they are fortified

Likelihood of purchasing fortified flour	Overall (n)	Purchase of maize flour because it's fortified (%)	UOR (95% CI)	p-value	Purchase of wheat flour because it's fortified (%)	UOR (95% CI)	p-value
Didn't prefer	373	16(4.7)	1	1	18(5.3)	1	1
Preferred	1062	128(11.7)	2.39(1.39 - 4.11)	0.002*	172(15.6)	3.28(1.98 - 5.43)	<0.0001*

UOR= Unadjusted odds ratio, (*) = statistically significant at 5%, CI=Confidence Interval, n=number of people in the sample.

These results are similar to a previous study done in New Zealand whereby the vast majority (74%) reported that they would not change their purchasing behavior or would be more likely to purchase the bread if they learned that their usual variety of bread is fortified with folic acid (Health and Learning, 2015). Although significant test was not performed, the participants maintained that as long as price, taste and brand are not changed, they would stick to purchasing the fortified bread. Whereas, another study done on consumer awareness, attitudes and behaviors on food fortification found that most participants were unlikely to purchase the flour they were intending to if they found it fortified as a result of mandatory fortification because this would deny them their freedom of choice when making purchase (Rowland *et al.*, 2010).

4.6 Consumption patterns of fortified foods in Kenya

4.6.1 Food acquisition

Slightly above half (52.3%) of the households purchase food for consumption as shown in figure 4.8. On the other hand, a very small proportion (0.1%) of households stated that they mainly received food from the food aid agencies whereas 0.4% of them receive as gift from friends and family.

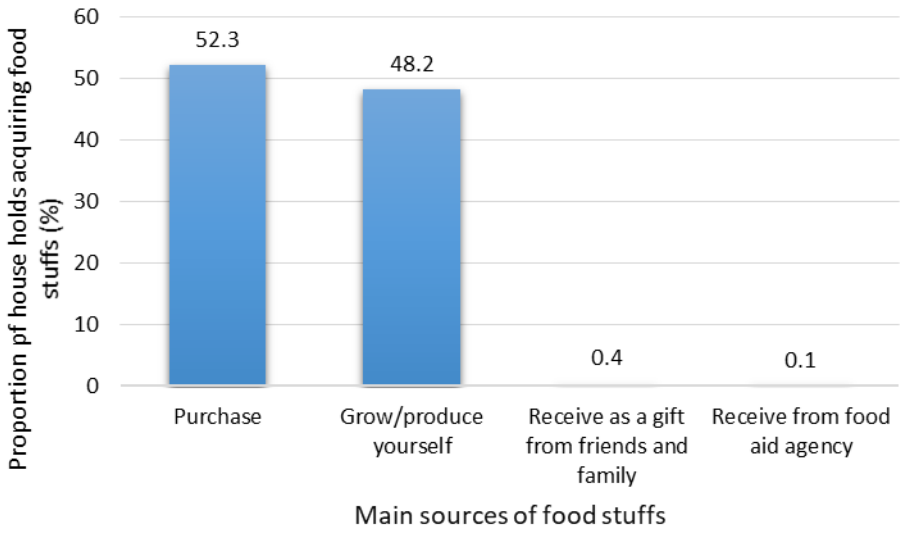

Figure 4.8: Acquisition of foodstuffs by the households

According to Kenya Demographics Profile (KDP, 2018), about 26.5% of the Kenyan population live in the urban areas and are expected to buy all or most of their foodstuffs. Similarly, those who live in the rural areas are anticipated to purchase industrially processed food products such as salt, cooking oils, wheat flour including condiments and edible oils.

Almost half (48.2%) of the respondents also reported that they source most of the foodstuffs from their farms. Respondents including those in urban areas reported that they source some foodstuffs from their rural farms. This finding is in agreement with Rowland *et al.* (2010) results who reported most New Zealanders preferred the locally-produced products because of the taste associated with the unprocessed fresh foods. Additionally, our results also confirm FAO, (2015) report that revealed Kenyan consumers especially the urban dwellers irrespective of their socio-economic status, prefer to source most of their food products such as cereals and grains including fresh fruits and vegetables from their rural farms due to taste associated with the locally-produced foods. Households which indicated that they mainly access food from friends, family and food aid agencies could be the poor households that have limited resources to purchase or grow foodstuffs in their farms.

4.6.2 Purchase of foodstuffs used as fortification vehicles in Kenya

Figure 4.9 shows that 81.5%, 81.2%, 70.1%, 69.7% and 50.3% of the respondents purchased maize flour, sugar, cooking oil, wheat flour, and salt for more than three times respectively in a span of three months. The other types of fortified food products purchased by the respondents included; bread spreads, milk, porridge flours, cereals such as weetabix and juices.

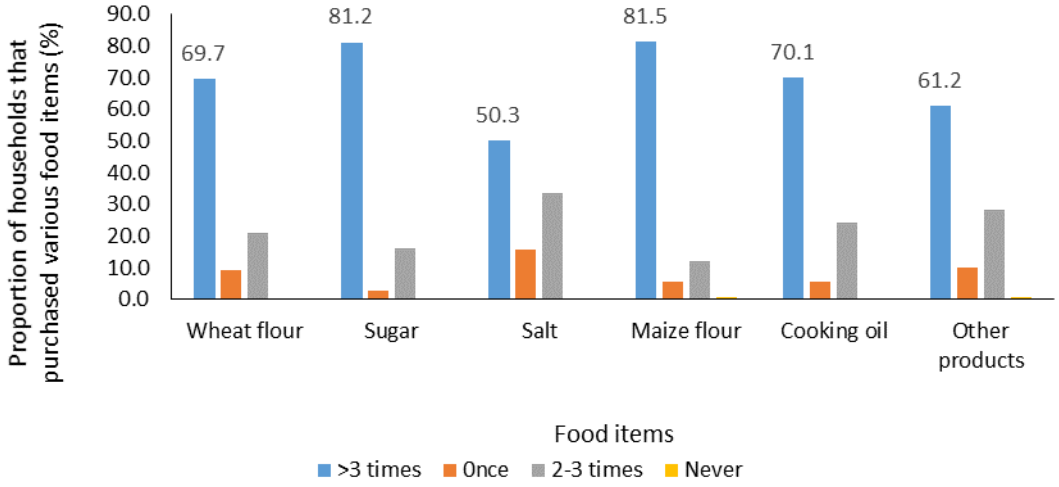

Figure 4.9: Frequency of purchasing food items used as fortification vehicles in Kenyan households

These food items are commonly used in most Kenyan households. The frequency of purchase of these food items could be influenced by the big sizes of households (54.8%) in this study which had more than 5 dependents. These results are similar to a study done in New Zealand which reported a higher frequency of shopping patterns among households with big family sizes. In addition, the economic status of households in the same study influenced the purchasing ability (Smith *et al.*, 2013). Most resource-poor households have limited purchasing ability whereby they tend to settle for small packaged food products that will allow them to afford thus increasing the purchasing frequency.

On the other hand, about 0.8%, 0.6%, and 0.4% of the respondents reported that they never purchased maize flour, the other identified types of fortified food products and salt in the past three months respectively. In addition, cooking oil, sugar and wheat flour were never purchased by 0.1% of the respondents over the past three months. Low purchase of these food items as indicated could be influenced by poverty, low purchasing ability and perceived health concerns associated with sugar, salt and processed maize flour.

4.6.3 Foods Purchased for their added vitamins and minerals

Consumers have various reasons they consider before purchasing given types of food items. Small proportions (17%), (15.4%), (15%), (14.6%) and (10.2%) of respondents reported that they purchased salt, wheat flour, cooking oil, maize flour and sugar respectively because they are fortified (Figure 4.10).

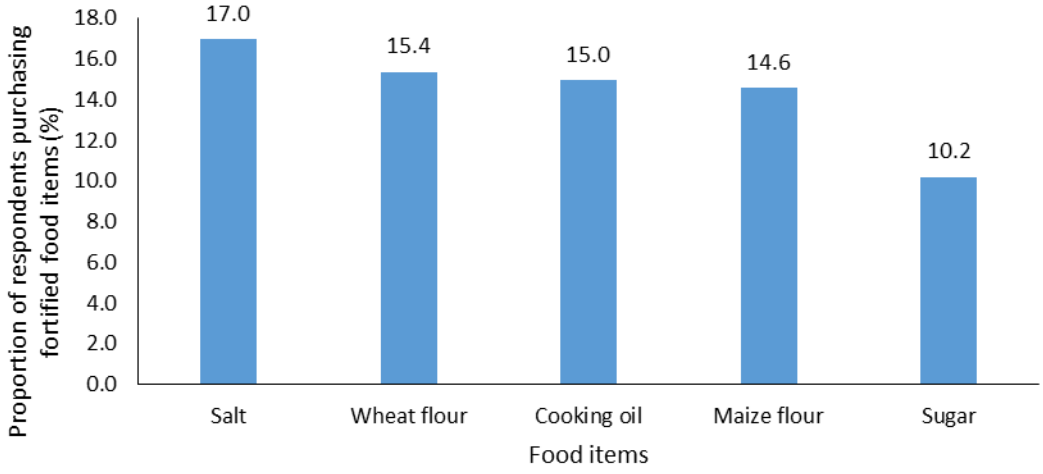

Figure 4.10: Purchase of food types by respondents specifically because they are fortified

These findings imply that most consumers' purchasing behavior is not guided by the expected health benefits of a food product. Most respondents acknowledged that they purchased the stated food items because of the need to use them since food is a basic need. For this reason, they purchased them without considering the health or nutritive

value of these food items. These findings contradict the results of Arganini *et al.* (2012) who reported 'healthiness' as a key factor in food purchasing decision. He further attributed the finding to females who comprised the majority of the study participants. A study done in Greece also reported that consumers concerned with nutrition and health are more likely to adopt the idea of consuming healthy foods than those less concerned (Soederberg and Cassady, 2015). Besides, prior information on potential health benefits of food items increases the use of nutritional labels and demand for a specific food type when making purchases.

4.6.4 Brands of salt purchased by respondents

Most (82.6%) households purchased Ken salt brand (Figure 4.11). The other salt brands used in Kenyan households include; Kay salt, San salt, Sea salt, Mzuri salt, Malindi salt and Pwani salt. About 4.7% of the respondents indicated that they did not know the salt brands they had purchased in the past three months.

Very few (0.6%) respondents also mentioned that they purchased any available brand in the market without necessarily considering the brand.

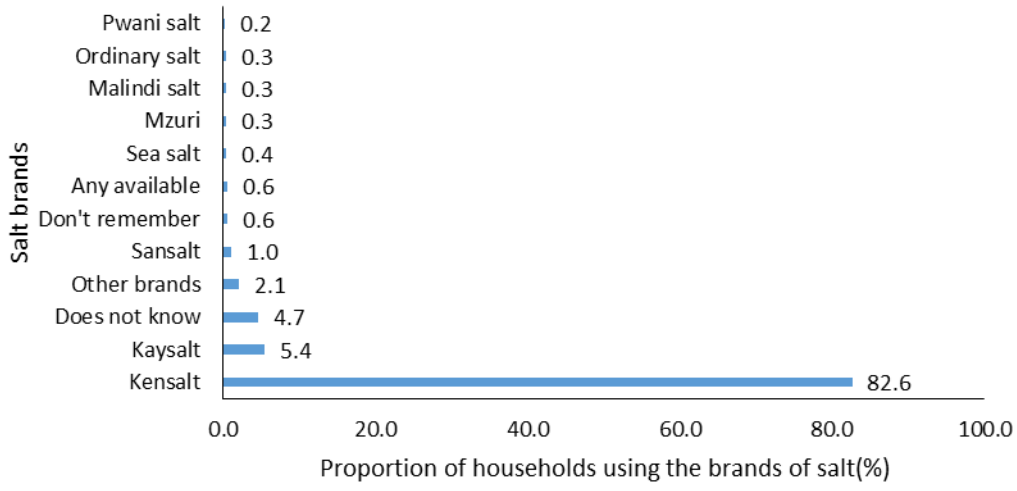

Figure 4.11: Brands of salt used in Kenyan households

Salt is one of the few products consumed basically by everyone and its consumption is relatively stable throughout the years (Delange *et al.*, 2001). The brands indicated above are edible salts usually fortified with iodine in efforts to prevent or reduce iodine deficiency disorders. Our findings confirm World Bank (2011) report that more than 90% of Kenyan households consume iodized salt.

4.6.5 Brands of wheat and maize flours purchased by respondents

The most commonly purchased wheat flour brands were Exe, Ndovu followed by Pembe (Figure 4.12) while Lotus and Aha were the least purchased brands of wheat flour indicated by the respondents. Similarly, about 1% did not have a specific preferred brand type thus they reported to have purchased any brand that was available in the shopping outlets.

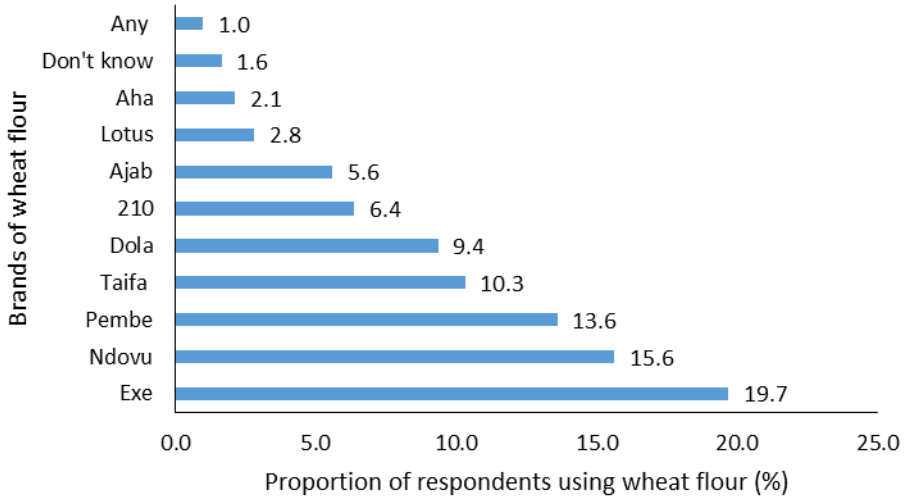

Figure 4.12: Brands of wheat flour purchased by respondents

Taifa, Dola, Pembe and Jogoo were the most common brands of maize flour purchased by Kenyan consumers (Figure 4.13). The least purchased brands included but not limited to Kingi, Jambo and the unpacked maize flour.

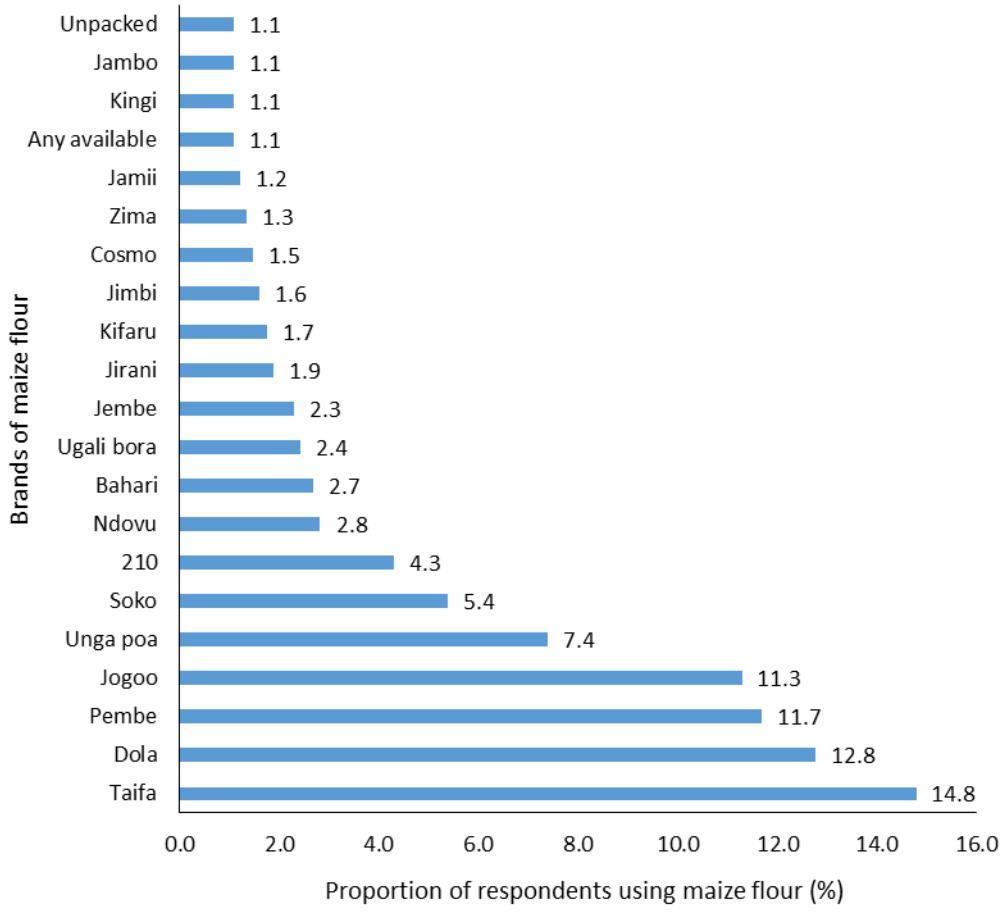

Figure 4.13: Common brands of maize flour purchased by respondents

In Kenya, maize and wheat flours are mandated by law to be fortified with some vitamins and minerals (Pambo *et al.*, 2016). These include; Vitamins A, B_1, B_2, B_3, B_6, B_{12}, iron and zinc. The most commonly purchased brands reported by respondents are industrially fortified in Kenya to specified legal standards. Thus, these findings reveal that most Kenyan households have access to fortified food products available in the market.

4.6.6 Brands of cooking oils and fats purchased by respondents

Chipsy, Golden fry and Fresh Fri were the most common brands of cooking fat and oils purchased by the respondents (Figure 4.14). On the other hand; Avena oil,

Cowboy cooking fat and Bahari oil were the least purchased cooking fats and oils brands.

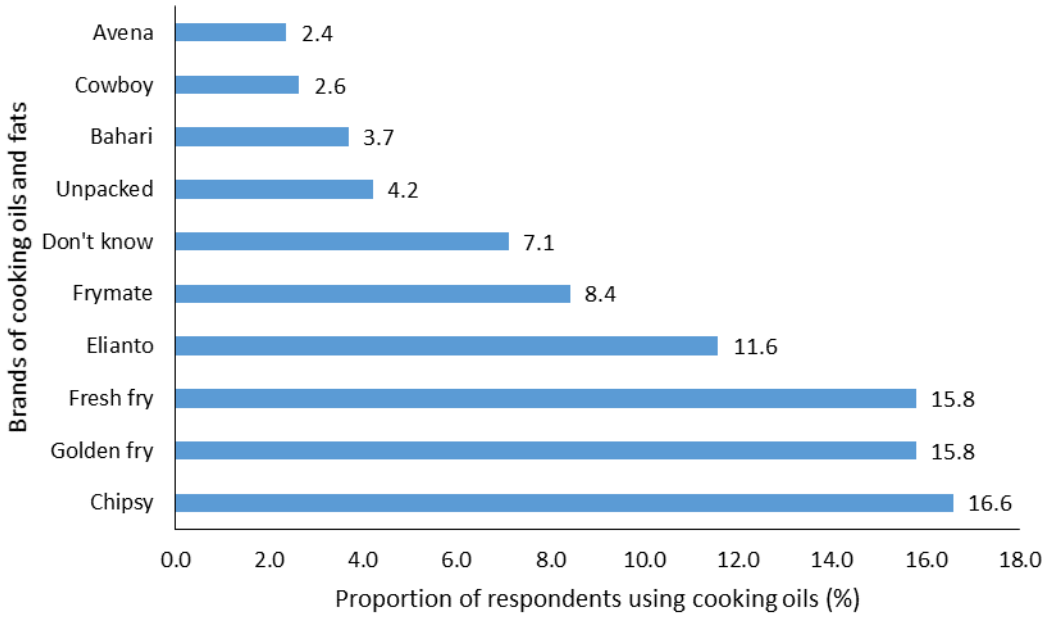

Figure 4.14: Brands of cooking oil commonly purchased by respondents

All these brands of cooking oils and fats mentioned by respondents were fortified with fat-soluble vitamins which included vitamins A, D, E and K. According to (Pambo *et al.*, 2014), cooking oils and fats are part of the food staples that were mandated and enforced by the Kenyan law to be fortified with fat-soluble vitamins such as vitamins A,D,E and K. This enhances healthiness of cooking oils in addition to their already known nutritional benefits.

4.6.7 Brands of sugar purchased by respondents

Almost half (48%) of the respondents purchased the locally unbranded sugar from shops and supermarkets usually packaged in brown khaki paper packets (Figure 4.15). The other sugar brands that were purchased by respondents included; Muhoroni, Mumias, Kibos, Chemelil, Nzoia, Sony and Kabras.

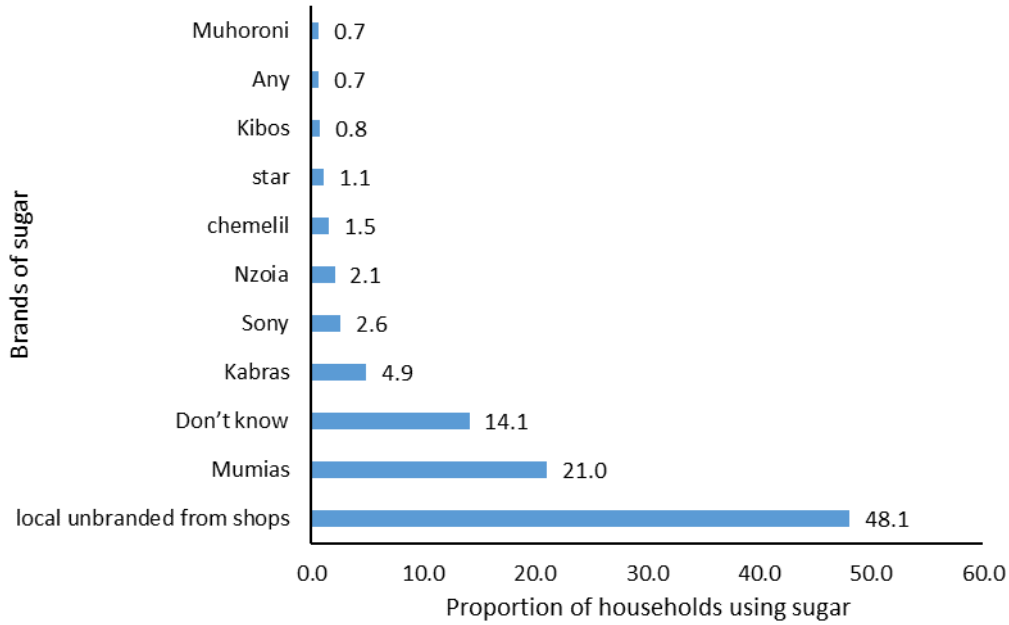

Figure 4.15: Brands of sugar purchased by households in Kenya

In the previous years, fortification of sugar with vitamin-A took off when the Mumias sugar company was operational. However, more than half (54%) of the Kenyan consumers in a previous study still considered the local unbranded sugar from shops because it was cheaper (Pambo *et al.*, 2014). These results are consistent with our current study whereby almost half (48.1%) of our participants also stated to have purchased the local unbranded sugar. Since the closure of the Mumias sugar company, none of the sugar industries in the country has picked up fortification of sugar with vitamin A. This could be attributed to high costs associated with establishing the fortification processing infrastructure. Thus, currently, there is no locally-fortified sugar in the Kenyan market.

4.6.8 Consumption of maize flour products in Kenya

About a third (35.9%) and 16.6 % of the respondents consumed *Ugali (A thick maize porridge –staple food in Kenya)* daily prepared from the posho mill flour and the packaged fortified maize flour respectively as shown in figure 4.16. On the other hand, a higher proportion of respondents reported never to have prepared soft porridge (*Uji)* from either packaged maize flour (65%) or posho-milled maize flour

(53.4%). Although, 15.6% and 9.5% of the respondents prepared porridge daily from posho-mill maize flour and packet maize flour respectively.

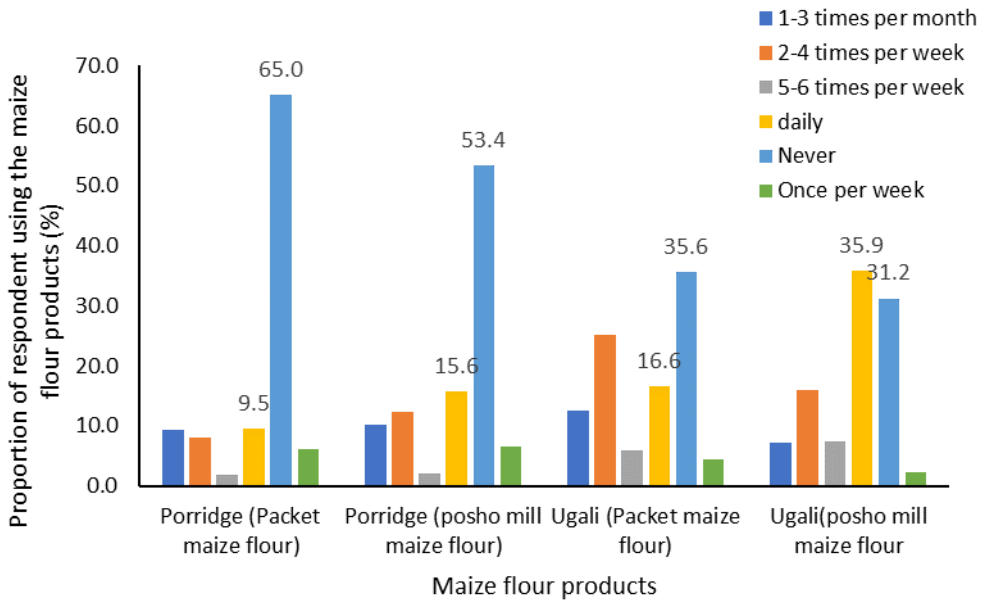

Figure 4.16: Consumption patterns of maize flour products in Kenya

There are two types of maize milling practices in Kenya. Hammer (posho) milling is frequently practiced whereby a household takes maize to the local mill (usually non-fortified) with the intention of using it for their own consumption. On the other hand, the industrially-milled (usually fortified and packaged in branded packets) maize flour are sourced from supermarkets and kiosks (Groote and Kimenju, 2012). The two forms of maize flour products prepared among Kenyan consumers are stiff porridge (*Ugali*) and soft porridge (*Uji*).

Respondents indicated a strong preference for maize flour to prepare *Ugali* unlike using the maize flours to prepare *Uji*. This result confirms the previous findings done on consumer preference for maize products in Kenya whereby consumers' choices indicated a strong preference for maize flour to prepare *ugali* for lunch and dinner among 70.5% of respondents. Whereas, very few (0.7%) respondents preferred to prepare porridge from the two types of maize flour products (Groote and Kimenju, 2012).

It is also evident that most of our respondents were more likely to use the posho milled maize flour than the fortified maize flour. These results confirm Groote and Kimenju,(2012) findings who reported that maize meal from the posho mill was a low-cost product compared to the industrially fortified maize flour thus it attracted a half of the consumers with no education and lower income. In the same study, it was further illustrated that the preference for the industrially fortified maize flour increases with education and income level such that consumers with university education and in formal employment preferred the industrially fortified maize flour to posho-milled maize flour (Groote and Kimenju, 2012). Similarly, for soft porridge (*Uji*), the strong preference for grain to be milled at the posho mill decreased with income level such that high and middle-income earners did not prefer to use the maize flour product. Instead, they mostly preferred other available fortified cereal flours or their mixtures sold in supermarkets and kiosk outlets (Groote and Kimenju, 2012). In addition, another study done on utilization of fortified maize flour in Mathare, Nairobi demonstrated that prior knowledge of fortified maize flour determined its utilization. Those who reported to never consuming fortified maize flour attributed this to its high price hence cannot feed their large families, low satiety value and perceived poor nutritional value (Samira *et al.,* 2020). In the current study, low education and knowledge levels about food fortification could be the attributing factors for strong preference for posho-milled maize flour among Kenyan consumers.

4.6.9 Sources of maize flour in the Kenyan households

A half (50.6%) of the respondents purchased fortified packet maize flour whereas very few respondents (3.0%) purchased the unpackaged maize flour (Figure 4.17). About 46% of Kenyan households take maize to the local mill for their own consumption. Some respondents who reported that they purchased the fortified packet maize flour clarified that it was for the purpose of mixing it with the posho-milled maize flour. This response showed that some Kenyan households were not only benefitting from the nutritional benefits associated with consuming whole maize meal flour but also consumed micronutrients in the packaged fortified maize flour.

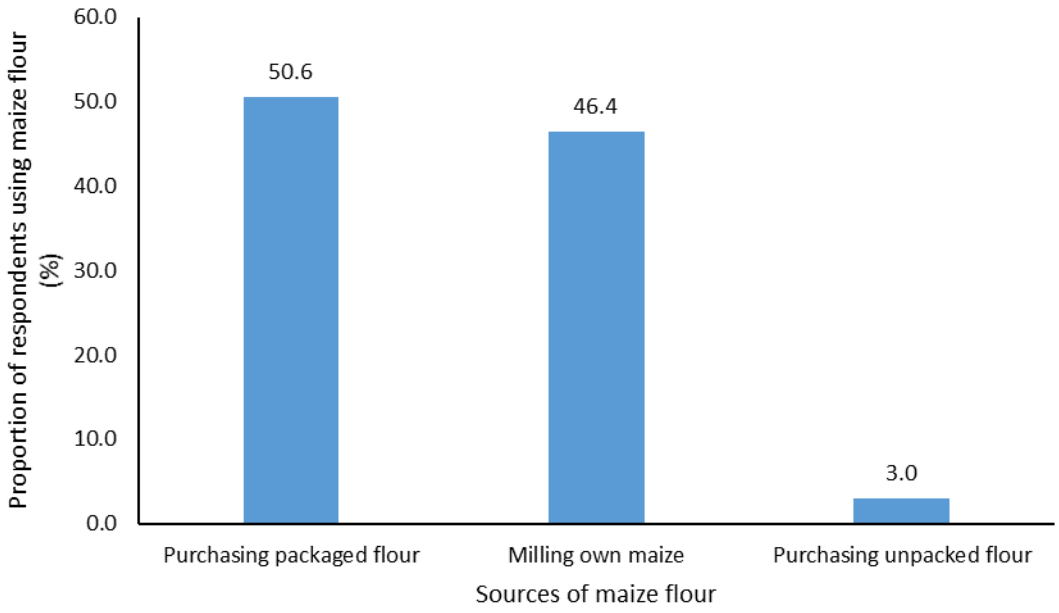

Figure 4.17: Respondents' sources of maize flour

A study done by Groote and Kimenju, (2012) also found that Nairobi residents preferred white maize flour (sifted, packaged flour) which are most likely to be fortified. Almost similar to our results, Groote and Kimenju, (2012) found that 49% of the respondents milled their own maize for flour. Unpackaged maize flour and the posho-milled maize flour have no added vitamins and minerals. Groote and Kimenju, (2012) further illustrated that consumers who milled their maize directly from the posho mill and purchased unpackaged flour were the low-income earners. This indicates a significant association of poverty and the likelihood of being at a greater risk of micronutrient deficiencies.

Another study was done on the level of knowledge and utilization of fortified maize flour in Nairobi, Kenya. The primary shoppers in Mathare reported to never consuming fortified maize flour and they attributed this to its high price hence cannot feed their large families (Samira *et al.,* 2020). Resource-poor households with large family sizes tend to have limited purchasing ability thus prevents them to access micronutrient-rich or fortified foods, making them most vulnerable to micronutrient deficiencies.

4.6.10 Factors considered when purchasing fortified maize flour

Almost a third (30%) of the respondents considered price as the most important factor when purchasing fortified maize flour (Figure 4.18). This was followed by the availability and flavor of maize flour among 24% and 18% of the respondents respectively. In comparison, target users were considered important when purchasing fortified maize flour by only 2% of the respondents. The other factors identified by respondents included; texture, color, expiry date and easy to cook maize flour.

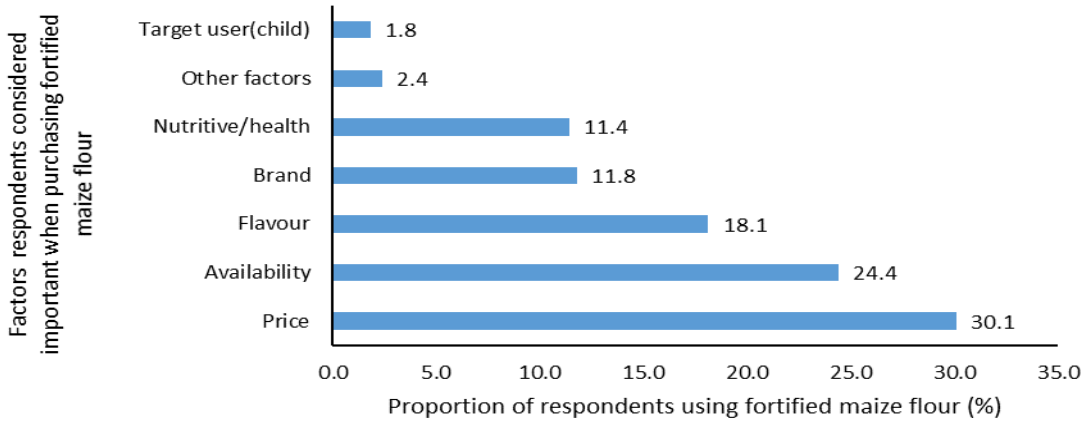

Figure 4.18: Factors respondents considered important when purchasing fortified maize flour

The results in this study are inconsistent with the previous findings on consumer preference for maize products in urban Kenya that reported consumers' willingness to buy fortified maize flour even after a sum of Ksh. 7.24 was added to the ordinary price of Ksh.100 for a 2 kilograms packet (Groote and Kimenju, 2012). Price is one of the important factors when it comes to consumer purchasing behavior. Fortification of industrially processed food products seems to be challenged by high prices associated with establishing the processing infrastructure (Fungo, 2013). As a result, a premium is usually added to these fortified products. This creates a barrier to access to fortified foods among households with low-income that have small price elasticity, who at the bottom line are the targeted population for food fortification initiatives (Fungo, 2013).

4.6.11 Association of food fortification knowledge and factors considered important when purchasing fortified maize flour

Table 4.7 shows an association of food fortification knowledge and factors considered important when purchasing fortified maize flour. Among the many factors, flavor is one that was statistically significant (p=0.04) associated with knowledge of food fortification. Moreover, flavor, brand and other factors (such as; texture, color, expiry date and easy to cook flour) were 2, 1.9 and 1.8 times more likely to be considered important compared to price respectively. Target users and price had equal chances of being considered important when making purchase decisions by Kenyan consumers.

Table 4.7: Association of food fortification knowledge and factors considered when purchasing fortified maize flour

Factors considered when purchasing fortified maize flour	n	Knowledge of food fortification	UOR (95% CI)	p-value
Price	432	135(31.3%)	1	1
Brand	169	66(39.1%)	1.96(0.89 – 4.30)	0.095
Nutritive/health	164	67(40.9%)	1.49 (0.73 – 3.05)	0.276
Flavor	260	82(51.3%)	2.19(1.03 – 4.64)	0.042 *
Target user	26	12(46.2%)	1	N/A
Others	384	110(28.7%)	1.83(0.97 – 3.48)	0.064

UOR=Unadjusted odds Ratio, CI=Confidence Interval, n= number of people in the sample, N/A=Not Applicable.

These results are unexpected since those with knowledge are expected to consider nutrition and target users of maize flour. However, flavor is also an important factor when it comes to consumer purchasing behavior. Consumers also expect to enjoy the foods they purchase despite having knowledge of food fortification benefits. These findings confirm a previous literature which reported that taste is one of the main determinants of a food choice (Pounis *et al.,* 2011). According to Pounis et al. (2011), low consumption of iron-fortified foods was reported by the study

participants including those identified with the nutrition knowledge. This was due to the unacceptable taste of iron-fortified product. Also, another study done in Mathare, Kenya found that the primary food shoppers (43%) considered the good taste of fortified maize flour a very important factor that makes them utilize it (Samira et al., 2020). Taste of a product influences consumers to repurchase it. Trusted brands were more likely to be considered compared to price. This result contradicts a study that reported price as the second most important factor influencing utilization of fortified maize flour of the primary food shoppers after the availability of maize flour (Samira et al., 2020). In the previous study, it was attributed that the current inflation price of fortified maize flour hinders many primary food shoppers from utilizing it making them to go for the cheaper and available flour in the market (Samira et al., 2020).

Other factors such as; texture, color, expiry date and easy to cook flour were more likely to be considered than price. This result is consistent with a study done on consumer preference of fortified maize flour in Kenya whereby flavor, color and nutritional value were the top three factors considered important when making purchase (Groote and Kimenju, 2012).

Target users and price had equal chances of being considered important. Price and availability of fortified maize flour could have resulted to adult's preference to be more influential than the target users (e.g. children's) preference when making purchase decisions.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

Micronutrient deficiency is a serious global nutritional problem that particularly affects women and children. Therefore, micronutrient deficiency poses a serious threat to national health and development. In both developed and developing countries, including those in Africa, there is a growing interest in finding sustainable solutions to reducing these deficiencies. Large scale fortification of foods with vitamins and minerals is found as the most cost effective strategy to eliminate micronutrient deficiencies among the target population. It is commercially viable as it retains the original nutrients and taste of food, and indeed provides the additional nutrients. Furthermore, it does not require consumers to change their consumption behavior. Determining the link between consumers' acceptance of fortified foods and their levels of knowledge, awareness and attitudes towards fortification is very important. This is because consumers are one of the determinants of successful food fortification interventions. This study aimed at assessing consumer knowledge, awareness, attitudes and practices on fortification in Kenya. The results from this study could be useful to the Government, food industries, consumer groups, and other stakeholders involved in implementing fortification activities for policy formulation. The information could also be useful for planning fortification intervention programs for the Kenyan consumers.

5.2 Conclusions

5.2.1 Socio-demographic characteristics

The results of this study showed that the wives were the ones who made most of the grocery shopping decisions in more than half (59%) of the households in Kenya. The study showed respondent's age, female gender, larger house holds, education level and formal occupation status determined food fortification knowledge and awareness among Kenyan consumers.

5.2.2 Knowledge of food fortification

Based on the findings of the present study, it can be concluded that Kenyan consumers have low levels of food fortification knowledge. There was a significant association between level of education and food fortification knowledge. In addition, respondents with tertiary and secondary education were 3 and 2 times respectively more knowledgeable of food fortification compared to their counterparts with no formal education. Hence, school can serve as a good avenue for inculcating fortification knowledge through appropriate and sustained nutrition education activities.

5.2.3 Awareness on food fortification

The study results have shown that most (72%) Kenyan consumers lack awareness on food fortification. Socio-demographic parameters such as gender, age, education level, household size and occupation of the respondents were significantly associated with awareness on food fortification. Radio (27%) and community health workers (19.1%) were identified as the main sources of food fortification information. Broadcasting media sources emerged as the most (79.6%) preferred channels for communicating food fortification information.

5.2.4 Consumer attitudes towards food fortification

Kenyan consumers generally have a positive attitude towards food fortification. The laws and measures that have been put in place by the government to regulate food fortification procedures, and the health claims labelled on foods should be effectively communicated to the consumers. Consumer preference for natural foods resulted from a cascade of perceptions about chemicals added to foods. However, fortified products were identified to be tastier. This result is important to food manufacturers who engage in food fortification activities. Moreover, respondents were appreciative of the positive health benefits and effect of fortification on maize flour. The asserted health benefits of fortified foods should be explained to consumers owing to the fact that it is the most important concern for the producers of fortified foods. Consumer perceived risks on food fortification could also be removed by seeking support from

scientific experts in this field. Our findings also emphasize the need to disseminate food fortification information to Kenyan consumers. Preference for a type of food specifically because it is fortified was reported by about 59% of the respondents. However, two-thirds of the respondents believe fortified foods are more expensive than non-fortified ones. Food manufacturers should develop incentives and marketing tactics that they can use to stimulate demand for fortified products.

5.2.5 Consumption patterns of fortified foods in Kenya

Majority of the households either purchase (52.3%) or grow (48.2%) foodstuffs on their farms for consumption. Even though greater than three quarters of the respondents stated that they purchase food items used as fortificants (wheat flour, salt, sugar, cooking oil and maize flour) in Kenya, less than 20% of them reported they purchased these food items for their added vitamins and minerals. Major factors considered when purchasing fortified maize flour are price and availability, flavor, brand, nutritive value, color, expiry date, texture, easy to cook flour and target users. Among these factors, flavor was one that was statistically significant ($p=0.04$) associated with knowledge on food fortification. These findings suggests that preference for fortified foods is driven by organoleptic characteristics.

5.3 Recommendations

5.3.1 Recommendations for policy

This study revealed the overall awareness and knowledge regarding food fortitication was low. The Government of Kenya, through the Ministry of Health and partners should create awareness of food fortification among Kenyan consumers.

5.3.2 Recommendation for practice

The ministry of health and partners should consider to integrate food fortification messages at all levels of education. Future communication about chemicals added to foods should also be targeted at shifting consumer attitudes away from the ‘synthetic equals dangerous’ perception to the more appropriate perception that all foods consist of chemicals, and all chemicals may be dangerous when ingested in large

amounts. When this is achieved, consumers would be able to judge food hazards more appropriately. Lastly, the government of Kenya and food manufacturers who fortify their products should introduce price subsidies of fortified food products to increase affordability among Kenyan consumers.

5.3.3 Recommendations for further research

Future studies should focus on tracking public opinion of specific population groups (women and children) with high levels/ who are vulnerable of micronutrient deficiencies. Also, further studies among health workers (given that they are the main source of information) is needed to enable a better understanding of awareness, knowledge and attitudes about food fortification and how fortification interventions can be implemented for their long-term effectiveness.

This research **is** not a conclusive one, therefore we suggest that since this study adopted a cross sectional survey, future studies may use longitudinal one. Also, the present study concentrated on the overall Kenyan consumers, therefore there is a need to expand the scope in future research in order to compare consumers from different socio-economic status in different geographical regions.

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APPENDICES

Appendix I: Baseline study on consumer knowledge, attitudes and practices on food fortification in Kenya

KNOWLEDGE, ATTITUDES AND PRACTICES ON FOOD FORTIFICATION QUESTIONNAIRE

Hello. My name is _____. I am a researcher from Jomo Kenyatta University of agriculture & technology (JKUAT). In collaboration with the Ministry of Health I am undertaking a study that seeks to develop understanding of consumers' knowledge, attitudes and practices on food fortification[1]. As part of the research, I am conducting a household survey and you have been identified as one of the respondents. Your participation is entirely voluntary and I do hope that you will agree to participate. This survey will take about 30-40 minutes, and my findings will be used to inform policy and interventions that would support health and nutrition for the poor and vulnerable in Kenya. All of the information that you share with me today will be strictly confidential, your name or identity will not be connected to any of your responses at any point. If I ask you any question you do not want to answer, just let me know and I will go on to the next question or you can stop the interview at any time.

Kindly confirm your voluntary acceptance to take part in this study by ticking in the appropriate box below

Yes ☐ No ☐

In case you need more information about the survey, you may contact:

PI: Prof. Daniel Sila

[1]Throughout this document, 'fortification' is used to refer to the addition of vitamins and minerals to food products. Foods which have nutritional benefits due to addition of naturally-occurring elements (such as live cultures in yoghurt) or have had other biologically active substances (such as Omega-3 fatty acid) are not included in this definition (Ipsos, 2010).

Jomo Kenyatta University of Agriculture & Technology (JKUAT)
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Phone-0716238803

A. Socio-demographic characteristics

Item	Response	Item	Response
Name of respondent		Name of the enumerator	
Telephone		Date of interview	
County		Interview start (hh:mm)	

Gender	Age of HH	Highest level of education	Marital status of HH	Household composition (No of household members)
1=Male, 2=Female		1= Primary 2=Secondary 3=Tertiary 4= Did not attend formal schooling	1 = Married 2=Divorced/Separated 3=Windowed 4=Never married	1=1-2 dependants/children 2=3-4 dependants/children 3=5-6 dependants/children 4=>7 dependants/children

What is your occupation	Who makes most (over a half) of the grocery shopping decisions
1= Self-employed 2=Formal employment 3=Casual labour 4==House wife/Husband 5=Other (state)	1 = Wife 2= Husband 3= Both 4=other (state

B. Awareness on fortification

Question	Indicator	Response
1. Before today, have you heard of food fortification/Are you familiar with the term "food fortification"?[2]	1=Yes; 0=No	
2. If yes, what was your source of information? Multiple responses)	1=Radio;2=TV; 3=Newspaper;4=MOH/health workers; 5=Women groups; 6=school/college or university; 7= Others (specify)	
3. What is your most preferred channel of communication for messages on fortification?	1= KBC radio; 2= Citizen radio; 3= Radio Maisha; 4= Radio Jambo; 5=Vernacular radio; 6= NTV; 7=Citizen TV; 8=KTN; 9=KBC TV; 10=Vernacular TV; 11=Daily Nation;12=The Standard; 13= The Star; 14= MOH/health workers; 15= Women groups; 16= school/college or university; 17= Others (specify)	
4. What are vitamins and minerals? (Qualitative response)		
5. Which vitamins and minerals do you consider to be the most important?	List 3 important vitamins	
	List3 important minerals	
6. What are the main sources of the minerals and vitamins listed in 3 above	Main sources of vitamins	
	Main sources of minerals	
7. Are there health risks for not consuming enough minerals and vitamins?	1= Yes; 0=No	
8. If yes to 7 above what do you think are the risks?	1. Slow growth and development 2. Risks of infections/being sick 3. Night blindness 4. Anaemia 5. Goitre 6. Spina bifida 7. Others (specify)	

C. Knowledge on food fortification

(For each statement given, please indicate whether you think it is true or false/Yes or No).

KNOWLEDGE			1= Yes or True; 0= No or False; 2=Unsure/Don't know
Statement			
1. Food fortification involves adding of some vitamins and minerals to food products			
2. Food fortification involves adding of vitamins only to food products			
3. Food fortification involves adding minerals only to food products			
4. Food fortification involves adding of proteins to food products			
5. Is there a way of knowing if a food is fortified or not? (Indicate Yes =1 or No = 0)			
6. Do you think the Government in Kenya has made it compulsory for food manufacturers to add vitamins or minerals to some types of food? (Indicate Yes =1 or No = 0)			
7. If yes/True to 7 above which types of foods are required by law to be fortified in Kenya? (Let the respondent state. Do not show options. Multiple responses possible)			
1. Maize flour		2. Wheat flour	
3. Oil/ Fats		4. Salt	
5. Juice		6. Margarine	
7. Other (Specify)			
8. Fortification of maize meal in Kenya is enforced by law (indicate Yes =1 or No = 0)			

D. Attitude

I would like to ask you whether you agree, disagree or you are unsure with the following statements

Statement	Agree = 1; Disagree = 2;Unsure/ Don't know=3
Overall assessment of adding minerals and vitamins to foods	
1) No foods should have vitamins or minerals added	
2) There are no restrictions to addition of vitamins and minerals to foods so long as they are labelled	
3) Some foods should not have vitamins or minerals added	
4) Adding vitamins and minerals to foods gets me concerned	
5) I am not concerned with manufacturers adding vitamins and minerals to foods	
6) It is possible to get all vitamins and minerals you need from foods naturally rich in those nutrients	
7) I prefer to get my vitamins and minerals naturally, from fruit and veggies	
8) Fortified foods taste better than non-fortified foods	
9) Fortified foods help one have a healthier personal diet	
Benefits of fortifying foods	
10) The benefits of adding minerals and vitamins to food will outweigh risks	
11) I do not already get enough vitamins and minerals in my diet	
12) Eating foods with added vitamins and minerals would help with a healthier personal diet	
13) Combination of healthy eating and supplements is best	
14) I just think that it's unnecessary to take fortified food if you're eating a balanced diet	
15) The reason maize flour would have folic acid added to it is to reduce the risk of babies being born with neural tube defects like spina bifida. Knowing this, would you say it should be compulsory for manufacturers to add folic acid to all maize flour?	
Adding minerals and vitamins to maize flour would;	

16) Promote health	
17) Improve flavor	
18) Improve color	
19) Improve keeping quality/shelf live	
20)	
Risks	
21) It is unnatural to add minerals and vitamins to foods	
22) I worry about the risks of adding minerals and vitamins to foods	
23) I am at a risk of lacking one or more minerals or vitamins	
24) There are health risks to the family for not consuming enough minerals and vitamins	
25) Ingesting a large quantity of a vitamin or mineral could be harmful.	
26) Vitamins and minerals added to foods are unnatural just like preservatives, flavorings, colors and artificial sweeteners	

Information about fortification	
27) I need more information to know if adding minerals and vitamins is good/bad	
28) I get confused about the benefits of added vitamins	
29) I don't trust health claims made about added vitamins and minerals	
Intention to Purchase fortified foods	
30) I would buy foods specifically added with vitamins and minerals	
31) I would avoid buying foods added with vitamins and minerals	
32) Fortified foods would be more expensive than non-fortified foods.	

Other cross cutting attitude items

Question	Indicator	Response
33) In your family, who do you think is at risk of lacking minerals and vitamins? (Multiple responses possible)	1=Everybody; 2= Children only 3=Pregnant women only 4.=Breastfeeding women only; 5= The sick only; 6= The elderly only; 7=Others (specify)	
34) How important do you think it is for your family to consume foods with added minerals and vitamins daily?	1=Not important; 2= Important; 3=Not sure	
35) How serious do you think the problem of not consuming enough minerals and vitamins is in Kenya today?	1=Not serious; 2= Serious; 3= Not sure	
36) Given a choice between foods containing added vitamins and minerals and another with no added vitamins and minerals, which one would you choose?	1= Food with added vitamins and minerals 2=Food without added vitamins and minerals 3= Not sure	
37) If you found that the flour you were thinking of buying contains added vitamins or minerals, are you likely to buy it?	0= Yes 1= No.	

E. Practices

1. Now thinking of the specific foods listed below, have you purchased the food within the last three months because it contained added vitamins and minerals?	1= Yes; 0=No	If Yes, which brand did you buy (qualitative)	How regularly have you purchased it over the last three months (1= once; 2= 2-3 times;3 >3 times; 0 4=Never)
Salt			
Wheat flour			
Maize flour			

Cooking oil			
Sugar			
Other (state)			

Question	**Indicator**	**Response**
2. What is the main source of maize flour in your household?	1=Milling own maize 2= Purchasing package flour 3= Purchasing unpackaged flour	
3. Which of the following factors do you consider important when purchasing maize flour?	1=Price; 2= Brand; 3= Nutrition/health; 4=Flavour; 5= Target user (e.g. child); 6 = Other (Specify)	

4. Now thinking of Maize floor (in its different forms) how often have you consumed or used it in your household in the last 3 months (1= daily; 2= 5-6 times per week; 3=2-4 times per week; 4= Once per week; 5 = 1-3 times per month; 6 = Never)

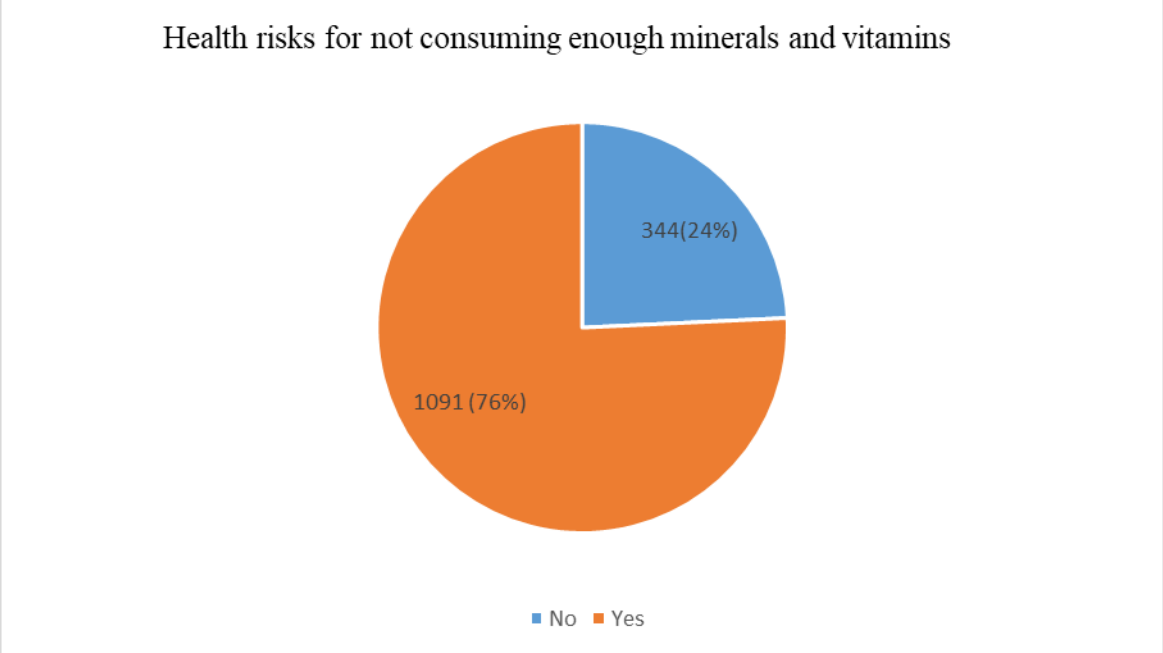
Form of use of maize flour	**Response**
Ugali (posho mill maize flour)	
Ugali (packet maize flour)	
Porridge (posho mill maize flour)	
Porridge (packet maize flour)	

Appendix II: Results to refer to on chapter 4 pages 48 and 57 respectively

Knowledge	Yes	No
Is there a way to know whether food is fortified or not?	520 (36.24)	915 (63.76)
GOK has made it compulsory to fortify some food	412 (28.71)	1023 (71.29)

Awareness of minerals and vitamins

Awareness of vitamins N=1435	Awareness of minerals	
	No	Yes
No	531(37.13%)	21(1.47%)
Yes	469(32.80%)	409(28.60%)



Appendix III: Work plan

Activities	**Jul 2017**	**Oct - Dec, 2017**	**Jan - Jun 2018**	**Jul-Nov 2018**	**Dec.2018-Feb.2019**	**Mar 2019-Dec.2020**	**Jan 2021-Jan.2022**	**Feb 2022-Jun. 2022**
Concept review								
Literature review								
Proposal writing and presentation								
Proposal editing and corrections								
ERC Approval								
Data collection, analysis and thesis writing and presentation.								
Manuscript publication								
Thesis submission, defense and graduation.								

Appendix IV: Budget

Activity	**Quantity**	**Unit Cost**	**Total**
Concept paper binding	10 copies of 10 pages	30/=	300/=
Proposal writing binding	4 copies of 30 pages	40/=	400/=
Summary copies binding	10 copies of 30 pages	40/=	400/=
Black cartridge	5 cartridges	1800/=	9000/=
Photocopying papers	10 reams	500/=	5000/=
Tablets for pretesting	30	25000	750000/=
Transport during pretesting and data collection	1 day for 30 persons	1000/=	30,000/=
Training assistants	30 assistants for 1 day	1000/=	30,000/=
Transport and accommodation during data collection	30 assistants for 30 days	1000/=	900,000/=
Statistical services			30, 000/=
Binding thesis	6 copies	1700	10200/=
Miscellaneous			30000/=
Grand Total			**1,795,300**

Appendix V: Sampled regions

COUNTY	S/COUNTY	DIVISION/ WARD	LOCATION	SUB LOCATION	TOTAL POPULATION	HHDs
NYANDARUA	NDARAGWA	NDARAGWA	MATHINGIRA	LESHAU	6292	19
NYANDARUA	OLJORO-OROK	OLJORO-OROK	GATIMU	GIKINGI	9164	19
NYANDARUA	OLKALOU	OLKALOU	NDUNDORI	RUIRU	6360	19
NYANDARUA	OLKALOU	OLKALOU	RURII	RURII	9770	19
NYANDARUA	NYANDARUA NORTH	KINANGOP NORTH	KINANGOP NORTH	KITIRI	8557	19
NYANDARUA	KINANGOP SOUTH	KINANGOP SOUTH	NJABINI	KIBURU	11099	19
NYANDARUA	KIPIPIRI	KIPIPIRI	WANJOHI	WANJOHI	13848	19
NAIROBI	NAIROBI EAST	EMBAKASI	MUKURU KWA NJENGA	MUKURU KWA NJENGA	130401	19
NAIROBI	MAKADARA	MAKADARA	MAKONGENI	MAKONGENI	12302	19
NAIROBI	MATHARE	CENTRAL	MATHARE	MLANGO KUBWA	38374	19
NAIROBI	KASARANI	KASARANI	ROYSAMBU	ROYSAMBU	28007	19
NAIROBI	KAMUKUNJI	PUMWANI	EASTLEIGH SOUTH	EASTLEIGH SOUTH /KIAMBIO	66264	19
NAIROBI	KIBRA	KIBERA	KIBERA	KIBERA	9786	19
NAIROBI	WESTLANDS	WESTLANDS	KANGEMI	GICHAGI	19454	19
KILIFI	KILIFI	CHONYI	MWARAKAYA	KIZINGO	9842	19
KILIFI	KILIFI SOUTH	KIKAMBALA	MTWAPA	KANAMAI	15389	19
KILIFI	MAGARINI	MAGARINI	MAGARINI	MAMBRUI	16752	19
MOMBASA	CHANGAMWE	CHANGAMWE	CHAANI	CHAANI	58238	19
MOMBASA	LIKONI	LIKONI	LIKONI	BOFU	29154	19
MOMBASA	MALINDI	MALINDI	MALINDI	SHELLA	43434	19
KILIFI	RABAI	RABAI	RABAI	MGUMO /PATSA/MAZERAS	15909	19
MOMBASA	MOMBASA	ISLAND	MAJENGO	MAJENGO	30920	19

MOMBASA	KISAUNI	KISAUNI	KISAUNI	KISAUNI	79811	19
KAKAMEGA	BUTERE	KHWISERO	MULWANDA	MULWANDA	5242	19
KAKAMEGA	KAKAMEGA NORTH	KABRAS NORTH	CHEGULO	NAMUSHIYA	4482	19
KAKAMEGA	LUGARI	LIKUYANI	NZOIA	MUSEMWA	5049	19
KAKAMEGA	MUMIAS	MATUNGU	KOYONZO	KOYONZO	10035	19
UASIN GISHU	ELDORET WEST	SOY	KIPLOMBE	KUINET	12150	19
TRANS NZOIA	TRANS NZOIA EAST	CHERANGANY	CHEPSIRO	KIBUSWA	9843	19
TRANS NZOIA	CHERANGANY	CHERANGANY	MILIMANI	MILIMANI	7682	19
TRANS NZOIA	TRANS NZOIA EAST	KAPLAMAI	MOTOSIET	MOTOSIET	22571	19
TRANS NZOIA	TRANS NZOIA WEST	CENTRAL	KIBOMET	MILIMANI	13310	19
TRANS NZOIA	TRANS NZOIA WEST	CENTRAL	WAITALUK	KAPKOI SISAL	40377	19
TRANS NZOIA	TRANS NZOIA WEST	KIMININI	KIMININI	NABISWA	38731	19
TRANS NZOIA	TRANS NZOIA WEST	SABOTI	MACHEWA	MACHEWA	19999	19
UASIN GISHU	WARENG	KAPSERET	PIONEER	LANGAS	93436	19
NAKURU	MOLO	NJORO	NESSUIT	NESSUIT	7272	19
NAKURU	NAIVASHA	NAIVASHA	HELLS GATE	MIRERA	39209	19
NAKURU	NAKURU	MBOGOINI	WASEGES	NYAMAMITHI	2454	19
NAKURU	NAKURU	RONGAI	VISOI	KAPKWEN	4839	19
NAROK	NAROK NORTH	CENTRAL	NKARETA	NKARETA	6856	19
NAROK	NAROK SOUTH	MULOT	ILMOTIOK	ILMOTIOK	14003	19
NAROK	TRANS MARA	KEIYAN	MOITA	MOITA	4598	19
KISUMU	KISUMU EAST	WINAM	KAJULU WEST	WATHOREGO	11823	19
KISUMU	KISUMU EAST	WINAM	KOLWA CENTRAL	NYALUNYA	12487	19
KISUMU	KISUMU EAST	WINAM	KONDELE	MANYATTA 'A'	48004	19
KISUMU	KISUMU EAST	WINAM	TOWN	SOUTHERN	9163	19
KISUMU	NYANDO	MIWANI	NYANGOMA	SIDHO EAST II	6840	19
KISUMU	NYANDO	NYANDO	AWASI	BORDER II	6986	19

KISUMU	NYANDO	UPPER NYAKACH	THURDIBUORO	UPPER KADIANG'A	4390	19
MERU	IMENTI SOUTH	IGOJI	IGOJI	GIKUI	7889	19
MERU	MERU CENTRAL	ABOTHUGUCHI C.	KARIENE	KARIENE	3710	19
MERU	MERU CENTRAL	KIBIRICHIA	KIBIRICHIA	KIMBO	4149	19
KITUI	KITUI RURAL	CENTRAL	MALIKU	KAVISUNI	4403	19
KITUI	KITUI EAST	CHULUNI	NZANGATHI	KALUVA	9997	19
KITUI	KITUI WEST	MUTONGUNI	MUSENGO	MUSENGO	9233	19
KITUI	MWINGI NORTH	KYUSO	KAMUWONGO	KAMUWONGO	3530	19
KITUI	KITUI SOUTH	MUTHA	MATHIMA	KIVYUNI	2382	19
KITUI	MWINGI CENTRAL	CENTRAL	MWINGI	KYANIKA	7676	19
KITUI	MWINGI CENTRAL	NGUNI	MBUVU	MBUVU	4785	19
GARISSA	GARISSA	BALAMBALA	DUJIS	SHIDLEY	5971	19
GARISSA	GARISSA	CENTRAL	IFTIN	IFTIN	24600	19
GARISSA	GARISSA	CENTRAL	KORA-KORA	KORA-KORA	3235	19
GARISSA	GARISSA	CENTRAL	TOWNSHIP	GALBET	26942	19
GARISSA	GARISSA	CENTRAL	TOWNSHIP	MEDINA	16302	19
GARISSA	GARISSA	CENTRAL	TOWNSHIP	TOWNSHIP	22349	19
GARISSA	LAGDERA	CENTRAL	WABERI	WABERI	20617	19
GARISSA	LAGDERA	SANKURI	SHIMBIR	SHIMBIR	2385	19

Appendix VI: Letter of approval

MINISTRY OF HEALTH
OFFICE OF THE DIRECTOR OF MEDICAL SERVICES

Telephone: (020) 2717077
Fax: (020) 2713234
Email: dms@health.go.ke
When replying please quote

AFYA HOUSE
CATHEDRAL ROAD
P. O. Box 30016 – 00100
NAIROBI

REF: MOH/ADM/1/1

13th November, 2017

County Executive Committee Members of Health

Nairobi County	Garissa County
Mombasa County	Uasin Gishu County
Kilifi County	Tranzoia County
Kisumu County	Nakuru County
Kakamega County	Narok County
Kitui County	Nyandarua County

Through
Chairman
Council of Governors
Delta House, Westlands
Nairobi

RE: ASSESSMENT OF KNOWLEDGE, ATTITUDE AND PRACTICES SURVEY ON FOOD FORTIFICATION IN KENYA FROM 27TH NOVEMBER TO 1ST DECEMBER, 2017

Jomo Kenyatta University of Agriculture and Technology (JKUAT) in collaboration with The Ministry of Health (MoH) through the Nutrition and Dietetics Unit (NDU) applied for a six year European Union project on "Strengthening the Kenya National Food Fortification Programme" with the aim of improving health and nutritional status of the poor and vulnerable groups.

One of the specific objectives of the project is to raise knowledge, awareness and consumption of fortified foods among the Kenyan population. For this reason, there is need to conduct a survey on knowledge, attitude and practices (KAP) on food fortification to assess the baseline and determine the most appropriate channel of communication. The survey will be conducted in Nairobi, Nyandarua, Mombasa, Kilifi, Kisumu, Kakamega, Kitui, Garissa, Uasin Gishu, Tranzoia, Baringo and Narok counties from 27th November to 1st December 2017.

ISO 9001:2008
Certified

The purpose of this letter is to inform you of this activity and request for the support to the survey team conducting this activity in your county.

For any clarification, please contact John Mwai, on 0721449487 or kiriromwai@gmail.com.

Dr. Kioko Jackson K., OGW
DIRECTOR OF MEDICAL SERVICES

ISO 9001:2008
Certified