ASSESSING THE KNOWLEDGE, PERCEPTION AND ATTITUDE OF YOUTH ON THE UTILIZATION OF EDIBLE INSECTS AS FOOD AND FEED

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DECLARATION

This thesis is my original work and has not been presented for an award of a Diploma or conferment of Degree in any other University or Institution.

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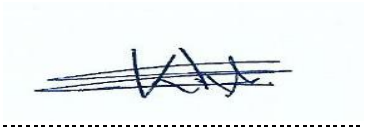
APPROVAL

This thesis has been submitted with our approval as the University supervisors.

Signature:  Date: 19/04/2023

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DEDICATION

The thesis is dedicated to my mother Gosego Morris and sister Pulane Morris.

ABSTRACT

Youth unemployment is increasing with the diminishing opportunities for formal employment. Cases of food insecurity associated with youth unemployment are also on the rise. Protein obtained from farmed animals is in high demand and costly for the poor unemployed youth. Incorporating edible insects in our food systems has the potential to improve food security among the youth. Though there is limited information on the perspective of youth about the use of edible insects as food and feed in Kenya, therefore, the purpose of the study was to assess the knowledge, perception and attitude of youth on the utilization of edible insects as food and feed. The specific objectives of the study were to; determine the level of knowledge of youth on the utilization of edible insects and to evaluate the perception and attitude of youth towards the utilization of edible insects as food and feed. The target population for the study was youth of Vihiga County, with the age range between 18 to 35 years. A pre-tested questionnaire was used to collect primary data from randomly selected 270 participants. The Statistical Package for Social Science (ver.25) and Microsoft Excel software were deployed to analyze data. Data was analyzed in the form of descriptive and inferential statistics. The study results revealed that majority of youth have little knowledge about consumption, nutrition, harvesting, processing and use of insects as livestock feed. The results also showed that youth have a positive perception and attitude towards the use of edible insects. From the Chi-square analysis it was observed that age and education level have a significant association with the familiarity of edible insects consumption, $p = .014$ and $p = .009$ respectively. The results also shows that there is a significant association between awareness on the nutritional value of insects with age and education level, $p = .001$ and $p = .009$ respectively. Logistic regression analysis was used to determine the relationship between demographic characteristics, knowledge, perception, attitude and the utilization of edible insects. The results revealed that education level, age, knowledge, perception and attitude have an impact on the utilization of edible insects. Hence, focus should be on educational interventions to raise awareness on the benefits of entomophagy, financial and technical support to enable sustainability of this business venture.

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ABBREVIATIONS AND ACRONYMS

FAO: Food and Agriculture Organization

JOGNN: Journal of Obstetric, Gynecologic and Neonatal Nursing

KNBS: Kenya National Bureau of Statistics

NCPD: National Council of Population and Development

SPSS: Statistical Package for Social Sciences

SSA: Sub Saharan Africa

UN: United Nations

UNESCO: United Nations Educational, Scientific and Cultural Organization

CHAPTER ONE
INTRODUCTION

This chapter gives the background information of the study, problem statement as well as objectives. The research hypothesis, questions, scope, justification, limitations and operational definition of terms are also presented in this chapter.

1.1 Background

The world population is considered to be comprised of about 50 percent of young people, which about 3.3 billion are below 25 years (Sommers, 2010). Gupte et al (2014) stated that Africa is experiencing rapid growth in its youth population than any other continent in the world. Many countries including Kenya have the highest population of youth; in the Policy brief of 2017 (NCPD), the population of youth in Kenya for people between 15 to 34 years of age was projected to reach 17.8 million in 2020 while 22.3 million is expected by the year 2030. The youth population constitutes a larger share of Kenya's asset for the present and future. But due to this high numbers there is a great competition for resources, opportunities, facilities and youth related issues.

Youth are an important asset to any community, because they have distinctive abilities like ambition, strength, and adventure, innovation, active and vibrant. They have the responsibilities of making a change in the society since they are the majority of the population currently and they are the future generation. Despite the role that youth can play in the development of our communities their increase in population is coupled with challenges (Sherrod et al., 2010). Conchas and Vigil (2010) explained that the struggles that youth come across put them in a position where they become disconnected from the society. In most cases youth are not involved or they do not participate in development like politics, policy making, and social development etc. since their importance is overlooked.

Faced with poverty most youth find it difficult to access capital as well as to acquire skills and information on investment. However, because of the high numbers, it has become an essential development challenge of this modern era. African youth are poor, struggling and frustrated therefore it is important to develop interventions for this large group of the population because failure to do that can lead to huge political, cultural, economic and social consequences. Involving the youth in development process is now an urgent matter to many countries (Hope, 2012).

World population is expected to increase with about one percent in the next two decades with the highest growth in developing countries (Roser et al., 2013) Africa is one of the continents in the world that is experiencing rapid growth in its population accompanied by social and economic challenges. High rates of population increase are putting Africa in a pressure of mitigating hunger. Africa is struggling with issues of malnutrition, 35 percent of the population is undernourished as compared to all of the developing countries which has about 14 percent of undernourished people. FAO (2009) has projected that in the year 2030 about 40 percent of the population have a high possibility of hunger. In Sub-Saharan Africa which is the mostly affected area there has been significant decline of undernourishment cases but now facing high levels of obesity and overweight. All the countries in Sub Saharan Africa have been working hard towards achieving food and nutrition security but it has proven to be difficult due to the issues of climate change and degraded environments (Fischer, 2010).

It has been reported that by the year 2050 the production of food need to increase food by 70 percent to be able to sustain every human life around the world (Lensvelt & Steenbekkers, 2014). The human population is predicted to increase to about 9 billion in 2050; as such there is rapid increase in demand for food especially the animal protein (Alexandratos & Bruinsma, 2012). This is more evident in developing countries and emerging economies where there are high food shortages. Currently accessibility of animal protein in developing countries is a challenge because of high prices and change in climate that has led to low production of livestock. Despite the challenges, high demand for animal-based protein is projected to increase more in future therefore, it is imperative that protein output increases to satisfy the need (Alemu et al., 2015).

The increasing world food demand has led to the edible insect movement as one of the strategies to increase and diversify food to tackle food security. Entomophagy is gaining popularity worldwide and Africa is no exception as it has been part of the traditional diet of local communities (Bessa et al., 2020). In Southern Africa about 67 percent of the population's animal protein intake is from insect. Insects are valued source of food for the future since they are very healthy; they are a good source of essential nutrients (Van Huis et al., 2013). Insects are an important part of the human environment. Their importance goes beyond being a source of food to humans but also provide services that enable production of other foods. They have an important role in providing ecological services. For instance bees and wasps are pollinators and hence assist in reproduction of plants. This service is an integral part of agriculture because it enables production of food. Waste management is made possible by beetles and termites. They turn waste; leaves, twigs, cow dung etc. into humus that provide nutrients to the soil. Where these insects exist there is improvement of soil nutrients and structure and also reduction in organic waste (Lensvelt & Steenbekkers, 2014).

Studies have shown that technology and innovation have been promoted due to what can be extracted/ obtained from insects. Desirable genes are extracted from insects to be used in other organisms. Non-nutritive components are used in the industrial sector such as cosmetic and textile (Tang et al., 2019). Insects use fewer resources such as water and land, making them attractive for domestication. Not only do they require less resources but insect farming lead to reduction of pollution due to their high food conversion rate they emit less greenhouse gases as compared to livestock production which contributes about 18 percent of the total greenhouse gases released into the atmosphere (Voelker,2019). Therefore rearing insects for human consumption can help in addressing protein demands and also contribute to the conservation of the environment (Van Huis & Oonincx, 2017). Insect farming can offer economic opportunities to the rural and poor population of the society and youth since insect farming requires low technology to operate and low capital investment.

In order to determine which insects are edible as well as to find and how to catch them, the ethnic people rely on conventional local wisdom. These specialized traditional skills have been handed down from one generation to the next. Only healthy insects are typically collected, processed and prepared for consumption. The majority of the grasshoppers collected come from the bushes surrounding villages and farmland. Other people know how to locate the burrow or holes and collect them by pouring water. Crickets and termites are collected using light traps (Chakravorty, 2014). Locals have mastered gathering insects in an ecologically sound manner based on their extensive experience in collecting. Cooking and preparing insects can be done in a variety of ways. Locals devised dishes like stewing, frying, roasting and steaming (Feng, 2018). There are many perspectives on the use of insects as food and feed among African communities. Such perceptions are influenced by historical context, literacy, culture and religion. In some parts of Nigeria, eating raw or roasted a whole termite queen is believed to increase intelligence quotient. In some parts of Cameroon, insects are eaten for various cultural rituals (Tamese et al., 2016). Among the literates the habitats of some insects have received criticism. Their perspective is that the habitats of such insects are not hygienic and their consumption can pose a serious health risk to humans (Babarinde, 2020). Despite their numerous nutritional benefits, edible insects' potential is still being investigated (Van Huis, 2013). Individual psychology, cultural customs, and personal perceptions are all barriers to incorporating this type of cuisine into the diet. Consumer's adoption of insects has been investigated. In advanced countries, such as Germany, insects are more readily accepted in diets when they have been processed (Hartamann et al., 2015). Food neophobia is caused by anxiety and dread of unfamiliar and potentially harmful foods (Schardong et al., 2019). Nevertheless, as van Huis (2013) points out, eating preferences are not permanent and can change over time. Reducing people's perceptions of how repulsive these foods are is one way to increase their willingness to eat novel animal foods (Sogari et al., 2017).

1.2 Statement of the Problem

The change in land use systems to pave way for urbanization have affected agricultural production, with high number of people in cities and towns resulting in food supply deficit (Becker et al., 2020). The plague of poverty continues to prevail on youth because of high standards of living in urban areas. Like most communities in Sub-Saharan Africa, the youth in Vihiga County (Kenya) are facing many challenges such as drug abuse, violent conflicts and crime, vulnerability to HIV and AIDS and erosion of support systems, access to employment and lack of possibilities for youth involvement and engagement. Youth unemployment has increased with the diminishing opportunities for formal employments. Cases of food insecurity associated with youth unemployment are also on the rise (County government of Vihiga, 2018). The food shortages and high demand of protein products in the Sub-Saharan Africa led to the consideration of edible insects as an alternative option to this challenge. Because of their high nutrient content, positive impact on the environment and economic value insects are considered to play a vital role in contributing to food security (Van Huis, 2019). Despite their tremendous benefits in food and feed production, the youth appear to have some reservations about the utilization of edible insects (Melgar-Lalanne et al., 2019). Because entomophagy is connected with negative perception, developed countries are dealing with their own difficult neophobia issues. The situation is significantly worse in cities, other African countries such as Botswana, Nigeria and Zimbabwe have noted that youth are rejecting entomophagy (Manditsera et al., 2018; Obopile & Seeletso, 2013). The aboriginal people have rich understanding of entomophagy however it is limited because it is passed down orally through generations, and part of it has been lost over time due to westernization and youth not being interested in agricultural activities. The limited distribution of knowledge on edible insects has motivated this study in order to promote entomophagy among the youth. Literature indicates that most insect based research focus on exploring the nutritional composition of insects, making insect based products and their potential in improving food security few studies have been done to understand the perception of the public especially the youth on this noble food (Orkusz et al., 2020).

1.3 Objectives

1.3.1 Broad Objective

i. The main objective of the study is to assess the knowledge, attitude and perception of youth on the utilization of edible insects as food and feed.

1.3.2 Specific Objectives

i. To determine the level of knowledge of youth on the utilization of edible insects as food and feed.
ii. To evaluate the perception and attitude of youth towards the use of edible insects as food and feed.

1.4 Research Questions

i. What is the level of knowledge of youth on the utilization of edible insects as food and feed?

ii. What is the relationship between perception, attitude and the use of edible insects as food and feed?

1.5 Justification

Sub Saharan Africa communities are challenged with issues of food insecurity with Kenya not being an exception. Kenya Integrated Household Budget Survey of 2015/16 indicated that the poverty index of Vihiga County was standing at 43.2 percent (Vihiga County, 2018). The youth population is mostly affected due to high rates of unemployment opportunities and low paying jobs. A large proportion of the county's economy is based on agriculture which most of the activities are heavily dependent on rainfall but challenged with low agricultural production because of the change in climate. Therefore capitalizing on the use of natural resources such as edible insects can be an approach to food diversification for the youth community of Vihiga County. Edible insect harvesting has the potential to be an income generating venture.

Therefore the study intend is to investigate the views of youth as far as using edible insects as an alternative protein source and an income generating activity is concerned. In pursuit of exploring edible insects as food Hartmann and Siegrist (2017) emphasized the need for research that can help in convincing people to consume insects. As such a lot has to be done to understand and change the perception of the public on edible insects. Hence the investigation outcomes will be beneficial to the youth by raising awareness on the importance of edible insects, which can be exploited and be used in the food and feed sector. Increasing involvement of young people in the use of edible insects can help in reducing poverty by improving nutrition in the household. The findings are also important to extension officers who can help in improving information dissemination and adoption of the use of edible insects. Furthermore, the government and other stakeholders can develop policies and initiatives that can encourage entomophagy and micro farming among the youth.

1.6 Limitations of the Study

The study had some limitations which have to be considered when the results are interpreted. The researcher had no control over the sincerity of the participants in giving accurate and reliable information. These matters depended on the capacity of the individual to comprehend the English language in a way that communicates the same meaning to each participant. This was reduced by translating the questions to Kiswahili for better understanding. The research relied more on the data gathered from participants through the use of a semi structured questionnaire. This information source is known to be a subjective as such response biases might have occurred. Also the researcher was not familiar with the area of study in terms of geographical location, culture; language etc. so there was too much dependency on the enumerator. Due to the Covid-19 pandemic, data collection became

difficult. Going to each household to conduct interviews proved to be a challenge, hence the team had to call respondents to a central place and interviewed in small groups.

1.7 Scope of the Study

The study was focused on the youth of Vihiga County, Western Kenya. The county has five sub counties; Vihiga, Luanda, Sabatia, Hamisi and Emuhaya with twenty five wards. It main purpose was to assess the knowledge of youth on the utilization of edible insects, their perceptions and attitudes towards the use of edible insects as food and feed.

1.8 Assumptions

The data collection instrument was sound, reliable and consistent in measuring data, the sample used served as a representative of the target population. The survey participants were found to be objective and honest. The information given was correct and accurate on their knowledge, perception and attitudes on the use of edible insects as food and feed.

1.9 Definition of terms

In the study the following terms mean:

Attitude: an individual's feelings or opinion about something.

Diet: the kind of food that a person is accustomed to eating.

Edible insects: insects species that are used for human consumption.

Entomophagy: refers to the human consumption of insects as a food source.

Food insecurity: inability to have consistent access to adequate for a healthy and active life.

Food security: a condition in which an individual have accessibility to economic and physical means to obtain adequate, secure, and quality food which satisfies nutritional requirements and preferences at all times in order to live a healthy and active life.

Hunger: a condition brought about by prolonged lack of food.

Knowledge: understanding gained through learning or experience.

Nutrition security: having access to essential nutrients that are important to human growth and development.

Perception: the way in which something is regarded or interpreted.

Poverty: a condition in which an individual cannot afford basic human needs.

Youth: the period of transition from childhood to adulthood**.**

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter review relevant literature on youth and poverty, status of entomophagy in Kenya and the perception and attitude of the society towards entomophagy. The literature review was attended according to the research question and objective. Relevant research studies were identified, summarized and critically analyzed as and how they relate to the problem under study.

2.2 Definition of Youth

There is no single definition of youth that is generally accepted; it varies from country to country, society to society. Some people have the view that youth is actually a state of mind rather than a time in life (Jodie et al., 2016). Governments, communities, nonprofit organizations, institutions etc. define youth as a time in one's life and they give it a period when it starts and ends. According to the United Nations youth is a person between the ages of 15 to 24 years. The definition of youth is influenced by political, institutional, sociocultural and economic factors as such it differs from one nation to the other (UNESCO, 2019).

Kenya also has some slight differences in defining a youth, depending on the organization and its objectives. Youth is defined as a person between the ages of 18 to 35 years (Kenya Constitution, 2010). The Kenya youth development policy describes young people as individuals from the age of 18 to 34 years. The term youth is deployed by the Policy to denote both age and youth-hood. In the aspect of age, a youth is described in terms of gender, ascribed to the age bracket 18-34 years; meanwhile in the category of youth-hood the policy is precise to life stage between childhood and adulthood. This is the time when a person is finding a way through complicated aspects of life; socio-economic, personal and cultural changes, moving from being dependent to being independent, taking control and beginning some social responsibilities. The Policy view this stage of life as a time when one is at a risk of failure because they have to go through transition; staying healthy and safe, exercising citizenship, learning, forming families, transition to work and adherence to governance principles and national values (Ministry of Public Service, Youth and Gender, 2018).

In the sociological context Henze (2015, p.5) defines youth as 'the period of life in-between childhood and adulthood. It is described as a time of experimenting with roles and identities, still void of the burden of social norms and obligations, yet slowly preparing the youngsters for their lives as full members of the social collective. During this process of social integration young people find themselves in a complex social system, composed of such elements as tradition, history, social demands, hopes, and individual future prospects, all of which they have to incorporate into a coherent picture in order to build a proper foundation for their personal life.'

2.3 Youth and Poverty

It is important to note that poverty is multifaceted; as such it is supposed to be assessed by the level of earnings together with accessibility to public services. Youth-hood is a transitional period between childhood and adulthood, for which all youth at this stage are moving towards independence. This stage of life is exciting however youth encounter many challenges in their transition that may add to the already difficulties they may be going through. The community in which one lives in coupled with factors like; socio-economic background; gender, family support, race, and ethnicity determine the success of transition to adulthood (UN, 2005).

According to Min-harris (2009) out of the forty eight poorest countries worldwide thirty-two are found in the Sub-Saharan Africa. The high number is made possible because of issues like clinical diseases such as HIV/AIDS, dysfunctional governments, and conflicts. People living in rural areas; their livelihood and food security is vulnerable since nearly all the SSA agricultural activities are dependent on rain which is at a high risk due to weather shocks. The lack of social services in SSA, especially in education and health care is a major problem in coping with challenges of hunger and poverty.

People living in extreme poverty tend to be young people; as shown by figure 1. Poverty among the youth have the same characteristics as that of a larger population, it is common in rural areas and more severe among females. However poverty is greater among the youth than in the general population. Over 500 million youth survive on a daily budget below US$ 2 and 43 percent of the world's youth labour force is either unemployed or stuck in poverty while working (Castaneda et al., 2016). South Asia has a significant portion of the disadvantaged youth in the world, this equates to four out of ten young people surviving on less than a dollar or two a day. In Africa poverty among the youth is chronic and rising, with about 46 percent of young people living on less than US$ 1 per day. Three out of ten young people in Sub-Saharan Africa live on less than US$ 1 per day, while two out of ten live on a regular budget of less than two dollars a day (UN, 2005; Moore, 2005).

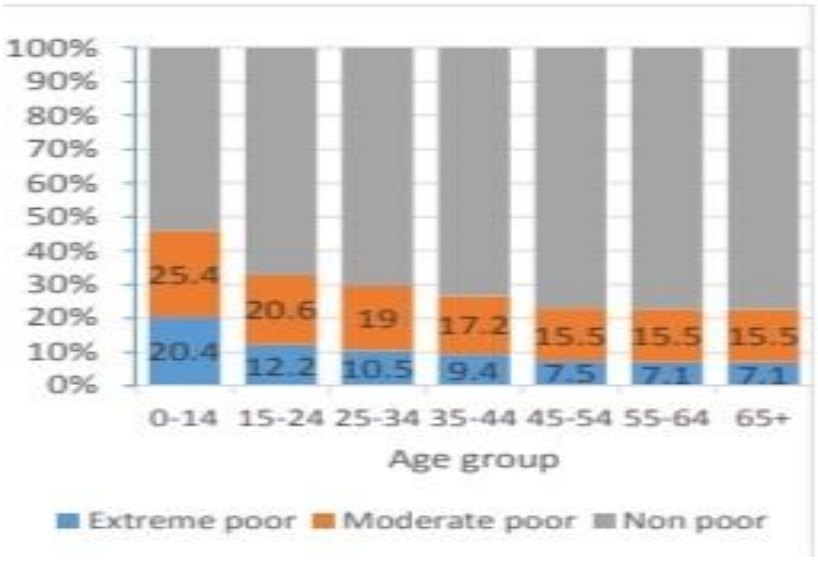

Figure 1: Poverty rate by age group (Castaneda et al., 2016)

The World youth report (2005) explained that rural youth population account for over half of the youth population around the world, due to unfavourable conditions they find themselves in. In many instances access to educational services that address their unique circumstances and need is minimal. Rural youth who find themselves in this kind of struggles are moving to cities and towns to look for greener pastures. According to Banks (2016) moving from rural to urban areas or across urban areas is 40 percent more likely in the younger generation than it is in the older generation. This rural-urban migration has resulted in urban areas becoming heavily congested and overworked, straining schools, sanitation, health services, water systems, and infrastructures which are inadequate. Increasing urbanization and decline in the possibility of getting employed have resulted to the African continents prevalent widespread urban poverty and instability. Cities are well known for serving a variety of purposes in all societies. They are at the center of many countries' technical advancements and economic prosperity, while inequality, poverty, environmental concerns and communicable and non-communicable diseases thrive in this kind of situation (Kuddus et al., 2020).

2.4 Entomophagy in Kenya

According to Christensen et al (2009) utilization of edible insects is not a new concept; it is a practice that has been part of the tradition to many communities around the world. In Kenya edible insects' consumption is popular in the western part of the country, where insects are collected for human consumption, feeding poultry or fish and some members of the community use them in traditional medicine. Diversity and abundance of insects is found around the lake region which includes; winged termites, grasshoppers, locusts, and crickets and they form an integral part of their diets (Ayieko et al., 2010a). Termites are one of the most abundant and widely consumed insect in Africa, even in Western and Lake Victoria region of Kenya they are part of their traditional diets. The insects are commonly consumed as relish, a snack or it can be used as an ingredient in other foods (Kinyuru et al., 2013).

Locals around the western and Lake Victoria regions collect insects directly from their natural habitats. Traditional methods of harvesting are employed to collect termites from the mounds; crickets are also located by the use of whizzing sounds. Due to the infrequent occurrence, harvesting and consumption is mainly during the onset of rains and wet periods. Some insects such as termites can be induced to come out during dry periods thus availing them all year round. In such instances, the harvesters hit the mound with sticks imitating a sound like rain to trick the termites to come out. Conventional food processing techniques such as roasting, sun-drying, grinding and boiling are used to add value to the insects (Jideani and Nitshiheni, 2017). Modern methods of preservation and value addition are being developed in order to reduce the disgusting factor and increase acceptability of edible insects in our diets. These include fortified cereals, as an ingredient in wheat buns (Kinyuru et al., 2009), meat loaf, crackers and muffins (Ayieko et al., 2010b) and cricket buns (Pambo et al., 2016).Some insects are believed to have some medicinal values and highly regarded in traditional medicine. For instance the lake fly is used by traditional healers in their herbal mixtures to treat some diseases. It has also been reported that women in the Lake Victoria region include lake flies when preparing meals for treatment of children who are fragile and sick. The latter has been scientifically proven to be true due to the nutritional value of the insect (Ayieko & Ariaro, 2008).

2.5 Food security

The concept of food security is described as a condition in which an individual have accessibility to economic and physical means to obtain adequate, secure, and quality food which satisfies nutritional requirements and preferences at all times in order to live a healthy and active life (FAO, 2006). That is food security is attained when the quantity and standard of food available is consistent, and an individual must have the means to acquire the food and be able to utilize it to achieve a state of healthy well-being. Van Huis (2015) argues that recently it has become imperative to consider sustainable food security for the future generation. Production of food especially animal production have a considerable effect on the environment in terms of pollution but the increase

in demand of protein source grows rapidly, as such there is a need to change our diets in order to cope with the challenge. To achieve change of diets people would have to resort to other sources of protein such as rapeseed, cultured meat, microalgae, duckweed, seaweed and insects (Gjerris et al., 2016).

2.5.1 Insects as food

Insects are the world's most abundant and diversified multicellular animals. Although insects are commonly thought of as pests that cause harm to plants, animal and human health, they contribute significantly in reducing food poverty in addition providing ecosystem services (Bernard & Womeni, 2016). In an ever increasing human population hunger and malnutrition are usually major issues. People are suffering from chronic protein deficiency and are looking for alternative protein sources. Insects are seen as the best option as they could provide large amounts of multiple nutrients. The use of diverse insects in traditional communities could be the solution in achieving food security. In most of the communities, people do not use all the available edible insects (Yen, 2009). Edible insects are essential part of the human diet in many parts of Latin America, Africa and Asia. Though many people in these regions (Latin America, Asia and Africa) live below the poverty line on a global scale; which is a daily income less than US$1.90 as such they are not able to secure adequate and quality food resulting in under nutrition particularly protein deficiency, hence the consumption of insects has the ability to alleviate hunger worldwide. Eating edible insects responsibly and in a healthy manner has become a common way alleviate poverty. Because of their high nutritional value edible insects provide an affordable and effective means to upgrade the livelihoods of the poor. The accustomed diets of developing countries are often deficient in essential nutrients such as proteins, vitamins and minerals. Most of the times they are not able to afford farm products like domestic animals and vegetables. Insects, on the other hand, are normally affordable but with the nutrients that are lacking in conventional diets (Tang et al., 2019).

2.5.2 Insects as feed

Kenya, although one of the few African countries with a highly developed animal feed sector, is nevertheless unable to sustain itself. Imports account for up to 40 percent of the total feed demand. Therefore the use of insect as feed could realize the unfulfilled demand (Abro et al., 2020). For a long time edible insects have been used livestock and aquaculture feeds, particularly in the tropics. Poultry fed on insects showed high growth rate, less susceptible to pathogens, and are more nutritional than those fed by plant based protein (Jozefiak et al, 2016). Insects contain valuable nutrients with fats, beneficial amino acids and micronutrients. Because insects can be mass produced sustainably in different methods they are a good alternative protein source (Chia et al, 2020).

With the rising cost of feed ingredients around the world, the industry is exploring new protein sources. The cost of feeding farmed animals on conventional feeds that are made of soy, fish meal, fish oil etc. is becoming increasingly difficult for industries. There is a lot of interest in finding replacement for these high-priced

ingredients by using Black soldier fly larva, maggots and yellow mealworm (Van Huis, 2012). Insect meals can give sufficient nutrients at relatively low cost. In developing nations, the traditional utilization of edible insects as feed and food keep on providing rural communities with important benefits; nutritional, economic and ecological. There are over 200 million Africans that consume insects on regular basis. Studies have shown that insects play a vital role in different food systems. They can provide a direct input to food and nutrition security through their high protein and calorie content and the income generated from their trading is overly important as an indirect contribution to food security (Raheem et al., 2019).

2.6 Perception and Attitude towards Entomophagy

The introduction of food that is not common can bring about mixed feelings which can either be positive or negative. People are always willing to try out new food products, though they are still concerned about the chemical and microbiological health risks that insects may pose (Imathiu, 2020). Food texture and appearance are the main attributes that influence the acceptability of food. The outer appearance of insects cause discomfort to people who attempt to consume them. Thus making it an important barrier to their acceptance as a food product (Bartkowicz, 2017). Therefore it is crucial to change the perspective of people towards entomophagy before they are subjected to edible insects. In most cases feelings of anxiety and non-acceptance known as neophobia is triggered whenever a new food product is introduced in a society. People are knowledgeable about the nutritional benefits of insects however there is a contradiction with regard to their viewpoint towards them. Hence it is necessary to understand people's perceptions on entomophagy in order to surpass the behavioural impediments related to the consumption of edible insects (Wilkinson et al., 2018).

A research by Yuksel and Canhilal (2018), carried out in Turkey revealed that the respondents were not prepared to consume insects. A major reason for the rejection of edible insect was the feelings of disgust. It was also discovered that tradition has a great impact on the feeling of disgust and attitude towards edible insects. In certain societies, anxiety is connected to insect as well as being regarded as distasteful by the community. Despite that, community perception can still be persuaded and changed with time like in the event of other foods such as sushi. In an Italian study by Sogari *et al* (2017), young people were curious and willing to consume edible insects but they feared disapproval from their family members and friends. Social influence has a major effect on consumer willingness to eat edible insects. Data highlight that pessimistic judgments that we get from our peers and relatives regarding entomophagy are significant, they can hinder an individual from incorporating edible insects in their diets.

Vaccaro *et al* (2019) explained that insects are seen as pests and quite a few of them are found around decomposing matter, as such depicting an unclean, unhygienic and disease causing images that induce distasteful and negative responses towards them, consequently rejecting them as food. Even though entomophagy is being practiced in Africa, there is some high level of non-acceptance by some communities because of the negative perception that is associated with their physical appearance. In a research study carried out by Ghosh *et al* (2020) in Ethiopia and Korea it was shown that the respondents from Ethiopian were not ready to accept insects as human food unlike the Koreans. The main reason was little or no knowledge about insects being used as food as well as issues of culture and religion. The findings showed that at least the elderly population of 50 years of age in Ethiopia had a bit of knowledge on the consumption of insects than the younger generation. In some perspectives consumption of insects is connected to hunger and lack of other proteins such as meat and fish. In a study conducted in Zambia it was noted that eating of edible insects was influenced by social class. People who considered themselves wealthy, educated especially urban dwellers viewed consumption of edible insects as a practice for the poor. The respondents indicated that entomophagy have many benefits but it was associated with poverty. They explained that they consume edible insects when there are no other food options (Stull et al., 2018).

Rural areas of developing countries are mostly blessed with unique and abundant biodiversity. But in most cases the populations have challenges of food insecurity and malnutrition. Vihiga County, Kenya is rich in biodiversity however people are not eating diverse and healthy diets (Boedecker, 2016). An inspiring story of a termite farmer, Mr Otendo from Gisambai village indicates the potential of this protein source in the county. In 2015 the farmer was running eight ant hills, which he harvest twice a week, dry fry and take the termites to Mbale for selling. Despite the knowledge and skills Mr Otendo possess to increase food production in the county many members of the community associate termite farming with poverty (FarmBiz, 2019). Nevertheless, it is important that more improved information about the nature, nutritional benefits and food safety should be disseminated to help in bringing positive opinions concerning entomophagy (Orkusz, 2020).

2.7 Theoretical Framework

Socio cultural theory of knowledge, Top down theory of perception and the tripartite model of attitude were used to guide the study. The foundation of socio cultural theory is social constructivist paradigm, which is of the view that through the interrelationships in the society knowledge is formed and shared by individuals. Socio cultural theory assume learning and development as being deeply rooted within social context and it takes place when an individual relate with other people, objects and events in a collective environment. Therefore the human psychological element cannot be segregated from the historical, cultural and social circumstances through which growth occurs (Wang et al., 2013).

Perception takes place when living things comprehend, and arrange impressions in order to create experiences that make sense about the world. The perception process is affected by a person's understanding and acceptance of the stimuli. It is dependent on the individual's ability to absorb data and understanding, people choose what to perceive and often the information is filtered (Pickens, 2016). When it comes top down theory of perception situational information is used to classify data based on knowledge that is already gained. The theory was coined by a Psychologist Richard Gregory (1970), in which he explained that in this kind of situation perception is referred to be a practical activity that is dependent on top down processing. The generated information from the environment through a stimulant is usually difficult to comprehend, therefore high coherence from prior experience or kept knowledge is necessary to make conclusions about the things we recognize (Cagli, 2018).

Attitude is referred to a psychological state that is structured by experiences, putting a powerful change to a person's reaction regarding conditions and objects that are connected. Attitude is described as the continuing collection of emotions, beliefs, and behavior aimed at a particular individual, idea, objects or groups (Jain, 2014). The Tripartite model of attitude comprises of three elements of attitude; feeling, beliefs and behavior.

The first element involves a person's emotions, while the cognitive response is about the individual's beliefs and the last element is about behavioural intention in response to the stimuli from the surrounding (Jain, 2014). Attitude is developed from the cognitive process; this is based on experience and the information that is acquired from people around us and other sources like the media. The element of feelings represents the emotional state of a person which can be positive, neutral or negative. The model shows that the first two elements of knowledge and emotions indicate attitudes but the last component depicts the person's readiness to behave in a certain way with reference to attitude (Sahney, 2017).

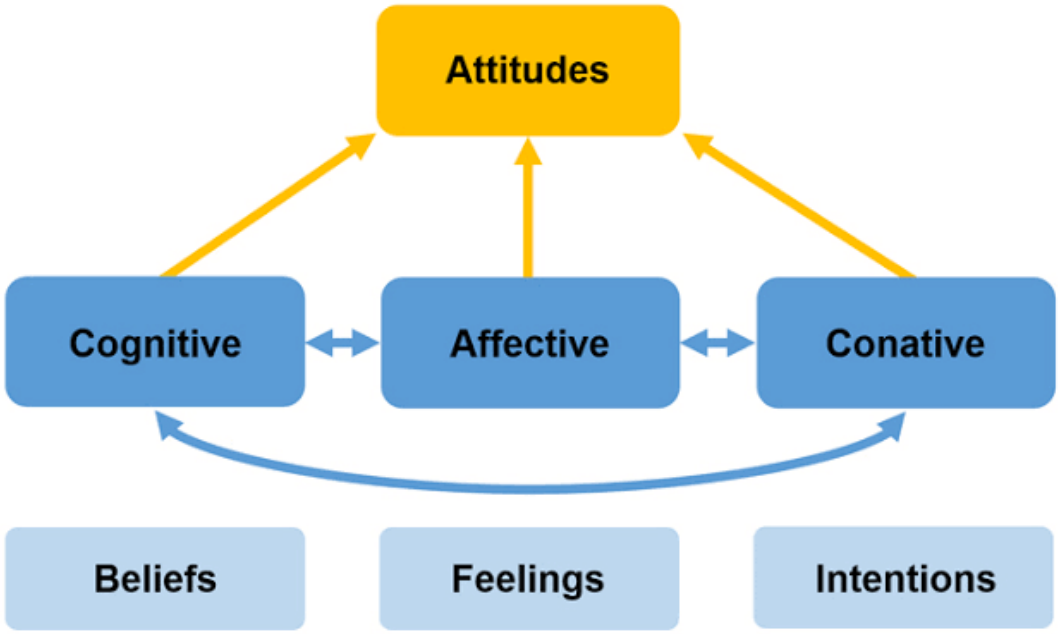

Figure 2: Triapartite Model of Attitude (Sauro, 2019)

The above theories are relevant to the study because through the social setting we acquire knowledge that can influence a person's actions. Since entomophagy is common in Western Kenya, it is assumed that the information regarding the practice is passed from the older generation to the younger generation. The interactions that take place with other members of the community also enable the accessibility of information. They also show that the experiences and knowledge retained influence the interpretation of information, attitudes are formed and consequently the actual behavior with respect to edible insects utilization. To transform the behavior of an individual, there is a need to change their perception through provision of more and better information.

2.8 Conceptual framework

A conceptual framework is an empirical tool for gaining a clear understanding of a phenomenon. It is a visual representation of the key variables and their associations that need to be investigated (Regoniel, 2015). The conceptual framework (figure 3) is showing independent variables in this study were demographic characteristics, knowledge, perception and attitudes while the dependent variable was the utilization of edible insects as food and feed. According to this framework the utilization of edible insects as food and feed by youth is determined by their knowledge, perception and attitude. To understand the actual relationship between the independent variables and the dependent variable gender and extension services were identified as intervening variables.

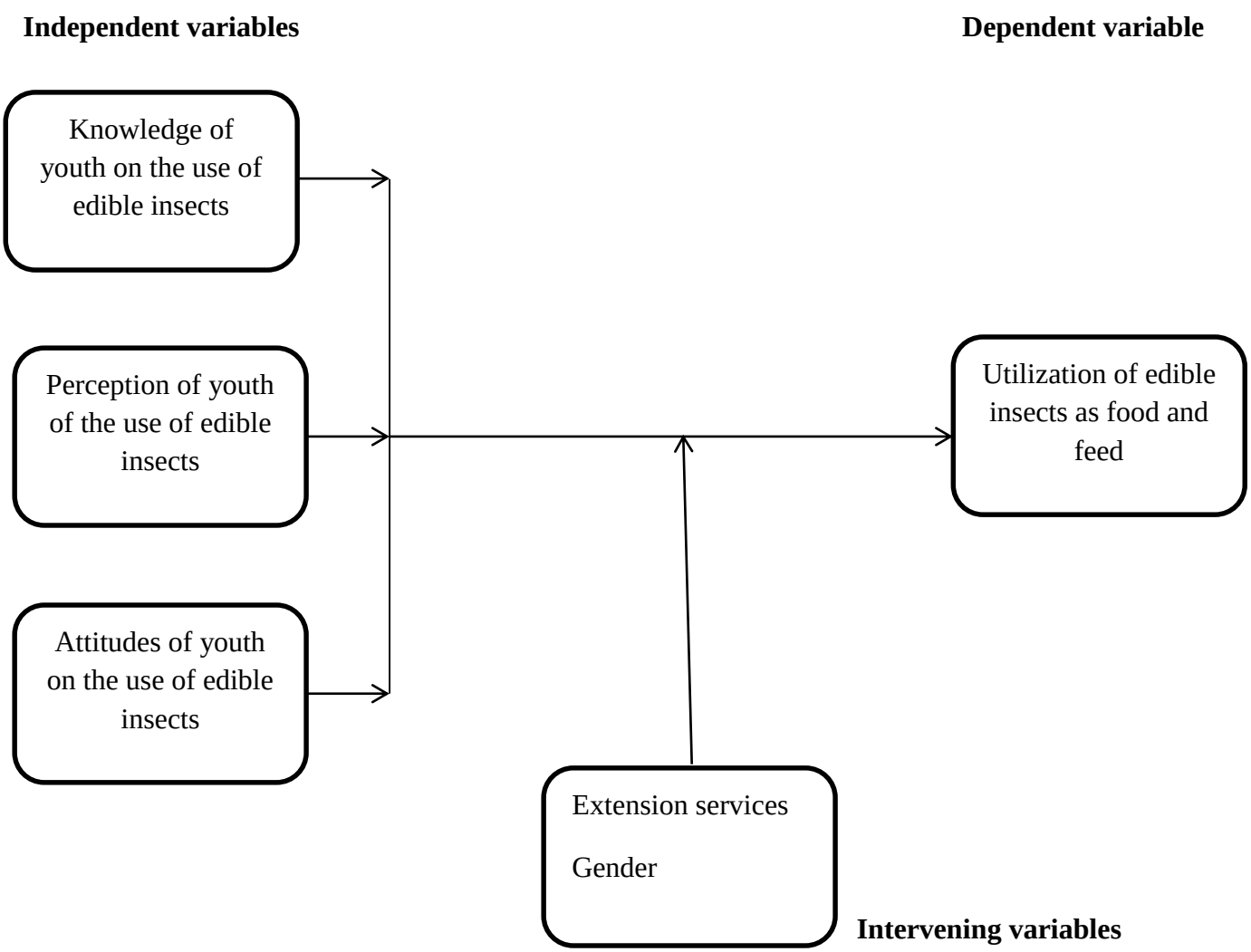

Figure 3: Conceptual framework

Source: Own Conceptualization

CHAPTER THREE
METHODOLOGY

3.1 Introduction

The approach for collecting and analyzing data is described in this chapter. It also include the summary of the research area, sampling technique and data collection method.

3.2 Study Area

The study was conducted in Vihiga County, which is in Western Kenya. There are five sub counties within the County; Vihiga, Luanda, Sabatia, Hamisi and Emuhaya. In conformity with the National Population and Housing census conducted in 2019, the county's population was around 590,013 people (KNBS, 2019). The county has the highest population densities than any other county in the country at 1, 033 persons per square km. Vihiga county population presents a youthful population consisting of 46 percent people aged between 15-35 years. The county is characterized by a beautiful landscape; caves, hills and forests that have the potential to be used for tourism activities. There are many economic activities taking place in the county which include and not limited to agriculture, fishing, timber, mining, tea production and cooperative societies. Vihiga County's economy is mainly from agriculture with about 98 percent of the land used for farming. It is estimated that 85 percent of the population in the county depend on agricultural activities for their livelihood but 65 percent of the population is said to be living in poverty (Ministry of Agriculture, Livestock, Fisheries and Cooperatives, 2017).

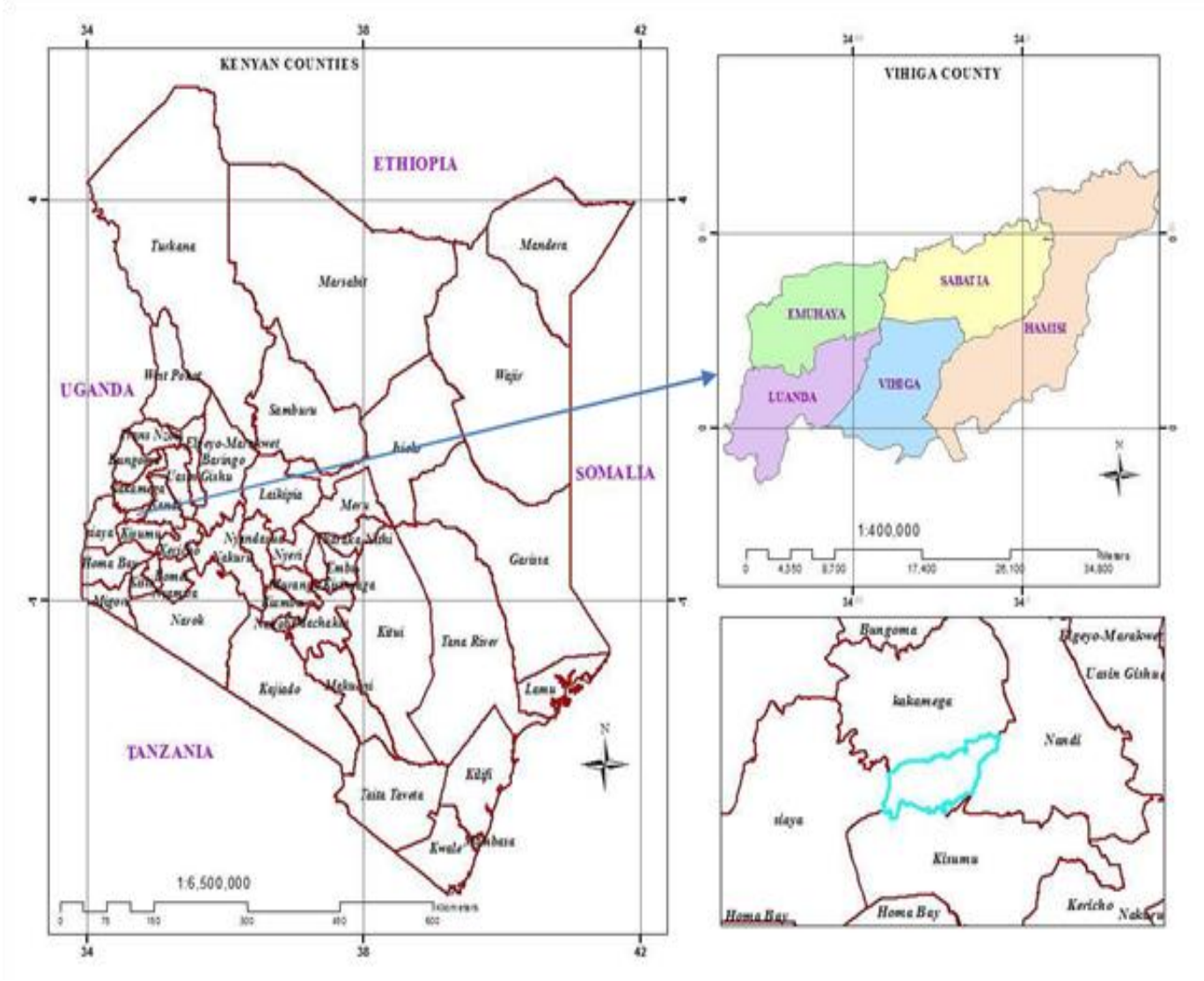

Figure 4: Map of the Study area

Source: County Government of Vihiga (2018)

3.3 Research Design

The study used a survey research design which is common for collecting primary data. Interviews can be conducted through face to face, online or telephone. The survey design use numbers to explain certain characteristics of a particular group of people. Examining the relationship between variables is a common aspect of this design. In surveys generalization is made to the entire population from the information collected from a chosen sample (Glasgow, 2005). This method was appropriate because it enabled gathering of information that described the attitudes, opinions, behaviours or beliefs of the population which cannot be observed directly.

3.4 Target Population

The target population represents the total group of people from which a sample population can be selected. In this case the target population is the youth of Vihiga County. The study applied to all youth both male and female in the area ranging from the age of 18 to 35 years.

3.5 Sampling Procedure and Sample Size

The target population of the study was purposively selected, where by persons of the age bracket 18 to 35 years were considered. This set of age group is what is referred as youth by the Constitution of Kenya (2010). A simple random sampling was used to choose 385 participants for the study, the assumption was that in each household there is a member who is a youth. The sample size was determined using Cochran's formula because the exact population of youth was unknown and the formula is considered appropriate for large population sizes.

Sample size was determined using Cochran's formula (1977):

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where:

p = estimated proportion of the population which has the attribute in question (0.5)

e = margin error (5%)

q= 1- p

$$n_0 = \frac{1.96^2 \ * 0.5 * 0.5}{0.05^2}$$

$$= \mathbf{385}$$

3.6 Research Instrument

Data was collected using a questionnaire with both closed and open ended questions. The survey method use questionnaires as the primary instrument for collecting data. It consisted of a collection of questions designed to elicit knowledge from respondents. The questions were prepared in a simple and concise way and they had a sensible flow. The survey tool was divided into four sections: The first part was based on the respondents' demographic characteristics such as sex, age, education level and so on. The second part entailed questions about general knowledge of edible insects. The questions captured information such as consumption, harvesting, processing and the use of edible insects as food and feed. The third section comprised of identification of edible insects available in Vihiga County, seasonality, time of harvesting and their names in local languages. The last part of the questionnaire collected data on the attitudes and perceptions of participants on the use of edible insects.

3.7 Pilot Testing

A pilot study was conducted before the main survey. A sample of 30 participants with similar characteristics to the target population for the main study was considered appropriate for conducting a pilot study (Hill, 1998). The pilot study enabled the researcher to be familiar with the research instrument, and detecting questions within the research instrument that needed to be amended. This piloting test ensured that questions were simple, understandable and straight to the point for the respondents to therefore improving the instrument's reliability and validity. It also helped in reducing researcher's biasness hence improving the quality and richness of data. Pre testing of the questionnaire also helped the researcher to evaluate the time needed by a respondent to complete the questionnaire. The questions that were found to be understood in a different way during pretesting were phrased to give the same meaning to all respondents and reduce confusion. The pilot study results and respondents were excluded from the main research. The results of the pre-test were not different from that of the final survey hence the instrument used was reliable.

3.8 Validity and Reliability of the Research Instrument

3.8.1 Reliability

Reliability refers to the accuracy of the instrument that is the extent to which the instrument can yield the same results when used repeatedly. A reliable instrument will produce results with little or no errors (Kimberlin & Winterstein, 2008). An instrument is reliable if it can measure a variable accurately and consistently and obtain the same results under the same condition over time. Reliability is to ensure that the set questions or items in an instrument is consistent and has high relatedness in gauging the targeted aims of a study. For the purpose of our study, internal consistency was performed to evaluate the consistency of the test items.

The responses of a pilot test were entered in SPSS to calculate Cronbach's alpha coefficient. The results of the alpha coefficient showed high consistency within the items presented by Table 1.

Table 1: Internal consistency reliability

Variable	Cronbach's alpha
Knowledge	.849
Perception	.715
Attitude	.749
Utilization of insects	.608

3.8.2 Validity

Validity is the degree to which a survey instrument covers the area under study that is it measures what it is supposed to measure. It is the evaluation of how accurate the research instrument is (Taherdoost, 2016). Content and face validity were used for this study. Face validity measures the degree of an instrument at the surface level in the aspects of appropriateness and suitability in relation to the purpose of the study (Heale & Twycross, 2015). Thus the questions which seemed to be misinterpreted were simplified to increase face validity. Content validity focuses on the capacity of the data collection items to collect and represent the data that is being measured (Appelman & Sundar, 2016). It is mostly assessed by using the opinions of experts. Therefore the questionnaire was given to two lecturers in the University for Content Validity before the pilot study. Their advices were considered and research tool was corrected. The pre-test also ensured validity of the research instrument because the same tool was used on the final study.

3.9 Data Collection Procedure

The researcher solicited the necessary authorization from relevant offices in the study area before collecting data. The community leaders of Vihiga County; Chiefs were informed about the research prior to data collection. Data was collected from youth using personal interviews between December 2020 and February 2021. A pre-test was done with 30 participants before the main survey was conducted. A field guide who was a resident of Vihiga County was deployed and helped the researcher with language translations and logistics. The field guide went through induction before data collection to get a better understanding of the purpose of the research thus relevant and quality data was collected. The researcher organized and supervised the entire work; copies of the questionnaire were personally delivered to participants for completion by the field guide; hence face to face interview were done. This method of collecting data was chosen because the questions and concerns of respondents' could be answered immediately by the interviewers, and additional explanations provided in that moment.

The whole questionnaire was translated into Kiswahili, and at some occasions the local languages which included Maragoli, Tiriki and Kinyore, that way the questions retained the intended meaning across all tribes. Youth who showed that they were well informed about edible insects during interviews were chosen for further investigations. Nine people were selected, with three representing each tribe, being Maragoli, Tiriki and Banyore. They were able to help the researcher to answer questions on the types of edible insects available, seasonal availability of edible insects, names in native language and the best time to harvest consumed edible insects in the area.

3.10 Data Analysis

The Statistical Package for Social Sciences version 25 and Microsoft Excel were used to analyze the collected data. The data generated from open ended questions, was analyzed through thematic analysis. Themes were created from the raw data and then coded. The Microsoft excel software was used to analyze the coded data. The data was then tabulated in percentages for better presentation of results. To evaluate the attitudes and perception of youth on the utilization of edible insects as food and feed in Vihiga County, a Likert scale type five-point continuum scale was deployed to measure perception and attitude. The respondents were required to specify the degree of their agreement on each attitude and perception statements. Data analysis was in the form of descriptive statistics in which results of the study were interpreted as frequencies and percentages. The second part of data analysis involved inferential statistics, where Chi-square test was used to determine an association between demographic characteristics and knowledge of youth on edible insects. The effect of knowledge, attitudes and perception of youth on the use of edible insects as food and feed was determined using a logistic regression analysis at 95% confidence level. Variance Inflation Factor test was done to check the degree of correlation among the independent variables. The test was also performed for perception and attitude statements. The results of the test were within the acceptable value (see appendix 3) as indicated by Johnston *et al* (2018) that VIF value which is not greater than 2.5 is desirable.

Therefore, dimension reduction of perception and attitude statements was not required. The regression model predicting the probability of respondent using edible insects as food or feed was as follows:

$$Y = \text{Logit}(P_i) = In\frac{P_i}{1-P_I}) = \beta_0 + \beta_1 X_1 \dots\dots\dots \beta_k X_k)$$

Where:

Y = the probability of youth using edible insects as food or feed

β_0 = constant term

$\beta_{1\text{-}k}$ = the coefficients of the predictor variables

$X_{1\text{-}k}$ = continuous and discrete predictor variables that affect the outcome variable Y

$$\frac{P_i}{1-P_i} = exp^{(\beta_0+\beta_1 X_1)}$$

Where:

$\frac{P_i}{1-P_i}$ = odds ratio

$exp^{\beta_0+\beta_1 X_1}$ = the exponent of the coefficients of the predictor variables

Table 2: Definition of variables in the logistic model

Variable	**Definition**	**Measurement**
Age	Age of participant in years	Categorical- 1 (18-23), 2 (24-28), 3 (29-35)
Gender	Gender of the participant	Dummy- 1 male, 0 female
Marital status	Marital status	Categorical- 1-Singele 2-Married 3-Others
Educational level	Number of years in school	Categorical-1 Secondary, 2-Certificate, 3-Diploma, 4-first Degree, 5- Masters
Employment	Employment status	Categorical- 1 Fulltime, 2-Part time, 3-Self-employed, 4-Unemployed, 5-Student
Familiarity with consumption	Awareness on the consumption of edible insects	Likert- (1- Very aware, 2-Moderately aware, 3- Aware, 4-Not aware)
Availability	Knowledge on the supply of insects at the nearest market	Dummy – 1 Yes, 0 No
Awareness on nutritional benefits	Knowledge on the nutritional benefits of insects to humans	Likert- (1-Very aware, 2-Moderately aware, 3- Aware, 4-Not aware)

Use as feed	Awareness on the use of insects as feed	Dummy- 1 Yes, 0 No
Harvesting	Knowledge /skill on how to collect insects	Dummy- 1 Yes, 0 No
Processing	Knowledge/skill on processing/preparation of insects	Dummy- 1 Yes, 0 No
Extension services	Provision of information and/or training from extension officer about the use of insects	Dummy- 1 Yes, 0 No
Perception	Edible insects are food for rural and poor people Edible insects are destructive pests Eating edible insects is old fashioned Consumption of edible insects is good for the environment Eating edible insects is the same as eating meat It is cheaper to buy edible insects than meat Edible insects are unhygienic and cause diseases They are source of cheap protein for small livestock. Edible insects are food for women and children Edible insects can be a good source of income Edible insects are nutritious It is a health risk to eat edible insects Edible insects provide diversity to food diets	Likert- (1-Strongly Agree, 2-Agree, 3-Neutral, 4-Disagree, 5Strongly Disagree)
Attitude	I can only eat them when used as a food ingredient Eating of edible insects is disgusting	Likert- (1-Strongly Agree, 2-Agree, 3-Neutral, 4-Disagree, 5Strongly Disagree)

	I can only eat edible insects if it is recommended by an official; government, health etc I cannot eat edible insects because my family and friends disapproves. I have been eating edible insects my whole life My religion forbids consumption of edible insects I would rather use edible insects as feed than food	
Utilization	Use of insects as food or feed	Dummy- 1 Yes, 0 No

3.11 Ethical Considerations

The Ethical Review Committee and Board of Postgraduate Studies of Jaramogi Oginga Odinga University of Science and Technology approved the research study. Before completing the questionnaire respondents were required to fill out a consent form that was attached to the questionnaire as such, all respondents who took part in the study were given sufficient information and assurances of anonymity about the study so that they participate voluntarily on the basis of informed consent. The participants were not pressured or coerced to complete the questionnaire, they did it at their own time and pace as such they had the liberty to withdraw from participating at any stage if they wished to do so. The confidentiality of the responses of the participants was guaranteed and privacy was respected.

CHAPTER FOUR
RESULTS

4.1 Introduction

The study analyzed data using a quantitative approach, whereby a descriptive statistics was adopted. Data was summarized and presented in frequency distribution tables and charts.

4.2 Return rate analysis

The return rate refers to the percentage of people who managed to answer and complete the survey from the total number of people who were contacted. Response rate give authenticity to the study and its findings. A high study response rate is crucial to ascertain that the research findings are a representative of the target population and that the questionnaire achieved its purpose, while a low response rate may jeopardize the credibility of the results (Fosnacht et al, 2013). The response rate for this study was calculated after data was collected, it was expected that 385 youth would take part in the study. However, the study did not achieve 100 percent response rate, 270 respondents managed to complete the questionnaires giving 70.1% return rate. Richardson (2005) stated that 50 % and above response rate is regarded as adequate and acceptable in social research surveys, and thus, 70% return rate is considered to be good.

4.3 Demographic characteristics

Table 3 : Demographic characteristics of respondents

Demographic Characteristics	**Frequency (N)**	**Percentage (%)**
Age		
18-23	84	31.1
24-28	97	35.9
29-35	89	33.0
Total	**270**	**100**
Gender		
Male	139	51.5
Female	131	48.5
Total	270	100
Marital status		
Single	166	61.5
Married	102	37.8
Divorced	2	0.7

Total	**270**	**100**
Education level		
Secondary	105	38.9
Certificate	53	19.6
Diploma	48	17.8
Bachelor Degree	59	21.9
Master's Degree	5	1.9
Total	**270**	**100**
Employment status		
Full time	15	5.6
Part time	19	7.0
Self employed	67	24.8
Unemployed	107	39.6
Student	62	23.0
Total	**270**	**100**

The findings revealed that 35.9% of respondents were between 24 and 28 years of age, the age bracket of 18-23 and 29-35 years had 31.1% and 33.0% of respondents respectively. The information on Table 3 shows the distribution of gender of youth in Vihiga County. The results reveal that there were more males at 51.5% than female (48.5%), though the difference was represented by a small margin. Gender of respondents was important in carrying out this research because it can influence the use of edible insects. The study sought to establish the marital status of respondents. It was noted that 61.5% were single while 37.8% were married. Only 0.7% of respondents were divorced. The study found that 61.1% of youth had gone to tertiary; 59.3% were Undergraduates and Postgraduates (1.9%) as shown in Table 2 and lastly 38.9% of respondents had secondary education as their highest level of education. Information in Table 2 also shows that, 39.6% of the respondents were unemployed, 24.8% were self-employed, 23% were students, 7.0% were working on part time basis and only 5.6% of them were employed permanently. This may be due to rural areas having limited employment opportunities.

4.4 Knowledge of youth on the use of edible insects as food and feed

This section presents results on knowledge of youth about edible insects, use of edible insects as food or feed, perception and attitudes of youth on the utilization of edible insects. Knowledge on edible insects was determined using a binary scale of yes and no, a four point Likert scale of very aware, moderately aware, slightly aware and not all aware and some of the answers derived from open ended questions.

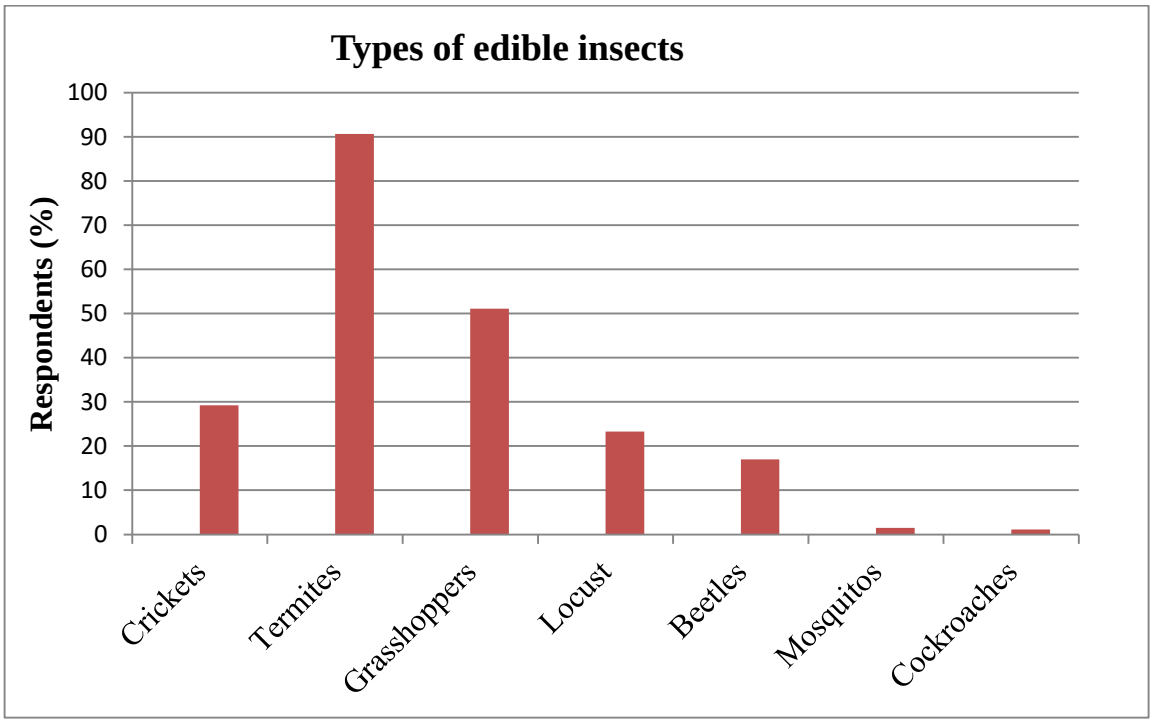

Figure 5: Types of edible insects in Vihiga

Findings in figure 5 show that 90.7% of respondents indicated that termites are available in the area. Other insects included Grasshoppers (51.1%), Crickets (29.2%), Locust (23.3%), Beetles (17%), Mosquitoes (1.5%) and cockroaches (1.1%). This implies that respondents were knowledgeable about locally available edible insects as they were able to identify them.

Table 4: Types of edible insects in Vihiga County: Seasonality and harvesting activities

Insect	Type	Banyore	Tiriki	Maragoli	Seasonal availability	Harvesting time
Termite *(Isoptera spp)*	Worker termite	Amache	Machee	Amage	April-August	Morning & Evening
	Soldier termite	Chingengeni	Mavalu	Tsindago	March-May	Morning & Evening
	Winged termite	Chiswa	Tsiswaa	Tsiswa	March-May	Early morning & Night
	Queen termite	Omwami	Omwami	Umwami	April-August	Anytime of the day
Cricket *(Gryllus sp)*	Field/Black cricket	Esichilili	Vitsinini	Kisili	March-May	Night
Locust *(Locusta migratoria)*	Migratory locust	Chisiche	Tsisichi	Tsisige	March-May	Early morning & Night
Grasshopper*(Caelifera spp)*		Litete	Litakala	Lidede/Lidagala	March-May	Early morning & Night
Beetle *(Scarabaeide spp)*	Dung Beetle larva	Lifunyu	Likunyuli	Ling'unyu	May-October	Morning & Evening
Cockroach *(Periplaneta fuliginosa)*	Smoky brown cockroach	Lichilili	Lisilili	Risiri	All year round	Night
Mosquito *(Culicidae spp)*		Isuna	Tsisuna	Isuna	All year round	Early morning & Night

Youth were able to identify edible insects in their local language as shown in Table 3; this was according to the native sub-tribes in Vihiga County being Banyore, Tiriki and Maragoli**.** The Banyore tribe is made up about 12 clans; Abasiratsi, Abamuli, Abasiekwe, Ababayi, Abakhaya, Abasikhale, Abamutete, Abatongoyi, Abamuhaaya, Aberaanyi, Abamang'ali, Abamuhaando. The Tirki tribe clans include; Bamuli, Bhikhava, Balukhoba, Basamia, Bahaliero, Bajisinde, Baumbo, Bashistungu, Bamoiya, Bamabi, Bamiluha, Balukhombe, Badura, Bamayuda, Barimbuli, Baguga, Basaniaga, Banyonji, and Basuba and the Maragoli are made up of 4 clans; Kizungu, M'wavi, Musaali and Kilima. It was indicated that most edible insects; termites, grasshoppers, locust etc occur during the rainy season of March-May while cockroaches and mosquitos were noted to be available throughout the year. However, high populations of mosquitos appear during rainy season when the conditions are favaourable. This table documented the available edible insects in Vihiga County identified by youth but not necessarily meaning all of them are consumed in the area.

Table 5: Familiarity on the consumption and nutritional benefits of edible insects (%)

Variable	Very aware	Moderately aware	Slightly aware	Not aware
Awareness on consumption	15.9	57.8	25.9	0.4
Awareness on nutritional benefits	5.9	35.2	47.0	11.9

The results in Table 5 shows that 57.8% of respondents were moderately aware about the consumption of edible insects in their area, 25.9% were slightly aware, 15.9 % were very aware while 0.4% of respondents were not aware. This means that majority of youth know about entomophagy to a certain extent. Furthermore, the results indicate that 47.0% of respondents were slightly aware about the nutritional benefits of edible insects, 35.2% fairly knew, 11.9% were not aware at all and 5.9% were very knowledgeable.

Table 6: Awareness on community consumption, availability, harvesting, processing and use of edible insects as livestock feed (%)

Variable	Yes	No	Not sure
Consumption of edible insects by the community	80.7	14.4	4.8
Availability of edible insects in local markets	61.9	38.1	
Harvesting	37.4	62.6	
Processing	57.0	43.0	
Livestock feed	53.0	47.0	

Table 6 indicates that 80.7% of respondents said that their community consumed edible insects, 14.4% indicated that they did not consume while it was noted that 4.8% were not sure whether their community consumed edible insects or not. Majority of the participants (61.9%) indicated that edible insects can be found in local markets while 38.1% showed that they are not aware that edible insects are available in local markets. Stable availability and easy access of a food product is important for its utilisation. Table 6 also shows that 62.6% of respondents did not possess any knowledge and skill on how to harvest any edible insect, while 37.4% indicated that they knew how to harvest. The majority (57%) of respondents agreed that they were able to process edible insects, and 43% did not know how to process edible insects. The findings also reveal that 53% of respondents are aware that edible insects can be used as livestock feed while 47% were not familiar with the practice.

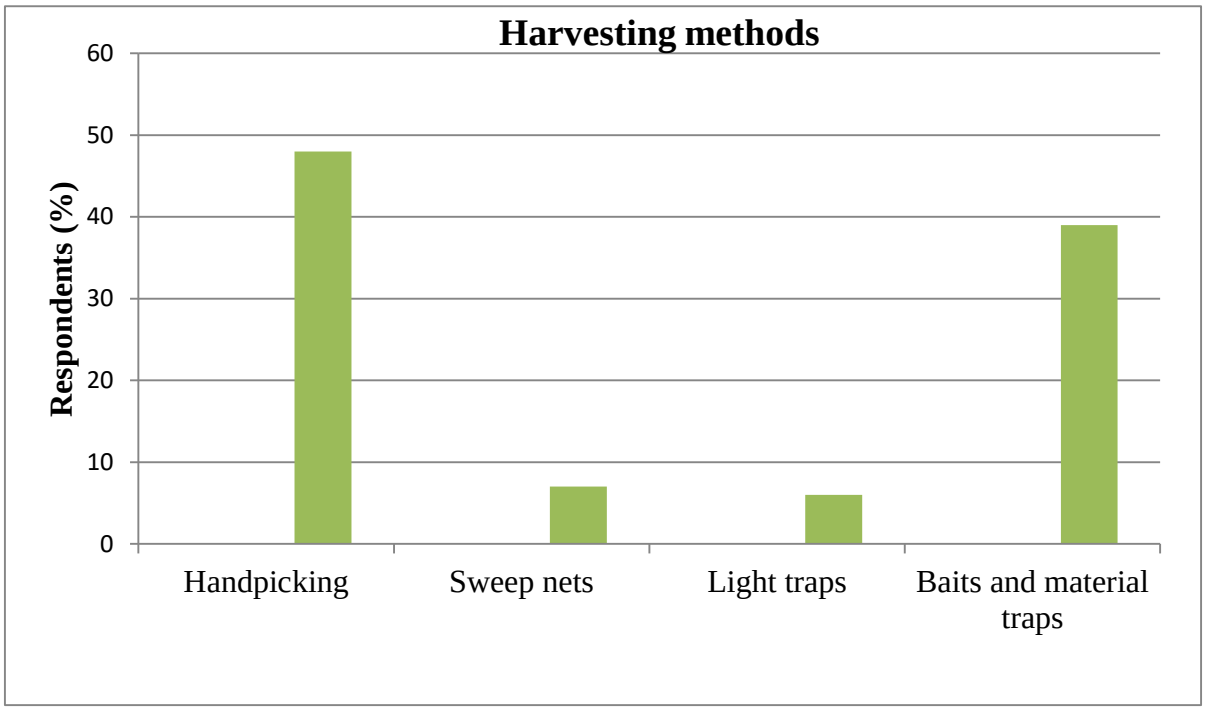

Figure 6: Harvesting methods

Figure 6 shows the common harvesting methods that were used by respondents. Respondents mainly used handpicking (48%) and baits and material traps (39%) to harvest insects. Sweep nets and light traps were also used by 7% and 6% of respondents respectively.

Table 7: Insect processing methods

Processing Method	Frequency (N)	Percentage (%)
Frying	140	51.9
Sun-drying	55	20.4
Grinding	21	7.8
Blanching	2	0.7
Roasting	6	2.2
Sprinkling with salt water	3	1.1

The findings in Table 7 indicate that 51.9% of respondents were using frying method as a way of processing edible insects. This was followed by sun-drying 20.4%, grinding method 7.8%, blanching 0.7% and roasting at 2.2%. The last portion of respondents (1.1%) indicated that they sprinkled edible insects with salt water.

4.4.1 Demographic characteristics influencing knowledge

Table 8: Chi square results between knowledge and demographic characteristics

Variables	n	Value	df	P-value
Familiarity to the consumption of edible insects				
Gender		1.904	1	.593
Male	139			
Female	131			
Age		15.015	6	.020*
18-23	83			
24-28	98			
29-35	89			
Marital Status		7.075	6	.314
Singe	166			
Married	102			
Others	2			
Education level		26.827	12	.008*
Secondary	105			
Certificate	53			
Diploma	48			
First Degree	59			
Master's Degree	5			
Employment		15.518	12	.214
Full time	15			
Part time	19			
Self employed	67			
Unemployed	107			
Student	62			
Availability of insects				
Gender		3.057	1	.080
Age		1.742	2	.418
Marital status		0.165	2	.921
Education level		1.390	4	.849
Employment		4.186	4	.381

Awareness on the nutritional value			
Gender	0.670	3	.299
Age	20.63	6	.002*
Marital status	15.059	6	.020*
Education level	30.101	12	.003*
Employment	26.230	12	.010*
Awareness on the use of edible insects as feed			
Gender	4.181	1	.041*
Age	1.912	2	.384
Marital status	3.081	2	.214
Educational level	7.350	4	.119
Employment	1.655	4	.799
Harvesting knowledge			
Gender	2.283	1	.131
Age	0.086	2	.958
Marital Status	0.391	2	.822
Educational level	6.041	4	.196
Employment	8.478	4	.076
Processing Knowledge			
Gender	0.179	1	.672
Age	1.048	2	.592
Marital status	1.197	2	.550
Educational level	2.466	4	.651
Employment	6.406	4	.171

Note: * *implies statistical significance at 5% level*

Table 8 presents results of a chi-square analysis for demographic characteristics along with proportions for their categories and knowledge indicators. It was observed that age and education level were associated with the familiarity of consumption of edible insects, $X^2(6, N=270) = 15.015$, $p = .020$ and $X^2(12, N= 270) = 26.827$, $p = .008$ respectively. The results showed that age group of 24-28 years and people with qualification of secondary education are more likely to be familiar with use of insects as food. The results also shows that there is a significant association between awareness on the nutritional value of insects with age, marital status, education and employment. The knowledge is likely to be shown by 24-28 years youth, single, and secondary unemployed youth.

It was noted that gender is significantly related to the awareness of the use of edible insects as livestock feed of which the highest proportion is from males, $X^2(1, N=270) = 4.181$, $p = .041$. Males are likely to know about the use of insects as feed more than their conterparts.

4.5 The use of edible insects as food and feed

Table 9: Use of edible insects as food and feed (%)

Variable	Yes	No	Total
Consumption	74.4	25.6	**100**
Livestock feed	23.7	76.3	**100**

From the above Table 9, 74.4% of respondents consumed edible insects, only 25.6% of the respondents indicated that they do not consume. The table also shows that 76.3% of the respondents did not use edible insects as livestock feed while 23.7% fed their livestock with edible insects.

Table 10: Edible insects consumed by youth

Edible insect	Frequency (N)	Percentage (%)
Crickets	7	2.6
Termites	191	70.7
Grasshoppers	44	16.3
Locust	12	4.4
Beetles	0	0

The most commonly consumed edible insect in the area were termites (70.7%) as shown by Table 10. The respondents also showed that they consumed grasshoppers (16.3%), locust (4.4%), crickets (2.6%), and with no response favouring beetles. This may be due to familiarity with termites, as the community is known to be consuming termites more than other edible insects.

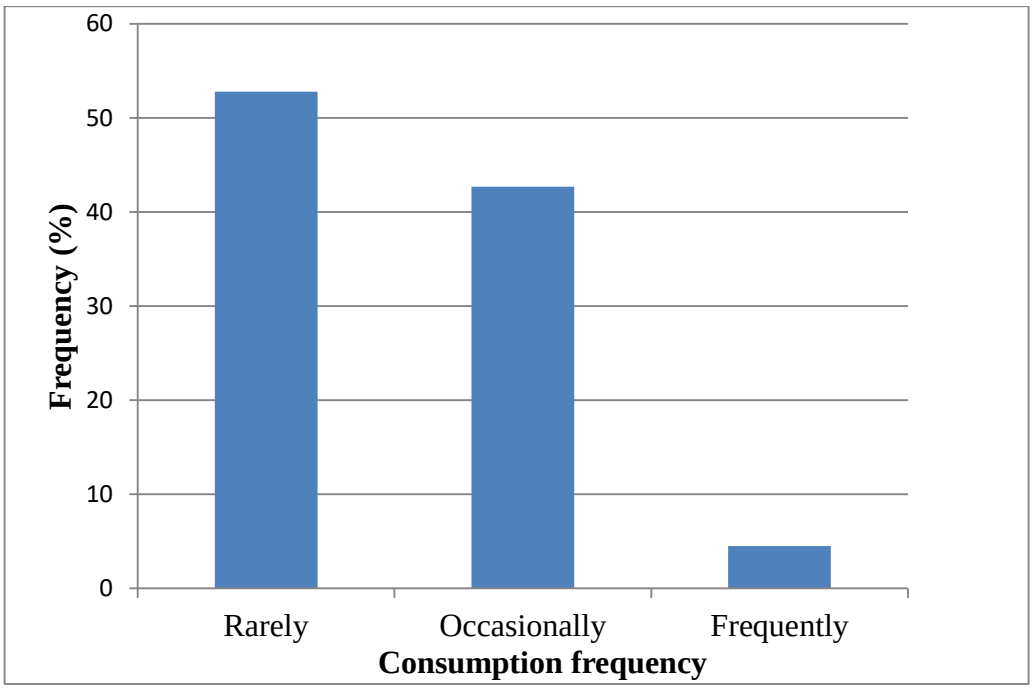

Figure 7: Edible insect consumption frequency

Figure 7 shows that most respondents (52.8%) rarely consumed edible insects. 42.7% consumed edible insects occasionally while 4.5% indicated that they consumed them frequently.This implies that as much as a high number of youth indicated that they cosume edible insects it only happens on a very few occassions.

Table 11: Domestic animals fed on edible insects

Type of animal	Frequency (N)	Percentage (%)
Poultry	62	96.9
Cats and Dogs	2	3.1
Total	**64**	**100**

From the respondents who indicated that they use edible insects as livestock feed, Table 11 shows that 96.9% of the respondents fed their poultry with edible insects while 3.1% indicated that other domesticated animals such as cats and dogs were also fed on grasshoppers and locusts. This is an indication that if edible insects can be extensively explored they can provide good sources of feed to the domesticated animals.

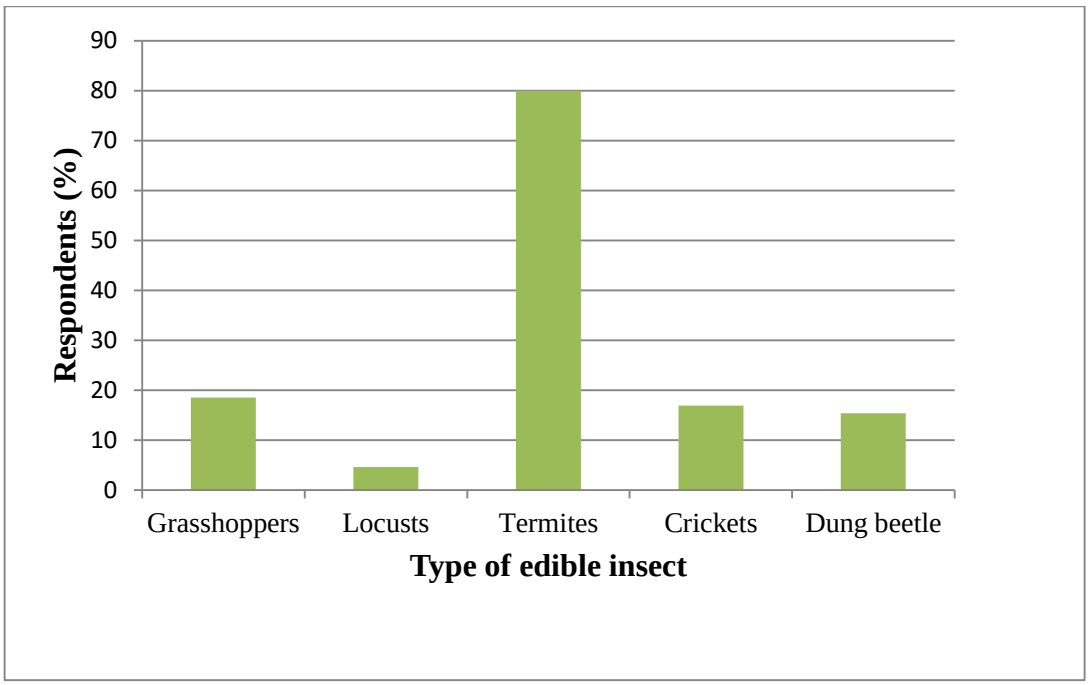

Figure 8: Edible insect used as feed

Figure 8, present edible insects that were used as livestock feed by youth in Vihiga County. Majority of respondents (80%) indicated that they used termites to feed their poultry followed by grasshoppers (18.5%), crickets (16.9%), dung beetle (15.4%) and 4.6% used locust.

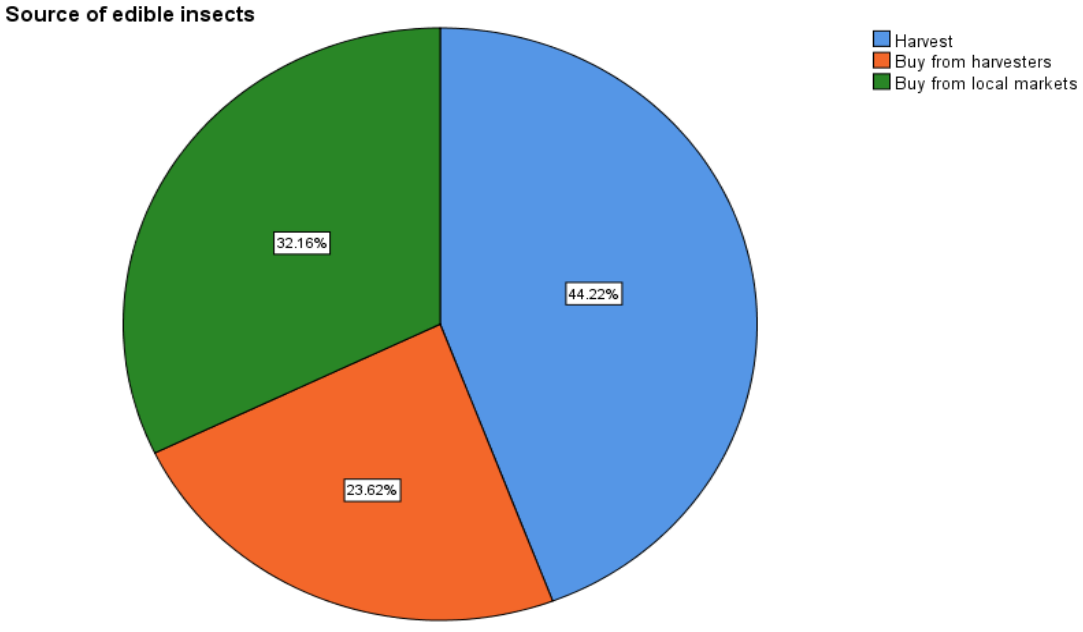

Figure 9: Edible insect sources

Figure 9, present the main sources of edible insects, 44.2% of respondents indicated that they obtained edible insects through harvesting, 32.2% bought from other people who harvest and 23.6% bought from sellers in the local markets. This shows that most youth harvest edible insects from the wild as compared to buying. Proximity to the local markets where those edible insects are available may also contribute to the choice of harvesting.

4.6 Perception of youth towards the use of edible insects

Information in Table 12 show that most youth (43.7%) indicated that edible insects are not food for rural and poor people, 38.9% showed that edible insects are destructive pests. The results indicate that youth believe that entomophagy is not an outdated practice; this was indicated by 38.1% of respondents. 56.3% of respondents considered entomophagy to have a positive effect on the environment, while it was noted that 36.3% showed that eating edible insects is not the same as eating meat. The youth believed (63.7%) that edible insects are more affordable than meat. It was observed that 39.3% indicated that edible insects provided diversity to diets and 45.9% showed that edible insects did not cause diseases. Further, they (48.9%) showed that edible insects are a cheap source of protein to livestock, 51.1% did not think that edible insects are only eaten by women and children. The findings further indicated that 38.1% of respondents see edible insects as a good source of income, 65.9% indicated that insects are nutritious and do not pose any health risk to human beings (37.8%).

Table 12: Perception of youth on the use of edible insects

Statement	SA	A	N	D	SD
Edible insects are food for rural and poor people	28 10.4%	60 22.2%	11 4.1%	118 43.7%	53 19.6%
Edible insects are destructive pests	56 20.7%	105 38.9%	50 18.5%	35 13.0%	24 8.9%
Eating edible insects is old fashioned	22 8.1%	57 18.9%	38 14.1%	103 38.1%	56 20.7%
Consumption of edible insects is good for the environment	48 17.8%	152 56.3%	38 14.1%	28 10.4%	4 1.5%
Eating edible insects is the same as eating meat	19 7.0%	71 26.3%	36 13.3%	98 36.3%	46 17.0%
It is cheaper to buy edible insects than meat	68 25.2%	172 63.7%	11 4.1%	16 5.9%	3 1.1%

Edible insects provide diversity to food diets	23 8.5%	106 39.3%	58 21.5%	69 25.6%	14 5.2%
Edible insects are unhygienic and cause diseases	20 7.4%	38 14.1%	31 21.5%	124 45.9%	57 21.1%
They are source of cheap protein for livestock	67 24.8%	132 48.9%	38 14.1%	25 9.3%	8 3.0%
Edible insects are food for women and children	13 4.8%	41 15.2%	16 5.9%	138 51.1%	62 23.0%
Edible insects can be a good source of income	45 16.7%	103 38.1%	82 30.4%	34 12.6%	6 2.2%
Edible insects are nutritious	51 18.9%	178 65.9%	31 11.5%	9 3.3%	1 0.4%
It is a health risk to eat edible insects	8 3.0%	45 16.7%	52 19.3%	102 37.8%	63 23.3%

Note: *SA- Strongly Agree, A- Agree, N- Neutral, D- Disagree and SD- Strongly Disagree*

4.7 Attitude of youth on the use of edible insects

Majority of respondents (45.2%) were observed that they did consume edible insects as a food ingredient, it was noted 30.0% regarded consuming edible insects as disgusting while 30.0% indicated that consumption of edible insects is not disgusting. 48.1% showed that accessing edible insects was a problem, it was also observed that their decision to consume edible insects was not influenced by government this was indicated by a 48.5% score. It was noted that the choice to consume edible insects by youth was not determined by the approval of their family and friends, indicated by a 67.8% score, 52.2% disagreed that their religion forbids them to eat edible insects. Moreover, the results showed that 43.7% of respondents did not want to use edible insects as livestock feed only, 44.8% indicated that they did not have the necessary information about edible insects in order to use them as food or feed.

Table 13: Attitudes of youth on the use of edible insects

Statement	**SA**	**A**	**N**	**D**	**SD**
I can only eat them when used as a food ingredient	10 3.7%	66 24.4%	45 16.7%	122 45.2%	27 10.0%

Eating of edible insects is disgusting	39 14.4%	81 30.0%	30 11.1%	81 30.0%	39 14.4%
It is difficult to get edible insects for consumption/feed	27 10.0%	130 48.1%	45 16.7%	62 23.0%	6 2.2%
I can only eat edible insects if it is recommended by an official; government, health etc.	11 4.1%	59 21.9%	28 10.4%	131 48.5%	41 15.2%
I cannot eat edible insects because my family and friends disapproves	4 1.5%	17 6.3%	7 2.6%	183 67.8%	59 21.9%
My religion forbids consumption of edible insects	19 7.0%	20 7.4%	6 2.2%	141 52.2%	84 31.1%
I would rather use edible insects as feed than food	16 5.9%	62 23.0%	45 16.7%	118 43.7%	29 10.7%
I don't have the necessary information about edible insects to use them as food/feed	25 9.3%	121 44.8%	55 20.4%	36 13.3%	33 12.2%

Note: *SA- Strongly Agree, A- Agree, N- Neutral, D- Disagree and SD- Strongly Disagree*

Table 14: Overall perception and attitude of youth

Type	**Perception**		**Attitude**	
	(N)	**(%)**	**(N)**	**(%)**
Negative	83	30.7	89	33.0
Positive	187	69.3	181	67.0
Total	**270**	**100**	**270**	**100**

The results of the study in Table 14 indicates that youth generally have positive perception and attitude towards the use of edible insects as food and feed.

4.7 Willingness of youth to use insects

The respondents were requested to indicate whether they are willing to include edible insects as part of their diets and also if they are to use them as an income generating activity. The results are shown below:

Table 15: Willingness to incorporate edible insects in food diets

Willingness	**Frequency (N)**	**Percentage (%)**

Yes	215	79.9
No	55	20.1
Total	**270**	**100**

The results in Table 15 show that most youth are willing to use edible insects as part of their food diets; this is indicated by 79.9% score while 20.1% were unwilling.

Table 16: Reasons for not willing to consume edible insects

Reason	Frequency (N)	Percentage (%)
Familiar with 1 edible insect	4	7.3
Preference	16	29.1
Disgusting	7	12.7
Requires time and energy to get them	6	10.9
Religion	22	40.0
Total	**55**	**100**

Youth who were not willing to consume edible insects indicated that religion (40.0%) was the main reason for their unwillingness as shown in Table 16. To some religions edible insects are regarded as blasphemous, unhygienic and detrimental to health. It was also noted that 29.1% showed that it was due to their food preferences, 12.7% indicated that consuming edible insects was disgusting, 10.9% said that harvesting required time and energy and the remaining 7.3% indicated that they are only familiar with 1 edible insect. Eating one type of edible insect can be monotonous as such causing a decline in the consumption of edible insect.

Table 17: Willingness to use edible insects as a source of income

Willingness	Frequency (N)	Percentage (%)
Yes	204	75.6
No	66	24.4
Total	**270**	**100**

Information in Table 17 indicate that 75.6% of youth were willing to use edible insects as a source of income while 24.4% found the idea not appealing to them.

Table 18: Reasons for not willing to use edible insects as a source of income

Reason	Frequency (N)	Percentage (%)
Seasonality of edible insects	20	30.3

Difficult to harvest	11	16.7
Low populations	17	25.8
Lack of experience in working With edible insects	11	16.7
Requires high capital to start up	1	1.5
No market	6	9.1
Total	**66**	**100**

Respondents gave the reasons in Table 18 for their unwillingness to use edible insects as a source of income. They included seasonality (30.3%), low populations of edible insects (25.8%), not easy to harvest (16.7%), having no experience in working with edible insects (16.7%), no established markets (9.1%) and high capital required to start the edible insects business (1.5%).

4. 8 Factors affecting the consumption of edible insects

A binary logistic regression analysis was used to analyze demographic and knowledge factors affecting the consumption of edible insects. The results of the analysis are presented in Table 19. The consumption of edible insects variable was coded 1 for those who consume and 0 for those who do not consume. The model was statistically significant, $X^2(14, N = 270) = 154.7$, $p < .000$. The variation in the consumption is explained by 43.6% Cox & Snell and 64.2% Nagelkerke and the success rate of model prediction is 87.8%. The Hosmer and Lemeshow test was not significant, $p \geq .585$, thus model fit of the data was considered good.

Table 19: Results of logistic regression for demographics, knowledge and the consumption of edible insects

	Coefficient	**Standard error**	**Significance**	**Odds ratio**
Gender	.163	.454	.743	1.177
Age	-.855	.416	.040*	.425
Marital status	.685	.547	.211	1.983
Education level	-.637	.205	.002*	.529
Employment	-.079	.262	.763	.924
Familiarity on consumption of insects	.462	.383	.228	1.587
Availability in local markets	-1.584	.458	.001*	.205
Awareness on nutritional benefits	-1.051	.404	.009*	.350
Harvesting knowledge	-1.554	.657	.018*	.211

Processing knowledge	-1.890	.507	.000*	.151
Extension services	1.183	1.493	.428	3.263
Perception	-1.199	.583	.040*	.302
Attitude	-1.397	.536	.009*	.247

Note: * *implies statistical significance at 5% level*

Table 19 above shows logistic regression results for consumption of edible insects, demographic characteristics, and knowledge. Age, educational level, availability of insects, awareness on nutritional benefits, harvesting and processing knowledge have a negative significant relationship with the consumption of insects. This implies that that the factors could affect the use of insects as food in reverse. The youth are likely not to eat insects despite having knowledge about their availability, harvesting, processing and nutritional benefits. The results also indicated that as age and educational level the respondent have a high chance of choosing not to eat insects. Perception is statistically significant with a negative relation towards the consumption of edible insects. The odds ratio of perception is 0.302. This indicates that respondent is 0.302 times more likely not to consume edible insects despite having a positive perception towards them. The coefficient of attitude is statistically significant and negatively associated with the consumption of edible insects. High positive attitude is associated with an increase in the likelihood of edible insect consumption. A respondent is 0.247 times likely not to consume edible insects.

4.9 Factors affecting the use of edible insects as feed

The results of regression analysis between the use of edible insects as livestock feed, demographic characteristics and knowledge are shown in Table 13. The model for this analysis was statistically significant, $X^2(13, N=270) = 150.3$, $p < .000$ and the values for Cox & Snell and Nagelkerke were .427 and .642 respectively. The accuracy of the model was at 88.9%. The model fit for the data was good due to the insignificance of the Hosmer and Lemeshow test, $p \geq .470$.

Table 20: Results of a logistic regression for demographics, knowledge and the use of edible insects as livestock feed

	Coefficient	**Standard error**	**Significance**	**Odds ratio**
Gender	.299	.446	.502	1.349
Age	.501	.391	.201	1.651
Marital status	.008	.550	.988	1.008
Education level	-.351	.175	.045*	.704
Employment	-.001	.243	.997	.999
Availability in local markets	.840	.505	.096	2.317

Nutritional benefits	.268	.312	.390	1.308
Harvesting knowledge	-2.846	.500	.000*	.058
Knowledge on use as livestock feed	-5.220	1.141	.000*	.005
Extension services	-2.073	2.145	.334	.126
Perception	.197	.581	.734	1.218
Attitude	-1.351	.541	.011*	.259

Note: * *implies statistical significance at 5% level*

Table 20 shows that the use of edible insect as feed is statistically significant to educational level, harvesting knowledge and knowledge on the utilization of insects as feed. This means that even though a respondent is aware that insects can be used as feed and also having the knowledge and skills to harvest insects there is a low chance of them using the insects as feed. The odds ratio of attitude is (0.259); it indicates that an increase in positive attitude a respondent is 0.259 times less likely to use edible insects as feed.

CHAPTER FIVE
DISCUSSION

5.1 Introduction

Discussion about the study's findings on the knowledge, perception and attitudes of youth towards the use of edible insects as food and feed it is stipulated in this chapter.

5.2 Discussion of the study findings

The utilization of edible insects as food and feed is not a new concept; it is a practice that has been part of the tradition to many communities around the world. They have been primarily used as supplementary food in most African countries (Defoliart, 1995). In this study seven species were found to be available in the area. The natural presence and abundance of edible insects is ascribed to the diversification in the quantity of insects consumed in different countries. Emergence of most edible insects is affected by precipitation hence their abundance during rainy seasons (Ayieko et al., 2010b). Insects and their consumption preferences differ from one area to another that is why in most communities, people do not use all the available edible insects (Fischer & Steenbekkers, 2018). According to Chan (2014) familiarity with entomophagy increases consumer readiness to adopt insects as food. The mostly consumed insects in Southern Africa are termites and mophane worms (Kelemu et al., 2015), edible stink bugs in Zimbabwe (Kunatsa et al., 2020), palm weevil in Ghana (Parker et al 2020), palm weevil, moth caterpillar, rhinoceros beetle in Nigeria (Idowu et al., 2019), and grasshopper, locusts and crickets are common in Japan and Thailand (Feng et al., 2018). The study found that termites were the most abundant and mainly used as food and feed among the youth in Vihiga County.

The most conventional method of collecting insects is from the wild. A wider array of species can be gathered at different developmental phases. Each species' harvesting is distinct and is based on its developmental stage (Mutungi et al., 2019). The present research indicated that early morning and evening were appropriate to harvest most edible insects. This was because insects such as grasshoppers, locusts and crickets are usually not active during those times making it easier to catch those (Sere et al., 2018). Hand picking and simple traps were reported to be mostly used to collect insects. The findings were also reported by (Charkravorty et al., 2019; Meutchieye et al., 2016; Durst & Hanboonsong, 2014). They found that the local people harvested insects through hand picking and traps such as light traps, net traps and water traps etc. According to Chakravorty (2014) the knowledge and skills on harvesting insects is passed from generation to generation. Women are usually responsible for collecting and preparing insects (Mandiretsera et al., 2018). Contrastingly, our findings reported that in terms of youth, males were more involved in harvesting and processing of insects. The current study revealed that the younger generation follow the traditional way of consuming insects; uncooked, fried, roasted and sun-dried. Meyer-

Rochow et al (2021) and Netshifhefhe et al (2018) reported the same results regarding the preparation of insects. The methods used in insects processing and preparation vary from species to species and from culture to culture. Processing makes the insect more palatable and digestible. Certain cooking techniques extend the shelf life of food items, enabling vendors to sell during off-peak times (Melgar-Lalane et al., 2019). We found that the socio demographic characteristics; age, educational level, and gender have significant association with entomophagy knowledge indicators. Higher education improves an individual's awareness and learning capabilities, hence increasing access to nutritional information of new food products (Ayuya et al, 2015). Comparably, Ghosh et al (2020) found that knowledge on edible insects consumption increased with age. In addition the study by Heanult-Ethier et al (2020) demonstrated that males are more likely to be informed about the use of insects as food and feed more than females.

The current study findings show that the utilization of insects is still practiced in Vihiga County. Despite being considered important, there is evidence of decline. The findings indicated that only 4.5% of the respondents consumed insects frequently and 23.7% of the respondents showed that they used insects as feed. Therefore, it is would be appropriate that youth are educated about the importance of entomophagy to improve the acceptance/usage. The study's findings revealed that respondents had a bit of knowledge on nutritional benefits, harvesting, availability and preparation but they were less likely to consume insects or use them as feed. Correspondingly, same results were reported by Sogari et al (2019) in a study to learn more about young Australian consumers' knowledge and attitudes. . Despite knowing about the uses and advantages of edible insects, it was found that the respondents had no intention of consuming them. On the contrary, Chia et al (2020) reported that awareness of the use of insects as feed positively influenced the use of insects. Moreover, Hlongwane et al (2021) that found availability of insects is a primary factor that influences eating of edible insects. Insect usage is declining, and habitat degradation is the cause. Awobusuyi et al (2020) described that insects availability, preference as well as acceptance influence their use. In any event, the diversity of consumption is dependent on the knowledge and culture of the population. If the benefits of an edible species are unknown, even though it may be abundant there, locals may choose not to eat it.

Availability, culture, taste, knowledge of usefulness are among the factors that influence the use of insects as food and feed (Raheem et al., 2019). Our findings reported that socio demographic characteristics; age and educational have a negative influence on the consumption of insects. This finding is in contrast with the study carried out by Liu et al (2020) which was investigating factors that influence Chinese consumers to consume edible insects. They found out that age positively affects the consumption of edible insects.

According to Megido et al (2016) age is related to awareness and experience about the benefits of entomophagy, all of which improve acceptance. Similarly, Education and the eating of edible insects have a negative correlation,

according to Manditsera et al (2018). A probable explanation is that young and educated individuals are profoundly enticed by Western culture, as a result of which they adopt diets and avoid eating traditional foods such as edible insects. The results showed that youth have a positive perception towards edible insects though there is a low chance of consuming them. This is in contrast with Verbeke (2015) study that showed that youth were more likely to consume edible insects due to their positive perception about them. Changing lifestyles and food preferences may be the cause for this outcome. There was no statistically significant relationship between perception and the use of edible insects as livestock feed. The results also indicated that an increase in attitude may influence the respondent not to consume insects. The attitude variable included the feelings of disgust, hence when participants feel/view them as such the chances of eating them become slim. Disgust and other negative emotional associated with insects as food are accompanied by reduced willingness to eat (Gmuer et al., 2016). An individual's willingness to consume edible insects is influenced by their attitude. The finding of the study is in line with Steggerda (2015) who discovered that intensions to consume edible insects was attributed to the attitude towards them. Attitude indicated a negative relationship towards the use of insects as feed. This result is different from Domingues et al (2020) who reported that positive attitudes were connected with the adoption of insects as livestock feed. Additionally, Chia et al (2020) showed that respondents had a positive attitude towards using edible insects as livestock feed.

Moreover, the results indicated that youth were willing to use insects as food and feed. For those who were not willing gave reasons including; seasonality, no experience in working with insects, difficulty in harvesting, low populations of insects, no market and high capital start up. The low populations of edible insects are caused by changing weather patterns hence relying on the insects from the wild may affect business badly. High population of insects are seen during rainy seasons, making the business to bloom at that particular time and go down during the dry season meaning there will be high fluctuations in terms of profits and sustainability of the business is not guaranteed. Due to the deterioration of the ecosystem brought on by the shifts in land use and urbanization, natural environment has been lost (Wagner et al, 2021). The other factor is climate change have increased temperatures and reduced precipitation. This has increased drought periods resulting in reduction of insect availability.

CHAPTER SIX
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter summarizes the research results, as well as conclusions and recommendations derived from the findings. The main purpose of the study was to assess the knowledge, perception and attitude of youth towards the use of edible insects as food and feed.

6.2 Summary of the study findings

The study explored the knowledge, perception and attitude of youth on the use of edible insects as food and feed. Some knowledge indicators were used to determine the level of knowledge of youth on entomophagy. These included the identification of edible insects in the area, familiarity with entomophagy, availability of insects in local markets, awareness on the nutritional benefits, harvesting and preparation. The results showed that youth were able to identify edible insects available in their County. They also indicated a bit of knowledge on the nutritional benefits, familiarity with entomophagy, availability, harvesting and processing. Handpicking, sweep nets, light traps, baits and material traps were some of the harvesting methods used by youth. The processing methods included frying, sun-drying, grinding, roasting, blanching and the use of salt water. The results indicated that youth consume and use edible insects as livestock feed though on occasional basis. Termites were the mostly used insects as both food and feed. Furthermore, the study enquired on the perception and attitude of youth towards entomophagy. The results showed that youth had a positive perception and attitude. A binary logistic regression model was used to determi9ne factors that may influence the consumption and use of insects as feed. The variables include in the model were; age, gender, education level, marital status, employment, familiarity with entomophagy, availability of insects, awareness on nutritional benefits, harvesting, processing knowledge, extension services, perception and attitude. The results showed that age, educational level, availability, awareness on nutritional benefits, harvesting and processing knowledge, perception and attitude could have an influence on the utilization of insects. All the variables showed an inverse relationship with the use of insects as food and feed. Lastly, the results indicated that youth were willing to use insects as food and feed. For those who were not willing gave reasons including; seasonality, no experience in working with insects, difficulty in harvesting, low populations of insects, no market and high capital start up.

6.3 Conclusions

The study found that majority of youth had little knowledge about insects in terms of; consumption, nutrition, harvesting, processing and use as livestock feed. It is noticeable that indigenous knowledge on entomophagy is slowly disappearing with the shift in eating habits and changes in the socio-economic environments. It was established that age, gender and education levels are associated with the awareness of youth on edible insects and

their use. The knowledge of youth was found to have an effect on the utilization of edible insects as food and feed. From the results on perception and attitude it may be concluded that youth have positive perception and attitude towards the use of edible insects as food and feed. Perception and attitude were found to have an effect on the consumption of edible insects and the use of edible insects as livestock feed. Thus the study fails to accept the hypothesis of no relationship between perception, attitude and the utilization of edible insects as livestock feed. According to the results of this study, majority of youth are willing to consume insects and use them as a source of income. Young people are considered to be early adopters of technology. In addition, their food culture is usually not as solid as it is with the older generation. Thus, it would be easy to change the perspective of youth than people who already have established their diet habits and norms. As such, it is imperative that indigenous knowledge is preserved and educational interventions are done to raise awareness on the benefits of entomophagy in order to improve the utilization of insects among the youth.

6.4 Recommendations

Based on the results of this study, the following recommendations are suggested for the improvement of the utilization of edible insects by youth

Institutions working on edible insects to liaise with communities to provide education in order to raise awareness and knowledge on the benefits of entomophagy, train youth on already established farming technologies of edible insects and livestock feed processing techniques.

Introduction edible insect trade policy by government which allows edible insect products in retail shops to improve their accessibility to people.

Edible insect farming business to be included in other farming activities, that way information about it to communities can improve, and can be promoted through extension services. If incorporated and promoted as a potential business financial institutions can also be attracted to provide credit to youth for startups.

6.5 Recommendations for further research

The study recommends further research on:

i. Needs assessment on youth of Vihiga County to adopt the use of edible insects.
ii. The influence of policies and institutions on the utilization of insets as food and feed by youth.
iii. Research that can provide a detailed documentation of the available edible insect species available in Vihiga County can be carried out.

REFERENCES

Abro, Z., Kassie, M., Tanga, C., Beesinamukama, D., & Diiro, G. (2020) Socio-economic and environmental implications of replacing conventional poultry feed with insect based feed in Kenya. *Journal of Cleaner Production, 265*. https://doi.org/10.1016/j.jclepro.2020.121871

Alemu, M.H., Olsen, S.B., Vedel, S.E., Pambo, K.O., & Owino, V.O. (2015). *Consumer acceptance and willingness to pay for edible insects as food in Kenya: the case of white winged termites,* IFRO working paper, No.10. http://hdl.handle.net/10419/204390

Alexandratos, N., & Bruinsana, J. (2012). World agriculture towards 2030/50: the 2012 vision. ESA Working Paper No: 12-03, FAO. https://doi.org/10.22004/ag.econ.288998

Appelman, A., & Sundar, S. S. (2016). Measuring message credibility: Construction and validation of an exclusive scale. *Journalism and mass communicationquartely, 93*(1), 59-79. https://doi.org/10.1177/1077699015606057

Ayieko, M. A., & Oriaro, V. (2008). Consumption, indigeneous knowledge and cultural values of the lakefly species within the Lake Victoria region. *African Journal of Environmental Science and Technology, 2* (10), 282-286. http://www.academicjournals.org/AJest

Awobusuyi, T. D., Pillay, K., & Siwela, M. (2020). Consumer acceptance of biscuits supplemented with a sorghum-insect meal. Nutrients, 12(4): 895. https://doi.org/10.3390/nu12040895

Ayieko, M. A., Oriaro V., & Nyanmbuga, I.A. (2010a). Processed products of termites and lake flies: Improving entomophagy for food security within the Lake Victoria region. *African Journal Food Agriculture Nutrition Development, 10*(2): 2085-2098. https://www.ajol.info/index.php/ajfand//article/view/53352

Ayieko, M. A., Ndong'a M. F. O., & Tamale, A. (2010b). Climate change and the abundance of edible insects in the Lake Victoria Region. *Journal of cell and Animal biology 4*(7), 112–118. Retrieved from https://www.academicjournals.org/JCAB

Ayuya, I. O., Gido, O. E., Bett, K. H., Lagat, J. K., Kahi, A. K., & Bauer, B. (2015). Effect of certified organic production systems on poverty among smallholder farmers: Empirical evidence from Kenya. *World Development, 67*, 27–37. https://doi.org/10.1016/j.worlddev.2014.10.005

Babarinde SA, Mvumi BM, Babarinde GO et al. 2021. Insects in food and feed systems in sub-Saharan Africa: the untapped potentials. Int J Trop Insect Sci. 41: 1923-1951. https://doi.org/10.1007/s42690-020-00305-6

Banks, N. (2016). Youth poverty, employment and livelihoods: social and economic implications of living with insecurity in Arusha, Tanzania. *Environment & Urbanisation, 28*(2), 437-454. https://doi.org/10.1177/0956247816651201

Bartkowicz, J. (2017). Tri-City Consumers Attitudes towards Eating Edible Insect as an Alternative Source of Food. *Handel wewnętrzny, 1*(366):156-166. https://www.researchgate.net/publication/327381837

Beckers, V., Poelmans, L., van Rompaey, A., & Dendoncker, N. (2020). The impact of urbanization on agricultural dynamics: a case study in Belgium. *Journal of Land use Science*, *15*(5): 626-643. https://doi.org/10.1080/1747423x.2020

Bernard, T., & Womeni, M. H. (2016). Entomophagy: Insects as food. *Insect physiology and ecology*. https://doi.org/10.5772/67384

Bessa, L.W., Pieterse, E., Siegge, G., Hoffman, L.C. (2020). Insects as human food; from farm to work. *Journal of the science of food and agriculture, 100*(14): 5017-5022. https://doi.org/10.1002/jsfa.8860

Boedecker, J. (2016). Why community action to improve nutrition in Kenya include a side order of termites. https://www.biodiversityinternational.org

Cagli, R.C. (2018). Law and Neuroscience: Probalistic perception; more and less than meets the eye. https://www.fordham.edu

Castaneda, A., Doan, D., Nguyen, M.C., Uematsu, H., & Azevedo, J. P. (2016). Who are the poor in the developing world? (World Bank Group, Working Paper No. 7844). Retrieved from http://documents.worldbank.org/curated/en/187011475416542282/Who-are-the-poor-in-the-developing-world

Chakravorty J. (2014). Diversity of Edible Insects and Practices of Entomophagy in India: An Overview. *J Biodivers Biopros Dev, 1*(3): 124. https://doi.org/10.4172/2376-0214.1000124

Chakravorty, J., Jugli, S., Boria, M., & Meyer-Rochow, V.B. (2019). Arunachal's Adi and Apatani tribes'traditional knowledge of harvesting and using edible insects. *Journal of Insects as Food and Feed. 5*(2): 125-135. https://doi.org/10.3920/JIFF2018.0019

Chan, C.J. Disgust and the Human Ecology of Insect Consumption: Examining the Barriers to Anthropo-Entomophagy. 2014. Anthropology Senior Theses. Paper 158. http://repository.upenn.edu/anthro_seniortheses/158

Chia, S. Y., Macharia, J., Diiro, G. M., Kassie, M., Ekesi, S., van Loon, J. J. A., Dicke, M., Tanga, C. M. (2020). Smallholder farmers' knowledge and willingness to pay for insect-based feeds in Kenya. *PLOS ONE, 15* (3). https://doi.org/10.1371/journal.pone.0230552

Christensen, D. L., Orech, F. O., Mungai, M. N., Larsen, T., Friis, H., & Aagaard-hansen, J. (2009). Entomophagy among the Luo of Kenya : a potential mineral source ? *International Journal of Food Sciences and Nutrition, 57*(3/4), 198-203. https://doi.org/10.1080/09637480600738252

Conchas, G. Q., & Vigil, J. D. (2010). Multiple Marginality and Urban Education : Community and School Socialization among Low- Income Mexican-Descent Youth. *Journal of Education for Students Placed at Risk, 15*(1/2), 51-65. https://doi.org/10.1080/10824661003634963

County Government of Vihiga. (2018). County Fiscal Strategy paper. https://doi.org/10.0.0.19/handle/123456789/1159

Defoliart GR. 1995. Edible insects as mini-livestock. *Biodiversity & Conservation, 4* (3): 306-321. https://doi.org/10.1007/BF00055976

Domingues, C. H. dF., Borges, J. A. R., Ruviaro, C. F., Gomes Freire Guldolin, D., & Rosa Mauad Carrijo, J. (2020). Understanding the factors influencing consumer willingness to accept the use of insects to feed poultry, cattle, pigs and fish in Brazil. *PL0S ONE, 15*(4). https://doi:1371/journal.pone.0224059

Durst PB & Hanboonsong Y. 2015. Small-scale production of edible insects for enhanced food security and rural livelihoods: experience from Thailand and Lao People's Democratic. *Journal of Insects as Food and Feed. 1*(1): 25-31. https://doi.org/10.3920/JIFF2014.0019

FAO (2006). *Food security*, policy brief, No.2. https://www.fao.org

FAO (2009). The state of Food and Agriculture. https://www.fao.org

FarmBiz Africa. (2019). *Eating termites is healthy and there are people who farm them for ready markets.* https://www.farmbizafrica.com

Feng Y, Chen XM, Zhao M, He Z, Sun L, Wang CY, Ding WF. 2018. Edible insects in China: Utilization and prospects. Insect Science. 25: 184-198. https://doi.org/10.1111/1744-7917.12449

Fischer, G. (2009). *World food and agriculture to 2030/50: How do climate change and bioenergy alter the long-term outlook for food, agriculture and resource availability?* Retrieved from https://www.fao.org>Fscher.-press

Fischer ARH, & Steenbekkers LPA. 2018. All insects are equal, but some insects are more equal than others. British Food Journal. 120(4): 852-863. https://doi.org/10.1108/BFJ-05-2017-0267

Fosnacht, K., Sarraf, S., Howe, E., & Peck, L.K. (2017). How important are high response rates for college surveys? *The review of higher education, 40*(2), 245-265. https://doi.org/10.1353/rhe.2017.003

Ghosh, S., Jung, C., Meyer-Rochow, V. B., & Dekebo, A. (2020). Perception of entomophagy by residents of Korea and Ethiopia revealed through structured questionnaire. *Journal of Insects as Food and Feed, 6*(1), 59-64. https://doi.10.3920/JIFF2019.0013

Gjnerris, M., Gamboigi, C., & Rocklinsberg, H. (2016). Ethical aspects of insect production for food and feed. *Journal of insects as food and feed, 2*(2): 1001-110. https://doi.org/10.3920/JIFF2015.0097

Glasgow, P. (2005). *Fundamentals of survey research methodology*. Retrieved from https://www.mitre.org>technical-papers

Gmuer, A., Nuessli, G. J., Hartmann, C., & Siergriest, M. (2016). Effects of the degree of processing of insect ingredients in snacks on expected emotional experiences and willingness to eat. Food Quality and Preference, 54, 117- 127. https://doi.org/10.1016/j.foodqual.2016.07. 003

Gupte, J., Lintelo, D., & Barnett, I. (2014) *Understanding Urban Youth and the challenges they face in Sub-Saharan Africa: Unemployment, Food Insecurity and Violent crime*. Retrieved from https://gsdrc.org

Hartmann, C., & Siegrist, M. (2017). Insects as food : perception and acceptance Findings from current research. *Ernahrungs Umschau, 64*(3), 44–50. https://doi.org/10.4455/eu.2017.010

Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence-Based Nursing, 18*(3), 66-67. https://doi.org/10.1136/eb-2015102129

Henze, V. (2015). *On the concept of Youth-Some reflections on the Theory*. Retrieved from https://edoc.hu-berlin

Henault-Ethier, L., Marquis, D., Dussault, M., Deschamps, M. H., Vandenberg, G. (2020). Entomophagy knowledge, behaviours and motivations: the case of French Quebeckers. *Journal of insects as food and feed, 6*(3), 245-259. https://doi.org/10.392o/JIFF2018.0039

Hope, R. K. (2012). Engaging the youth in Kenya : empowerment, education, and employment. *International Journal of Adolescence and Youth, 17*(4), 221-236. https://doi.org/10.1080/02673843.2012.657657

Hill, R. (1998). What sample size is enough in internet survey research? *Interpersonal Computing and Technology: An Electronic Journal for 21st Century, 6* (3-4).

Hillingdon Hospitals. (2006). Sampling in Research. Retrieved from https://www.thh.nhs.uk

Hlongwane, Z. T., Slotow, R., & Munyai, T. (2021). Indigenous knowledge about consumption of edible insects in South Africa. *MDPI, 12*(1). https://doi.org/10.3390/insects12010022

Idowu AB, Oliyide EO, Ademolu KO, Bamidele JA. 2019. Nutritional and anti-nutritional evaluation of three edible insects consumed by the Abeokuta community in Nigeria. Int J Trop Insect Sci. 39:157-163. https://doi.org/10.1007/s42690-019-00021-w

Jain, V. (2014). 3D Model of attitude. *International Journal of Advanced Research in Management and Social Sciences, 3*(3). https://www.garph.co.uk

Jideani, A. I. O., & Netshiheni, R. K. (2017). Selected edible insects and their products in traditional medicine, food and pharmaceutical industries in Africa: Utilization and prospects. [e-book]. https://doi.org/10.5772/intechopen.68330

Jodie, L. R., & Brook-Gunn, J. (2016). Evaluating youth development programs: progress and Promise. *Applied Development Science, 20*(3), 188-202. https://doi.org/10.1080/10888691.2015.1113879

Johnston, R., Jones, K., & Manley, D. (2018). Confounding and collinearity in regression analysis: a cautionary tale and an alternative procedure illustrated by studies of British voting behavior. *Qual. Quant., 52*(4), 1957-1976. https://doi.org/10.1007/s11135-017-0584-6

Jozefiak, D., Jozefiak, A., Kieronczyk, B., Rawaski, M., Swiatkiewicz, S., Dlugosz, J., et al. (2016). Insects-a natural nutrient source for poultry: A review. *Annals of Animal Science, 16*(2), 297-313. https://doi.org/10.1515/aoaos-2016-0010

Kelemu S, Niassy S, Torto B, Fiaboe K, Affognon H, Tonnang H, Maniania NK, Ekesi S. 2015. African edible insects for food and feed: Inventory, diversity, commonalities and contribution to food security. J. Insects Food and Feed. 1(2): 103-119. https://doi.org/10.3920/JIFF2014.0016

Kenya National Bureau Statistics. (2019*). Kenya population and housing census: population by county and sub-county, 1*(11). https://www.knbs.or.ke>wpdmpro

Kimberlin, C.L., & Winterstein, A.G. (2008). Validity and reliability of measurements used in research. *American Journal of health system phamarcy, 65*(23), 2276-2284. https://doi.org/10.2146/ajhp070364

Kinyuru, J., Kenji, G. M., & Ayieko, M. (2009). Nutritional potential of longhorn grasshopper (Ruspolia differens) consumed in Siaya District, Kenya. *Journal of Agriculture, Science and Technology,* (11), 32-46. https://journals.jkuat.ac.ke/index.php/jagst/article/view/7

Kinyuru, J. N., Konyole, S. O., Roos, N., Onyango, C. A., Owino, V. O., Owuor, B. O., Estambale, B. B., Friis, H., Aagaard-hansen, J., & Kenji, G. M. (2013). Nutrient composition of four species of winged termites consumed in western Kenya. *Journal of Food Composition and Analysis, 30*(2013), 120–124. https://dx.doi.org/10.1016/j.jfca.2013.02.008

Kuddus, A., Tynan, E., & McBryde, E. (2020). Urbanization: a problem for the rich and the poor? *Public Health Reviews, 41*(1). https://doi.org/10.1186/s40985-019-0116-0

Kunatsa Y, Chidewe C, Zvidzai CJ. 2020. Phytochemical and anti-nutrient composite from\selected marginalized Zimbabwean edible insects and vegetables. J Agric Food Res. 2: https://doi.org/10.1016/j.jafr.2020.100027

Lensvelt, E. J. S., & Steenbekkers, L. P. A. (2014). Exploring Consumer Acceptance of Entomophagy : A Survey and Experiment in Australia and the Netherlands Exploring Consumer Acceptance of Entomophagy : A Survey and Experiment in Australia and the Netherlands. *Ecology of Food and Nutrition, 53*(5), 543–561. https://doi.org/10.1080/03670244.2013.879865

Liu, A., Li, J., & Gomez, M. I. (2020). Factors influencing consumption of edible insects for Chinese consumers. *Insects, 11*(10). https://doi.org/10.3390/insects11010010

Manditsera, F. A., Lakemond, C. M. M., Fogliano, V., Zvidzai, C.J., Luning, P.A. (2018). Consumption patterns of edible insects in rural and urban areas of Zimbabwe: taste, nutritional value and availability are key elements for keeping the insect eating habit. *Food security*, 10, 561-570. https://doi.org/10.1007/s12571-018-0801-8

Melgar-Lalanne, G., Hernandez-Alvarez, A., & Salinss-Castro, A. (2019). Edible insects processing: Traditional and innovative technologies. *Comprehensive reviews in Food Science and Food Safety, 18*(4). https://doi.org/10.1111/1541-4339.12463

Megido, C. R., Sablon, L., Geuens, M., Brostaux, Y., Alabi, T., Blecker, C., & Francis, F. (2016). Edible Insects Acceptance by Belgian Consumers: Promising Attitude for Entomophagy Development. *Journal of Sensory Studies, 29* (1), 14–20. https://doi.org/10.1111/joss.12077

Meutchieye F, Tsafo KEC, Niassy S. 2016. Inventory of edible insects and their harvesting methods in the Cameroon centre region. Journal of Insects as Food and Feed. 2(3): 145-152. https://doi.org/10.3920/JIFF2015.0082

Meyer-Rochow VB, Gahukar RT, Ghosh S, Jung C. 2021. Chemical Composition, Nutrient Quality and Acceptability of Edible Insects Are Affected by Species, Developmental Stage, Gender, Diet, and Processing Method. Foods. 10: 1036. https://doi.org/10.3390/ foods/1005.1036

Min-Harris, C. (2009). *Youth Migration and Poverty in Sub-Saharan Africa : Empowering the Rural Youth*. https://www.du.edu>hrhw

Ministry of Agriculture, Livestock, Fisheries and Cooperatives. (2017). *Role of the Departments in the County's Development agenda*. https://vihiga.go.ke>agriculture

Ministry of Public Service, Youth and Gender Affairs. (2018). *Kenya Youth Development Policy*. www.nationalyouthcouncil.go.ke

Ministry of Youth Affairs. (2007). *Kenya National Youth Policy*, Sessional paper, No. 3. www.csakenya.org

Moore, K. (2005). *Thinking about youth poverty through the lenses of chronic poverty, life-course poverty and intergenerational poverty.* https://www.chronicpoverty.org>5

Mutungi C, Irungu FG, Nduko J, Mutua F, Affognon H, Nakimbugwe D, Ekesi S, Fiaboe KKM. 2019. Postharvest processes of edible insects in Africa: A review of processing methods, and the implications for nutrition, safety and new products development. Crit. Rev. Food Sci. Nutr. 59(2): 276–298.

https://doi.org/10.1080/10408398.2017.1365330

National Council for Population and Development. (2017). *Youth Bulge in Kenya: A blessing or a curse*. https://www.ncpd.go.ke

Obopile, M., & Seeletso, T.G. (2013). Eat or not eat: an analysis of the status of entomophagy in Botswana. *Food Security, 5,* 817-824. https://doi.org/10.1007/s12571-013-0310-8

Orkusz, A., Wolanska, W., Harasym, J., Piowowar, A., & Kapeko, M. (2020). Consumers' Attitudes Facing Entomophagy: Polish Case Perspectives. *International Journal of Environmental Research and Public Health, 2427*(17). https://doi:10.3390/ijerph17072427

Pambo, K. O., Okello, J. J., Mbeche, R., & Kinyuru, J. N. (2016). *Consumer Acceptance of Edible Insects for Non-Meat Protein in Western Kenya*. Paper presented at the African Association of Agricultural Economists (AAAE) conference, Addis Ababa, Ethopia. https://www.researchgate.net/publication/310600251

Parker ME, Zobrist S, Lutterodt HE, Asiedu CR, Donahue C, Edick C, Mansen K Pelto G, Milani P, Soor S, et al. 2020. Evaluating the nutritional content of an insect-fortified food for the child complementary diet in Ghana. BMC Nutr. 6(7): 1-11. https://doi.org/10.1186/s40795-020-0331-6

Pickens, J. (2016). *Attitudes and Perceptions*. https://www.researchgate.net/publication/267352543

Raheem, D., Carrascosa, C., Oluwole, O. B., Nieuwland, M., Saraiva, A., Millán, R., & Raposo, A. (2019) Traditional consumption of and rearing edible insects in Africa, Asia and Europe. *Critical Reviews in Food Science and Nutrition, 59*(14), 2169-2188. https://doi.org/10.1080/10408398.2018.1440191

Regoniel, P. (2015). Conceptual framework: A step by step guide to how to make one[Blog Post]. In research-based Articles. https://simplyeducate.me/2015/01/05/framework-guide/

Richardson, J. T. E. (2005). Instruments for obtaining students feedback: a review of the literature. *Assessment and evaluation in higher education, 30* (4), 387-415. https://dx.doi.org/10.1080/02602930500099193

Roser, M., Ritchie, H., Ortiz-Ospina, E., & Rodes-Guirao, L. (2013). World population growth. https://ourworldindata.org/wolrd-population--growth

Sahney, S. (2017). *Consumer behavior*. https://researchgate.net>3173

Sauro, J. (2019). *Do attitudes predict behavior?* https://measuringu.com/attitudes-behavior

Schardong, I.S., Freiberg, J.A., Santana, N.A., & Richards, N.S.P. (2019). Brazillian consumers' perception of edible insects. *Ciencia Rural, 49*(10). https://doi.org/10.1590/0103-8478cr20180960

Sere, A., Bougma, A., Ouilly, J. T., Traore, M., Sangae, H., Lykke, A. M., Ouedraogo, A., Gnankine, O., Bassole, I. H. N. (2018). Traditional knowledge regarding edible insects in Burkina Faso. *Journal of Ethnobiology and Ethnomedicine, 14* (59). https://doi.org/10.1186/s13002-018-0258-z

Sherrod, L. R., Flanagan, C., & Youniss, J. (2010). Dimensions of Citizenship and Opportunities for Youth Development : The What, Why, When, Where, and Who of Citizenship Development. *Applied Developmental Science, 6*(4), 264-272. https://doi.org/10.1207/S1532480XADS0604

Sommers, M. (2010). Urban youth in Africa. *Environment and Urbanisation*, *22*(2), 317–332. https://doi.org/10.1177/0956247810377964

Sogari, G., Menozzi, D., & Mora, C. (2017). Exploring young foodies ' knowledge and attitude regarding entomophagy : A qualitative study in Italy. *International Journal of Gastronomy and Food Science, 7*(2017), 16–19. https://doi.org/10.1016/j.ijgfs.2016.12.002

Sogari, G., Boguava, D., & Marinova, D. (2019). Australian consumers' response to insects as food. Journal of Agriculture, 9 (108). https://doi.org/10.3390/agriculture9050108

Steggerda, S. (2015). Consumer attitudes towards edible insects. https://edepot.wur.nl

Stull, V. J., Wamulume, M., Mwalukanga, M. I., Banda, A., Bergmans, R. S., & Bell, M. M. (2018). "We like insects here": entomophagy and society in a Zambian village. *Agriculture and human values, 35*, 867-883. https://doi.org/10.1007/s10460-018-9878-0

Taherdoost, H. (2016). Validity and Reliability of the Research Instrument ; How to Test the Validation of a Questionnaire / Survey in a Research. *International Journal of Academic Research in Management, 5*(3), 28–36. Retrieved from https://ssrn.com/abastract=3205040

Tamese, J.L., Kenkeunou, S., Tchatchouang, L.J., Olm, N., Aissatou, L.M., Tombouck, D., & Youssa, B. (2016). Insects as food, traditional medicine and cultural rites in the west and south regions of Cameroon. *JIFF, 2*(3): 153-160. https://doi.org/10.3920/JIFF2015.0088

Tang, C., Yang, D., Liao, H., Sun, H., Liu, C., Wei, L., & Li, F. (2019) Edible insects as a food source: A review. *Food production, processing and nutrition, 1*(8). https://doi.org//10.1186/s43014-019-0008-1

UNESCO. (2019). By youth, with youth, for youth. https://en.unesco.org

United Nations. (2005). Youth in a global Economy, World Youth report. www.un.org

Vaccaro, D, Aderson, K, Clark, L, Gluhosky, E, & Lutch, S. (2019). Inquiries of entomophagy: developing and determining the efficacy of youth-based curriculum. https://scholarworks.umt.edu/uttp/226

Van Huis, A. (2012). Potential of insects as food and feed in assuring food security. *Annual review of Entomology, 58*(1). https://doi.org/10.1146/annurev-ento-120811-153704

Van Huis, A., Itterbeek, J. V., Klunder, H., Mertens, E., Halloran, A., Muir, G. and Vantomme, P. (2013). Edible insects: future prospects for food and feed security [e-book]. www.fao.org

Van Huis, A. (2015). Edible insects contributing to food security ? *Agriculture and Food Security, 4*(20), 1-9. https://doi.org/10.1186/s40066-015-0041-5

Van Huis, A., & Oonincx, D. G. A. B. (2017). The environmental sustainability of insects as food and feed. A review. *Agron. Sustain. Dev, 37*(43). https://doi.org/10.1007/s13593-017-0452-8

Van Huis, A. (2019). Insects as food and feed, a new emerging agricultural sector : a review. *Journal of Insects as food and feed, 1*(1), 1–18. https://doi.org/10.3920/JIFF2019.0017

Verbeke, W. (2015). Profiling consumers who are ready to adopt insects as a meat substitute in a Western society. *Food Qual. Pref.*, 39, 147-155. https://doi.10.1016/j.foodqual.2014.07.008

Vihiga County. (2018). County Integrated Development Plan 2018-2022. Retrieved from https://vihiga.go.ke

Voelker, R. (2019). Can insect compete with beef, poultry as nutritional powerhouses? *JAMA, 321*(15): 439-441. https://doi.org/10.1001/jama.2018.20747

Wagner, D. L., Grames, E. M., Forister, M. L., Berenbaum, M. R., & Stopak, D. (2021). Insect decline in the Anthropocene: Death by a thousand cuts. Proceedings of the National Academy of Sciences of the United States of America, 118(2). https://doi.org/10.1073/pnas.2023989118

Wang, L., Bruce, C., & Hughes, H. (2013). Sociocultural theories and their application in information literacy research and education. *Australian Academic and Research Librabries*, *42*(4), 296-308. https://doi.org/10.1080/00048623.2011.10722242

Wilkinson, K., Muhlhausler, B., Motley, C., Crump, A., Bray, H., & Ankeny, R. (2018). Australian consumers'

awareness and acceptance of insects as food. *Insects, 9*(44), 1-11. https://doi.org/10.3390/insects9020044

Yen, A.L. (2009). Edible insects: Traditional knowledge or western phobia? *Entomological Research, 39*(2009), 289-298. https://doi.org/10.1111/j.1748-5967.2009.00239.x

Yuksel, E., & Canhilal, K. (2018). A survey of public opinion about entomophagy in Erciyes University. *International Journal of Agriculture and Wildlife Science, 4*(2), 203-208. https://dx.doi.10.24180/ijaws.44055

APPENDICES

Appendix 1. JOOUST-BPS letter

JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE & TECHNOLOGY

BOARD OF POSTGRADUATE STUDIES

Office of the Director

Tel. 057-2501804
Email: bps@jooust.ac.ke

P.O. BOX 210 - 40601
BONDO

Our Ref: A451/4130/2019

Date: 8th October 2020

TO WHOM IT MAY CONCERN

RE: KEINEETSE EMELDA MORRIS - A451/4130/2019

The above person is a bonafide postgraduate student of Jaramogi Oginga Odinga University of Science and Technology in the School of Agricultural and Food Sciences pursuing Master of Science in Food Security and Sustainable Agriculture. She has been authorized by the University to undertake research on the topic: ***"Assessing the Knowledge and Perception of Youth on the Utilization of Edible Insects as Food and Feed, Kenya".***

Any assistance accorded her shall be appreciated.

Thank you.

JARAMOGI OGINGA ODINGA
DIRECTOR BOARD OF
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DATE .....
P. O. BOX 210 - 40601, BONDO
UNIVERSITY OF SCIENCE & TECHNOLOGY

Prof. Dennis Ochuodho
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

CHIEF
CENTRAL MARAGOLI LOCATION
Date: 4/11/2020

Appendix 2. JOOUST-ERC letter

JARAMOGI OGINGA ODINGA
UNIVERSITY OF SCIENCE AND TECHNOLOGY

DIVISION OF RESEARCH, INNOVATION AND OUTREACH
JOOUST-ETHICS REVIEW OFFICE

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P.O. BOX 210 - 40601
BONDO

OUR REF: JOOUST/DVC-RIO/ERC/E3

18th March, 2021

Keineetse Emelda Morris
A451/4130/2019
JOOUST

Dear Ms. Morris,

RE: APPROVAL TO CONDUCT RESEARCH TITLED "ASSESSING THE KNOWLEDGE AND PERCEPTION OF YOUTH ON THE UTILIZATION OF EDIBLE INSECTS AS FOOD AND FEED"

This is to inform you that JOOUST ERC has reviewed and approved your above research proposal. Your application approval number is **ERC/17/3/21-14.** The approval period is from 18th March, 2021 – 17th March, 2022.

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations and violations) are submitted for review and approval by JOOUST IERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to NACOSTI IERC within 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks of affected safety or welfare of study participants and others or affect the integrity of the research must be reported to NACOSTI IERC within 72 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to JOOUST IERC.

Prior to commencing your study, you will be expected to obtain a research permit from National Commission for Science, Technology and Innovation (NACOSTI) https:oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

Prof. Francis Anga'wa
Chairman, JOOUST ERC

Copy to: Deputy Vice-Chancellor, RIO Director, BPS Dean, SAFS

Appendix 3. Data Analysis
Variance Inflation Factor

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.334	13	1.795	16.391	.000[b]
	Residual	28.033	256	.110		
	Total	51.367	269			

a. Dependent Variable: Do you eat edible insects?

b. Predictors: (Constant), Att, employment_1, Gender_1, process_1, familiar_1, feed_1, availability_1, education_1, marital_1, harvest_1, Per_2, benefits_1, age_1

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.868	.235		12.186	.000
	Gender_1	.007	.042	.008	.158	.875
	age_1	-.056	.037	-.103	-1.520	.130
	marital_1	.014	.051	.017	.280	.780
	education_1	-.071	.018	-.202	-3.988	.000
	employment_1	-.009	.024	-.023	-.381	.703
	familiar_1	.046	.037	.068	1.216	.225
	availability_1	-.195	.045	-.218	-4.313	.000
	benefits_1	-.084	.033	-.148	-2.529	.012
	feed_1	-.009	.045	-.011	-.211	.833
	process_1	-.216	.047	-.245	-4.618	.000
	harvest_1	-.129	.050	-.143	-2.558	.011
	Per_2	-.145	.052	-.160	-2.757	.006
	Att	-.152	.043	-.199	-3.498	.001

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Gender_1	.921	1.086
	age_1	.466	2.147
	marital_1	.606	1.652
	education_1	.833	1.200
	employment_1	.599	1.668
	familiar_1	.684	1.462
	availability_1	.837	1.195
	benefits_1	.624	1.604
	feed_1	.813	1.231
	process_1	.758	1.319
	harvest_1	.684	1.463
	Per_2	.633	1.579
	Att	.656	1.523

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.198	13	1.631	15.107	.000[b]
	Residual	27.632	256	.108		
	Total	48.830	269			

a. Dependent Variable: Do you practice that use of insect as livestock feed?

b. Predictors: (Constant), Att, employment_1, Gender_1, process_1, familiar_1, feed_1, availability_1, education_1, marital_1, harvest_1, Per_2, benefits_1, age_1

Logistic regression

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	154.675	13	.000
	Block	154.675	13	.000
	Model	154.675	13	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.204	.234		5.153	.000		
	Gender_1	.039	.042	.046	.945	.345	.921	1.086
	age_1	.020	.037	.037	.544	.587	.466	2.147
	marital_1	.057	.051	.067	1.107	.269	.606	1.652
	education_1	-.032	.018	-.094	-1.819	.070	.833	1.200
	employment_1	-.004	.024	-.010	-.161	.872	.599	1.668
	familiar_1	.087	.037	.133	2.344	.020	.684	1.462
	availability_1	.072	.045	.082	1.600	.111	.837	1.195
	benefits_1	-.013	.033	-.023	-.381	.703	.624	1.604
	feed_1	-.350	.044	-.411	-7.877	.000	.813	1.231
	process_1	-.023	.046	-.027	-.503	.616	.758	1.319
	harvest_1	-.359	.050	-.409	-7.191	.000	.684	1.463
	Per_2	-.001	.052	-.001	-.020	.984	.633	1.579
	Att	-.040	.043	-.054	-.927	.355	.656	1.523

a. Dependent Variable: Do you practice that use of insect as livestock feed?

1	152.237[a]	.436	.642

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	6.559	8	.585

Classification Table[a]

			Predicted		
			Do you eat edible insects?		Percentage
	Observed		No	Yes	Correct
Step 1	Do you eat edible insects?	No	47	22	68.1
		Yes	11	190	94.5
	Overall Percentage				87.8

Variables in the Equation

		B	S.E.	Wald	df	Sig.
Step 1[a]	Gender_1	.163	.454	.129	1	.719

	age_1	-.855	.416	4.236	1	.040
	marital_1	.685	.547	1.567	1	.211
	education_1	-.637	.205	9.687	1	.002
	employment_1	-.079	.262	.091	1	.763
	familiar_1	.462	.383	1.454	1	.228
	availability_1	-1.584	.458	11.945	1	.001
	benefits_1	-1.051	.404	6.758	1	.009
	process_1	-1.890	.507	13.878	1	.000
	harvest_1	-1.554	.657	5.596	1	.018
	Per_2	-1.199	.583	4.230	1	.040
	Att	-1.397	.536	6.792	1	.009
	Do you receive any information and/or training from Extension Officers about the use of edible insects as food and/or feed?	1.183	1.493	.628	1	.428
	Constant	19.373	4.362	19.720	1	.000

Variables in the Equation

		Exp(B)
Step 1[a]	Gender_1	1.177
	age_1	.425
	marital_1	1.983
	education_1	.529
	employment_1	.924
	familiar_1	1.587
	availability_1	.205
	benefits_1	.350
	process_1	.151

	harvest_1	.211
	Per_2	.302
	Att	.247
	Do you receive any information and/or training from Extension Officers about the use of edible insects as food and/or feed?	3.263
	Constant	259080590.548

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	150.344	13	.000
	Block	150.344	13	.000
	Model	150.344	13	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	145.382[a]	.427	.642

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	7.638	8	.470

Classification Table[a]

			Predicted		
			Do you practice that use of insect as livestock feed?		Percentage
	Observed		N0	Yes	Correct
Step 1	Do you practice that use of insect as livestock feed?	N0	190	16	92.2
		Yes	14	50	78.1
	Overall Percentage				88.9

Variables in the Equation

		B	S.E.	Wald	df	Sig.
Step 1[a]	Gender_1	.310	.451	.473	1	.492
	age_1	.500	.391	1.633	1	.201
	marital_1	.009	.551	.000	1	.987
	education_1	-.351	.175	4.026	1	.045
	employment_1	.003	.244	.000	1	.990
	availability_1	.822	.517	2.525	1	.112
	benefits_1	.267	.313	.728	1	.394
	process_1	.090	.556	.026	1	.871
	harvest_1	-2.883	.551	27.326	1	.000
	Per_2	.197	.581	.115	1	.734
	Att	-1.351	.541	6.237	1	.013
	Do you receive any information and/or training from Extension Officers about the use of edible insects as food and/or feed?	-2.093	2.148	.949	1	.330
	feed_1	-5.242	1.152	20.713	1	.000
	Constant	14.511	5.519	6.913	1	.009

Variables in the Equation

		Exp(B)
Step 1[a]	Gender_1	1.364
	age_1	1.649
	marital_1	1.009
	education_1	.704
	employment_1	1.003
	availability_1	2.275
	benefits_1	1.306
	process_1	1.094

	harvest_1	.056
	Per_2	1.218
	Att	.259
	Do you receive any information and/or training from Extension Officers about the use of edible insects as food and/or feed?	.123
	feed_1	.005
	Constant	2003996.928