CONSUMER WILLINGNESS TO PAY FOR CHICKEN MEAT DERIVED FROM CHICKEN FED ON INSECT-BASED FEED IN KENYA

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DECLARATION

This thesis is my original work and has not been presented for examination in any university.

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DEDICATION

I would like to dedicate this thesis to my loving parents Mr. and Mrs. Joel Kang'alikya for their tireless encouragement, provision and love in the course of my study.

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ABBREVIATIONS AND ACRONYMS

AKAFEMA	Association of Kenya Feeds Manufacturers
CE	Choice Experiment
CGIAR	Consultative Group on International Agricultural Research
CV	Contingent Valuation
DBDC	Double bounded dichotomous choice
FAO	Food and Agriculture Organization
G.O.K	Government of Kenya
GMO	Genetically Modified Organisms
ICIPE	International Center for Insect Physiology and Ecology
KNBS	Kenya National Bureau of Statistics
PCA	Principal Component Analysis
SBDC	Single bounded dichotomous choice
RUM	Random utility theory
SSA	Sub-Saharan Africa
TAR	Theory of reason action
TPB	Theory of Planned Behavior
TPBFs	Termites based food products
USAID	United States Agency for International Development
WTP	Willingness to Pay

ABSTRACT

Poultry production in Kenya is faced by a major hindrance of feed deficiency, especially protein source. This has resulted in less supply of poultry products which does not match the current growing consumer demand for poultry meat. The growing demand owes to consumer preferences switch from red meat to white meat, population growth and urbanization among other factors. Different protein sources used in poultry production in Kenya include fish fillets and soya which compete with human consumption. Due to competing needs and pricy feeds there has been less protein source for poultry production in Kenya.

In order to upsurge poultry production in Kenya, there is a need to increase protein source and this can be met via different options, one being the introduction of new protein source such as insect-based feed. Commercial rearing of insects as feed for poultry production is presently going on at International Center for Insect Physiology and Ecology (ICIPE) through Improving Livelihoods by Increasing Livestock Production in Africa (ILIPA) project. The project is expected to ensure continued supply of insect-based feed which is affordable. However, before the dissemination of the feed to poultry producers as an alternative protein source, there is a need to know consumer preference and WTP for poultry products derived from insect-based feed.

This study reports finding on consumer WTP for chicken meat derived from chicken fed on insect-based feed in Kenya. The specific objectives were; to assess consumer preferences for chicken meat derived from chicken fed on insect-based feed; to assess consumer awareness of insects as feed; to estimate WTP value for chicken meat and assess factors influencing consumer WTP for chicken meat derived from chicken fed on insect-based feed. In the current study,

poultry meat was represented by chicken meat which provides 72 percent of the total poultry products produced in Kenya. Six hundred and fifty consumers of chicken meat were interviewed in Kenya in different chosen counties.

The study found that half of the consumers were aware that insects are feed for chicken. Most consumers surveyed (68 percent) preferred white meat to red meat. White meat was most preferred because majority of consumers (78 percent) attached nutrition value to it. Almost all consumers, 93 percent, were willing to pay for chicken meat fed on insects as protein source. Consumers who were not willing to pay expressed that the meat was not fit for their health as they perceived some of the insects such black solder fliers and housefly maggots as dirty and unhygienic. In all the study sites consumers were willing to pay a mean amount of KShs. 537.50 per one kg of chicken meat derived from insect-based feed. Consumers in Uasin Gishu had the highest mean amount for WTP of KShs. 605.60, followed by Nyeri County consumers' WTP which was KShs. 505.60. Kakamega County mean WTP price came third at KShs. 473.66 and the least amount was recorded in Kiambu County (460.85). The WTP mean amount differed for the four counties because each county had a different market price for chicken meat. Factors that influenced consumer WTP were consumer's income, consumer preference for chicken meat derived from insect-based feed, crickets as a preferred insect type, black solder fly as a preferred insect type, consumer awareness of black solder fly and cricket, supermarket as a preferred market outlet education level and age. Factors such household size and gender were not significant.

CHAPTER ONE: INTRODUCTION

1.1 Background

The agricultural sector is one of important sectors in Kenya in that it provides the country with a GDP of 22.6 percent (FAO, 2015). It employs 75 percent of 9.2 million person labor force (Kenya Labor Market Report, 2016). Out of this, women make 80 percent of the labor force (FAO, 2013). The main agricultural foodstuffs in Kenya include tea, corn, wheat, sugarcane, coffee, horticulture, dairy products, beef, pork, poultry, and eggs (Kenyan Market Report, 2016). Despite its significance, the growth of Kenya's agriculture sector remains lower than the 6 percent targeted by the government. However, recently, the annual growth rate of the sector rose from 3.5 percent in 2014 to 5.6 percent in 2015 (Kenya National Bureau of Statistics (KNBS), 2016).

Livestock, a subsector of the agricultural sector, accounted for about 12 percent and 40 percent of national GDP and agricultural GDP respectively in 2013 (GOK, 2014). It is a source of food and cash income for over 10 million Kenyans in both the formal and informal sectors (Omiti and Okuthe, 2009). Livestock plays different roles in the household, such as; accumulation of wealth, security against incidents, the production of milk, meat, hides, manure, draught power, as well as display of status (Moll, 2005). One of the value chains of the livestock subsector is poultry which accounts for 0.7 percent GDP and employs three million people in Kenya (GOK, 2012).

The poultry value chain has exhibited slow growth over the past decade (KNBS, 2015). National production of poultry meat in Kenya has increased from 22,000 metric tons (MT) in 2005 to about 22,700 MT in 2014, representing a growth rate of 3 percent in a decade (KNBS, 2015).

This growth is attributed to the commercial production of poultry at smallholder levels and also increasing demand for poultry meat. However, despite the growth in poultry meat production, there is still a poultry meat supply gap (USAID, 2010). A number of reasons have been advanced to explain the shortfall in poultry meat supply. These include weak support services such as, lack of market information, weak policy and regulatory frameworks, low access to financial and technical services, lack of large quantities of feed and costly poultry feed due to high price of feed raw materials (USAID, 2010; Oosthuysen, 2013).

The demand for poultry meat in Kenya has been increasing with increase in population. Also, changes in lifestyles for people in developing countries such as Kenya are geared towards urbanization. This has resulted in higher disposable income and therefore improvement of taste for food and purchase of higher quality products (Sotunde, 2013). Demand for white meat is on the rise compared to red meat as it is a source of protein with lower fat content (Bett et al., 2012). On the other hand, despite red meat containing greater levels of fat it comprises higher levels of vitamins like iron, zinc and B vitamins (Higgs, 2000). Even though red meat has more vitamins and minerals, high intake of it has been linked with increased prevalence of certain cancers, especially colorectal cancer (Higgs, 2000). According to Bett et al. (2012), growth in consumption of chicken is accredited to its perception as a healthy alternative to red meat. According to Delgado et al. (1999), poultry consumption in Kenya is expected to grow at 3.7 percent per annum through 2020, followed by beef at 2.9 percent and pork at 2.4 percent.

Poultry production in Kenya is faced by lack of feed (Oosthuysen, 2013). Feed costs account for over 70 percent of the production costs making it critical for successful poultry production in

Kenya (Mwanzia, 2010). The high cost of feed is due to high cost of ingredients used to manufacture feeds (Munguti and Karisa, 2011). The poultry value chain consumes about 64 percent of commercial feed in Kenya (State Department of Livestock, 2014). The most frequently used protein-rich ingredients in poultry diet are fish and soya bean, sunflower seed and rapeseed (Opiyo et al., 2014). Use of soya bean and fish (*Oreochromis niloticus*) competes with human consumption as a protein source (Opiyo et al., 2014). Hence, there is a need for an alternative source of protein in poultry production.

Insects have been suggested as a viable alternative source of protein for use in poultry production (Verbeke et al., 2015). Studies have shown that insects have more protein and micronutrients such as iron and vitamins compared to fish and soyabean (FAO, 2012; Alemu et al., 2015; Verbeke et al., 2015). Some insect species have been used as an alternative animal feed sources such as *Hermetia illucens* (black soldier fly) and *Musca domestica*, (housefly maggots), commercially produced as feed in France (Veldkamp et al., 2012). Other insects that have been used as a source of poultry and fish feed within African countries include termites (*Isoptera*) in Burkina Faso (Diawara, 2013) and housefly (*Musca domestica*) larvae for chicks and broilers in West Africa (Awoniyi et al., 2003). The use of insect-based feed in poultry production in Kenya could add to the menu of existing sources of protein which could result in meeting the rising demand for poultry meat. Chicken fed on insect-based feed has been shown to be of better texture, better taste, high calcium content and less fat (ICIPE, 2016). Animal proteins are of superior quality than those of plant origin (Ravindran and Blair, 1993). A review by Ravindran and Blair (1993) demonstrated that essential amino acids derived from animal protein supplements are superior in terms of amino acid composition to those obtained from plant

protein supplements in poultry feed formulations. Similar finding were reported by Bukkens (2005) who stated that the amino acid composition of most insects is better than that of legumes or grains. Anand et al. (2008) evaluated four acridid species for their nutritional composition and stated that acridid have a higher proportion of protein content in comparison to conventional fish and soybean meals. The authors concluded that acridid could be used as high protein feed supplement for poultry nutrition. Therefore, chicken fed on insect protein source was expected to be of better nutritional quality than normal chicken fed on fish and soybean protein source. In addition, by feeding insects to chicken, the use of antibiotics in the poultry industry which may lead to human infection with drug resistant bacterial strains may be lessened (Hall et al., 2011). Rearing of insects for use in animal feed is alleged to be a promising venture, though there are risks associated with it. Several studies and reviews about insects as feed for animals and food for persons indicate possible chemical, microbiological and allergenicity risks in both animals and humans (Henry et al., 2015; Charlton et al., 2015). Other risks include deficits in specific amino-acids and complications of digestibility and palatability (Klunder et al., 2012). Most of these challenges are not yet well understood and therefore more research on insects' use as feed is needed.

Consumers have shown to have preferences for insects as feed and food (Kinyuru et al., 2015). For instance, in Kenya *Chironomus plumosus* (Lake Flies), *Isoptera* (Agile termites), *Lasius Niger* (Black ants), and *Caelifera* (Grasshoppers) have traditionally been consumed in some local areas (Kinyuru et al., 2015). Verbeke et al. (2015) found that two thirds of consumers in the study had preferences and favorable attitudes towards the use of insect as animal feed in Belgium. In assessing the potential of edible insects as food and feed, Rumpold and Schluter

(2013) emphasized the necessity of consumer acceptance studies to assess the prospects and challenges in relation to idiosyncratic and economic incentives for uptake and commercialization of edible insects. Food safety issues and processing procedure for transforming insects into protein for poultry feed or for food industry need also to be addressed, since this might influence consumer acceptance for insects as feed or food (Van-Huis, 2013). In the current study, poultry meat was represented by chicken meat because it contributes 72 percent of the total poultry meat produced in Kenya (FAO, 2008).

1.2 Statement of the problem

Poultry feed is one of the most critical inputs that constrains poultry farming among smallholder farmers in Kenya. Feed costs account for over 60 percent of the total cost of poultry production (Opiyo et al., 2014). Currently, the main sources of protein in poultry production are soybean and fish (*Oreochromis niloticus*), which face huge competition from human consumption (Opiyo et al., 2014). In the last five years, the prices of poultry feed have been increasing due to expensive protein ingredients used in feed formulation (AKAFEMA, 2010; Opiyo et al., 2015). Hence, there is need to lessen the current feed costs for increased poultry production, through the introduction of alternative protein sources such as insect-based feed which are affordable and accessible.

Previous studies on acceptance of insects as feed and food confirm that consumers would trust and accept palatable insects for consumption if they get information from particular commercial breeders (Alemu et al., 2015; Verbeke et al., 2015). Another study indicated that generally, consumers are willing to pay for insect-based feed if the nutritional content from the product is

high and satisfying (Rumpold and Schluter, 2013). Alemu et al. (2015) found that acceptance of insects as food in Kenya depended also on the nutritional content from the insects. However, little is known about consumer preferences and acceptance of insects as a feed source. Thus most of the current literature focuses on insects as food and therefore, the current study, unlike the past ones, does not focus on insects as food but as feed. Little is known about consumer willingness to pay (WTP) for chicken meat derived from chickens that have been fed on insect-based feed in Kenya. In addition, consumer WTP for chicken fed on insect-based feed and the factors influencing WTP are not known. This study aimed to fill these gaps in knowledge. It is important to understand consumer WTP for chickens fed on insect-based feed as this will facilitate the introduction of feed made of insect protein in chicken production. It is expected that this will result in increased production and hence supply of chicken meat to meet the growing demand for it in urban set ups.

1.3 Objectives of the study

The general objective of this study was to assess consumer WTP for chicken meat derived from chicken fed on insect-based feed in Kenya. The specific objectives were:

1. To assess consumer awareness of insects as feed for chicken.
2. To assess consumer preferences for chicken meat derived from chicken fed on insect-based feed.
3. To estimate consumer WTP value for chicken meat derived from chicken fed on insect-based feed.
4. To assess the factors influencing consumer WTP for chicken meat derived from chicken fed on insect-based feed.

1.4 Hypotheses

1. Consumers are not aware of insects as feed for chicken.
2. Consumers do not prefer chicken meat derived from chicken fed on insect-based feed.
3. Consumers are not willing to pay any amount to acquire chicken meat derived from chicken fed on insect-based feed.
4. Social-economic, market and institutional factors taken singly have no significant effect on consumer WTP for chicken meat derived from chicken fed on insect-based feed.

1.5 Justification of the study

According to Kenya's vision 2030, the livestock sector is expected to grow and comprise intensive production techniques. One of the vision's highlights in the livestock sector is to promote, regulate and facilitate livestock production for social-economic development and industrialization. Therefore, if insect feed innovation is used in poultry production, this could offset the challenge of protein source in poultry production and thus enable the country to meet the rising demand for poultry products. However, concerns such as consumer acceptance for insect-based feed use in poultry production need to be identified before commercial production of insects as feed and the distribution to poultry farmers. Hence, having a study that assesses consumer WTP for chicken meat facilitates achieving the vision's goal. This is because this study will provide knowledge on consumer preference and WTP for chicken meat derived from insect-based feed, which will influence poultry production.

The information generated by this study on consumer WTP for insect-based feed and factors influencing their WTP can be useful to researchers at ICIPE. It was expected that consumers

were willing to pay for chicken meat derived from insect-based feed. Therefore, this knowledge is useful in the decision to commercialize the rearing of insects and also in guiding the introduction of insect–based feed. Farmers can benefit from this study in knowing consumer preferences, as consumers are expected to have preference for chicken meat derived from insect-based feed. This can be of help to farmers in their decision to either include insect-based feed moreover, the insect types preferred in poultry production or not. The policy makers can benefit from this study in gaining information helpful in designing appropriate policies and supportive mechanism to promote poultry production. This study adds to the existing stock of scientific knowledge in availing information on consumer preferences and WTP for poultry meat derived from insect-based feed in Kenya, which is currently not available. While the above study provides useful insights into consumers' decisions for preference and acceptance of the use of insect-based feed in chicken production, these insights are confined by their narrow focus on an individual consumer rather than social, cultural and environmental contexts within which consumer decisions are made.

1.6 Organization of the Thesis

This thesis is organized as follows: Chapter two reviews relevant literature on consumer preference and awareness of insect-based feed as well as consumer WTP for insects as feed or food. It also provides literature for methods used in empirical work. Chapter three gives details of the analytical framework and the approaches used for data collection and analysis. Chapter four presents the results and discussion from the analysis of consumer socio-economic characteristics as well as their WTP and factors influencing their WTP. In chapter five, a general summary, conclusions and recommendations are presented.

1.7 Limitations of the study

The current study focused on only four counties in Kenya. Therefore, there is a need for further research to capture more information on consumer preference and WTP for chicken fed on insect-based feed in the other excluded counties in Kenya. In addition, the current study was hypothetical and hence was restricted on stated preferences which require carefully designed survey and sampling procedures and therefore, obtaining the data needs a substantial investment of time and resources, hence expensive. Unfortunately, the current study did not have enough funds to acquiring huge sample size and was restricted in resources. Moreover, the current study was limited in knowledge on the adverse effects that prolonged uses of insects have on chicken and consumers. Also, the nutritional composition, bioactive compounds and safety for consumption of different insect species under different dietary conditions needs to be extensively investigated. Hence there is need for future scientific data and research on the use of insects as feed. While the above study provides useful insights into consumers' decisions for preference and acceptance of the use of insect-based feed in chicken production, these insights are confined by their narrow focus on an individual consumer rather than social, cultural and environmental contexts within which consumer decisions are made.

CHAPTER TWO: LITERATURE REVIEW

2.1 Understanding the concept of willingness to pay

Willingness to pay is defined as the sum of money that persons are willing to give up in order to acquire an improved product that meets their desired outcomes (Arrow et al., 1993). It arises when there is new innovation coupled with a shift towards a more consumer/producer demand-driven marketplace (Lusk and Hudson, 2004). The estimates of WTP values have different uses when considered for agribusiness or environmental policy (Lusk and Hudson, 2004). In environmental policy use, the primary objective is to estimate the mean WTP and also aggregate changes in the welfare of the affected parties. This is different in agribusiness which is interested in WTP estimates that can be used to derive compensated market demand for new products.

Zapata and Carpio (2014) demonstrated that the maximum sum of money that a producer is willing to pay for a new product is equal to the perceived variance between the *ex post* and *ex ante* firm's profit levels. The various factors that influence an individual WTP are those linked to their social and economic characteristics and those associated to the attributes of the product (Krystallis and Chryssohoidis, 2005). The consumer will have a zero WTP if the utility he/she perceives to get is less than the amount of money they forego and hence will not be interested in a good/service and vice versa (Herriges et al., 2004). The maximum WTP is considered as an expression of an individual's values about a good or service (Herriges et al., 2004).

2.2 Review of Theoretical Literature

2.2.1 Theories Underpinning WTP

Two dominant theories are used to anchor the concept of WTP. These are the random utility theory or model (RUM) and the theory of planned behavior (TPB). The RUM states that consumers will choose the alternative good or service that maximizes utility (Baltas and Doyle, 2000). Because utility is unobservable, people choose what they prefer and what they do not is influenced by random factors (McFadden, 1973). Thus the utility function of a given choice consists of a deterministic and an error component. This shows that is not possible to forecast with certainty the alternative that the decision maker will choose. Nevertheless, it is possible to express the probability that the perceived value associated with a particular option is greater than other available alternatives (Luce, 1959; Casscetta, 2009).

The RUM is based on revealed preferences for commodities that are already in the market (Herriges et al., 2004). Therefore, RUM is not suitable for a study such as the current one that deals with a commodity that is yet to be availed in the market. Because nonmarket goods are not yet traded on the market, their economic value can be determined based on how much people are willing to pay. Both hedonic prices and travel cost methods are used to estimate the economic value of non-marketed commodities (Herriges et al., 2004). The hedonic price method (HPM) is used in estimating economic values of an ecosystem or environmental services that directly affect market prices. It is often applied to estimate variations in housing prices that reflect the value of local environmental attributes (Taylor, 2003). The travel cost method (TCM) is used to estimate the value of recreational benefits derived from ecosystems (Parsons, 2003). It assumes the value of the site, or its recreational services, is a function of peoples' WTP to get to the site.

It uses actual behavior (revealed choices) to infer values. The basis of the travel cost method is that time and travel expenses incurred by visitors is the "price" of accessing the site. The travel cost method is useful in estimating economic benefits or costs generated by changes in access costs for recreational sites, elimination of existing recreational sites, addition of new recreational sites, or changes in environmental quality at recreational sites (Poor et al. 2004). These two methods (HPM and TVC) were not appropriate for the current study as this study did not analyze economic benefits and costs for chicken meat derived from chicken fed on insect-based feed.

The TPB is derived from the theory of reasoned action (TAR) (Mathieson, 1991). The TAR states that an individual's intention to perform a behavior is determined by two factors, one reflecting his individual interests and the other his social influence (Ajzen and Madden, 1986). This means that the wellbeing of an individual or the utility associated with a particular behavior or choice together with other social characteristics influence an individual's choice to behave in a certain way. The TPB suggests that the performance of a behavior is a joint function of intents and perceived behavioral control (Ajzen, 1991). Intentions capture the motivational aspects that effect a behavior; they show how hard people are willing to try in order to do a behavior. Overall, the sturdier the intention to participate in a behavior the more possible is its performance, since the likelihood of accepting it is high (Ajzen and Madden, 1986). On the other hand, perceived behavioral control refers to people's perception of the ease or difficulty of performing the behavior of interest (Ajzen, 1991). The current study involves a non-marketed commodity, poultry meat derived from insect-based feed; therefore, it used TBP theory that captures behavioral intention. (see details in Chapter 3).

2.2.2 Approaches for measuring WTP

The two general approaches used to estimate WTP are indirect and direct measurements. The indirect approach looks at previous practical choices that comprise trade-offs between money and expected outcomes while the direct measurement of WTP uses survey approaches to elicit stated monetary values for non-marketed goods and services (Turner et al., 2001). The indirect approach uses data on observed behavior while the direct approach simply asks an individual how much he or she is willing to pay for a hypothetical market good (Whittington et al., 1990). In economics, the direct approach is termed as contingent valuation (CV) (O'Brien and Viramontes, 2009). It has utility for use in this study because is based on stated preference for nonmarket goods and services. The most common methods for indirect measure of WTP are conjoint analysis, CV and price tests using a simulated purchase price (Le Gall-Ely, 2009).

2.2.2.1 Conjoint analysis

The term "conjoint analysis" refers to decomposition into part-worth utilities or values of a set of individual evaluations of, or separate choices from, a designed set of multiattribute substitutes (Louviere, 1988). It is a survey-based method often used to obtain consumer perception and preferences for the attributes of a good or a serve (Lancaster, 1966). There are different paradigms used in applying conjoint analysis to study consumers' travel decisions, however, all these paradigms have in common the use of experimental or quasi-experimental design techniques to construct sets of multi-attribute alternatives (Louviere, 1988). Lancaster (1966) theorized that the good/service does not give utility to the consumer *per se*; rather, it is the characteristics it possesses that give rise to utility.

Conjoint analysis is used for measuring an individual's preference for product attributes (Cattin and Wittink, 1982). Product attributes can be considered as assets of probable realizations which are referred to as "attribute levels". The respondent is offered with a number of product outlines consisting of attributes and arranges them according to his or her preference (North and De Vos, 2002). The overall preference assessments are used to make an inference of the comparative contributions of the different attribute levels of the product (Breidert et al., 2006). Breidert et al. (2006) argue that with conjoint analysis, the price is assimilated into the conjoint designs as an additional attribute in order to provide WTP estimations. This, however, leads to three types of problems associated with the inclusion of price attributes in conjoint experiments (Lancaster, 1966). The first problem is that by considering price as an attribute in a conjoint study, part-worth utilities are assessed for price levels, yet, by definition, price does not have utility (Breidert et al., 2006). Rather, the price reveals an exchange rate between different utility scales, indicating that the price of a good does not influence the good's utility (Breidert et al., 2006). Additional problems associated with conjoint analysis include the occurrence of interactions between price and other characteristics which are prospected to arise that violate the additive-compensatory model, and hence, the traditional conjoint analysis does not incorporate a decision rule (Breidert et al., 2006). Conjoint analysis was therefore not applicable in the current study because the elicitation of WTP was not based on attribute levels for the chicken meat derived from chicken fed on insect-based feed.

2.2.2.2 Contingent Valuation (CV)

Contingent valuation is a study-based method for eliciting values people place on goods, services, and amenities (Boyle 2003). It involves survey data, for which an indiscriminate sample of persons are asked to answer a question comprising a hypothetical market transaction with the purpose of eliciting their WTP (Arrow et al., 1993). From an economic point of view, WTP is the variable of interest. The type of data acquired is contingent on the elicitation format. This often entails of presenting the individual under survey with one or a number of prices that she can either accept to pay or not, thus leading to data on WTP (Fernandez et al., 2001).

The estimation of WTP depends on how the data on WTP was elicited (Umberger et al., 2009). Hence, there are different types of elicitation techniques in CV. These include payment cards, closed-ended single-bound dichotomous choice questions, open-ended questions, bidding games, and closed-ended double-bound dichotomous choice questions (Umberger et al., 2002). According to Cameron and Quiggin (1994), several types of bias are minimized by adopting the double-bounded dichotomous choice valuation questions. This is because it uses a follow up question which has been confirmed to improve efficiency in CV models (Haab et al., 2007).

The closed-ended double-bounded dichotomous choice techniques have become a reliable approach in CV studies (Haab and McConnell, 2002). The coefficient estimates from the double-bounded model are asymptotically more effectual than those from the single-bounded model and also yield tighter confidence interval (Hanemann et al., 1991). The CV method of measuring WTP will be employed in the current study through the use of the bidding game to elicit

consumer WTP for chicken meat derived from insect-based feed. This approach was adopted given the hypothetical market setting of the subject matter.

2.2.2.3 Choice Experiments (CE)

Choice experiments are trials of choice sets or choice scenarios drawn from all possible choice sets in an experiment (Hanley at al., 1998). The samples of the experiment are drawn *a priori* according to statistical design principles in such a way that the overall CE contains of a set of choice sets that satisfies certain estimation requirements of certain methods of choice models (Kragt and Bennett, 2011). There are four steps involved in the design of a choice experiment (Alpizar et al., 2001). The first step is definition of attributes and attributes levels. Secondly the experiment is designed. The third stage entails contents of the choice experiment and the preparation of questionnaire while the last stage encompasses the choice of the sample and the sampling strategy (Alpizar et al., 2001).

According to Das (2011), CEs are more accurate than CV in assessing the marginal value of changes in the characteristic of the goods/services. This is regularly a more useful focus from a management or policy perspective than focusing on either the gain or loss of the good, or on a discrete change in its attributes (Das, 2011). CE models are based on attribute theory of value therefor, they are much easier to pool with either site-choice travel cost models or hedonic price models than CV. However, the CE is faced with some disadvantages including that it is extra difficult to derive values for a series of elements executed by policy or project using CE than CV (Navrud, 2004). The CE was not applied in the current study because the study did not focus on samples of the experiment and their attributes.

2.3 Empirical studies on consumer WTP for nonmarket goods in sub-Saharan Africa

Alemu et al. (2015) assessed consumer acceptance and WTP for edible insects as food in Kenya. This study focused on the supply side of insects to establish and optimize the insect production sector and develop the value chain. The study argues that the ultimate success of a product development depends on consumers' product judgment and acceptance and hence sort to acquire information about potential demand of insects as is of paramount importance for policy advice. Consumer preferences and WTP were assessed using a stated-choice experiment method. Results from their latent class model revealed that consumers preferred and were willing to pay more for termite-based food products (TBFPs) in Kenya. About 80 percent of consumers were associated with pro-entomophagy attitude while the rest had food neophobic traits. Irrespective of the tradition of consuming insects, consumers generally preferred TBFPs with high nutritional value suggesting that this attribute was the most vital factor in the use of insects as food. The current study differed with Alemu's because the former did not focus on insects as food *per se* but as a feed source and therefore, an input in chicken production. Alemu's study is relevant to the current study in availing crucial information on importance of insects as either food or feed. In addition, that study contributes useful knowledge on consumer preference for insects and factors influencing their WTP for TBFPs. The knowledge of these factors was useful in designing and identification of useful variables which were considered in the current study.

De Groote and Kimenju (2008) evaluated consumer WTP for genetically modified (GM) food in Kenya. The study assessed urban consumers' WTP for yellow maize and consumer preference for white maize in East and bio-fortified maize in using a semi double-bounded logistic model. The study found that 68 percent of consumers were willing to purchase GM maize meal at

similar price as their preferred maize meal brand. Only a minority would buy yellow maize at the same price as white maize. According to the survey, contrary to expectation, positive benefit perceptions of GM maize were not significant; however the effects of the negative perceptions, health risks, and concerns about ethics and equity were large and significant. Trust in the government's capacity to control and regulate the industry, on the other hand, was a strong positive factor that influenced consumers.

Consumer acceptance of GM maize meal was high in urban areas. De Groote and Kimenju's (2008) study and the current study were similar in assessing urban consumers WTP for new products in the markets. Therefore, this study provides a well-founded methodology on dichotomous choice model in acquisition of consumer WTP prices for insect-based feed. This knowledge was integrated in the current study methodology and also in obtaining the relevant variables. However, the current study differed from the latter as it was based on consumer WTP for insect-based feed and not GM maize.

Erih et al. (2015) examined consumer WTP for the inclusion of cassava flour in bread in Lagos State, Nigeria. A bivariate probit was used to estimate the mean WTP prices and factors influencing consumer WTP. The study found that the factors that influenced consumer WTP for composite cassava-wheat bread were the respondent's age, gender, marital status, household's head position in Nigeria and the proportion of income spent on bread. The current study found Erih's study was useful to the current one in verifying the application of CV method and identification of variables useful in the model. However, the current study and Erih's focused on different commodities; for instance Erih's study focused on cassava while the current study

focused on insect-based feed. The two studies also differ in the application of the statistical model as the current study used double-bounded logit model and the latter used probit model.

Verbeke et al. (2015) assessed the acceptance of as well as the determinants of the use of insects in animal feed among livestock farmers, citizens and other stakeholders, in Belgium using an ordered logit. The study found that the attitude and acceptance towards insects were generally favorable across the respondents. Perceived benefits of using insects in animal feed pertained mainly to lowering the dependency on protein imports and better valorization of organic waste. Benefit perceptions were stronger and outweighed risk perceptions as a determinant of accepting the use of insects in animal feed. However, the strongest determinant of accepting was a person's own willingness to eat insect-based foods. Overall, the study found indicated a positive atmosphere and momentum for change towards the adoption of insects as a new ingredient in animal feed in Belgium. The current study is similar to that of Verbeke et al.'s (2015) as it assesses consumer WTP for insects used as a source of feed as well as the factors influencing WTP. However, Verbeke et al.'s differs with the current one in that the former assessed different stakeholders in the acceptance and consumption of insects as feed and food in Belgium. The current study focused on consumers alone and not combination of different stakeholders in insects use as feed and food. Verbeke et al.'s study also differs with the current study in terms of the study site, as the former was conducted in Belgium while the current one was undertaken in Kenya. The two countries have different socio-economic and demographic settings.

2.4 Role of Insects as feed and food sources

The literature documents on insects as either feed or food. Varieties of insect species are the natural feed source for fish and poultry and can be exploited as feed in poultry production (DeFoliart, 1989; Farinaet al., 1991; Okedi, 1992). The amino acids derived from most insects' protein are superior to those from plant supplements in poultry feed formulations (Bukkens, 2005; Ravindran and Blair, 1993). In addition, various insect species have a higher proportion of protein content compared to conventional fish and soybean meals (Anand et al., 2008). Furthermore, their clean feeding habits and their efficient food conversion factor (Leunget al., 1970; Nakagaki and DeFoliart, 1991) make them a promising commodity to be promoted for feed. Insects also provide a good natural source of animal protein and a sustainable alternative to traditional protein sources for free-range poultry (Hardouin and Mahoux, 2003). For instance, Chitin, a polysaccharide found in the exoskeleton of insects has a positive influence on the functioning of the immune system (FAO, 2014).

Khusro et al. (2012) study on Insects as poultry feed in Australia showed that a number of insects such as silkworms, fly larvae, crickets and grasshoppers can be safely fed to chickens without compromising the quality and palatability of the meat. The survey found that poultry farmers had an acceptance of feeding insects to poultry provided it could be done economically and indicated that insects could be reared and fed on a variety of organic waste materials. However the study stated that the safety and economic viability of breeding and rearing insects on organic waste and feeding to poultry need to be assed. Despite nutritional and environmental benefits attached to insect production there is still much to be explored on insects' use as feed and food. In a preliminary study of the edible stink bug (*E. delegorguei*) (Kelemu et al., 2014), the presence of

alkaloids, flavonoids, anthraquinones, tannins, steroids, triterpenoids and cyanogenic glycosides was detected. However, none of these components was characterized and changes in their levels in different seasons as well as in uncooked and cooked insects, their sources and safety for consumption were not established (Kelemu et al., 2014). To meet the research-for-development agenda and pathways to sustainable use of insects as food, feed and medicinal use, scientific data is required to validate this knowledge.

CHAPTER THREE: METHODOLOGY

3.1 Theoretical framework

Commercial bulk production of insects as feed is an emerging innovation which is in the final stages of development at ICIPE and is yet to be availed in the market. Because the innovation is not yet offered in the market, one cannot observe explicitly the acceptance or purchase decision by the potential consumer. Hence, the purchase decision can only be inferred from the potential consumer's stated preference for chicken meat derived from the insect-based feed, which in turn reveals the acceptance and WTP. In cases where nonmarket goods or services are the subject of the study, the theory of planned behavior (TPB) offers a consistent theoretical basis for assessing the acceptance of the new commodity or performance of a particular behavior (Davis, 1989). TPB asserts that the performance of a behavior is a joint function of *intention* and *perceived behavioral* (Ajzen, 1991). Intentions capture the motivational factors that affect a behavior; they indicate how hard people are willing to try in order to undertake a behavior (Ajzen and Driver, 1992). *Ceteris paribus*, the stronger the intention to participate in a behavior the more likely is its performance (Ajzen, 1991). Hence intention is a strong predictor of behavior (Kalafatis et al., 1991) as displayed in Figure 3.1.

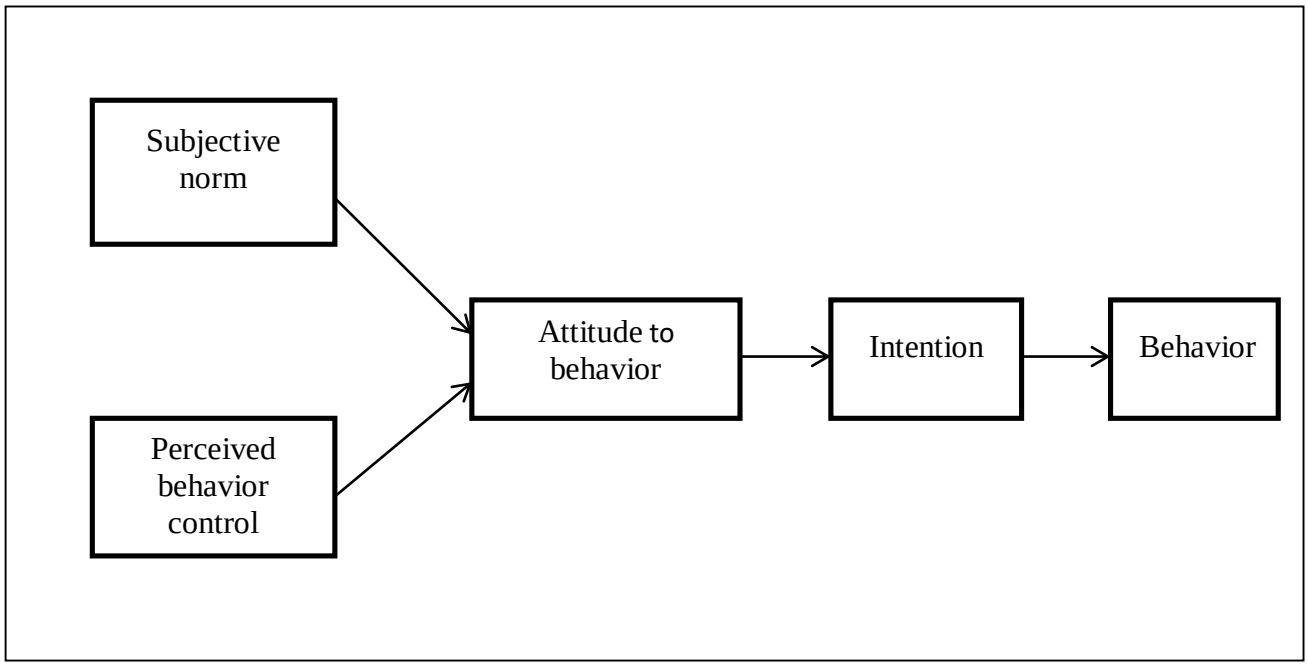


Figure 3.1: Theory of planned behavior

Source: Kalafatis et al. (1991)

Behavioral intention is an outcome of attitude towards behavior, which in turn is an outcome of subjective norm and perceived behavioral control (PBC) (Kalafatis et al., 1991). Perceived behavior control refers to people's perception on the ease or difficulty of performing the behavior of interest (Ajzen, 1991). This means people perceive how their satisfaction will be met depending on the performance of a service or a good of interest. It is include in the TPB model as a determinant of performance of a behavior that has both a direct and indirect effect on behavior intentions (Kalafatis et al., 1991). Subjective norm, on the other hand, is defined as the decision to either take up or reject a good or service (Mueller, 2004). It is based on salient beliefs, also called normative beliefs, about whether a particular referent thinks the respondent should or should not do the action in question (Ajzen, 1991).

Both PBC and subjective norm are in turn determined by fundamental belief structure, namely, control and referent beliefs respectively. Control beliefs are beliefs that deal with the presence or absence of necessary resources and opportunities (Mathieson, 1991). They are based in part on past experience with the behavior, but they will usually also be influenced by second-hand information about the behavior, by the experiences of acquaintances and friends, and by other factors that increase or reduce the perceived difficulty of executing the behavior in question (Ajzen, 1991). Referent beliefs pertain to the focus on the communication, that is, to the object or issue of reference; they are essentially post-comprehension mental phenomena (Heshizer and Wilson, 1995). Referent sources include fathers, mothers, coworkers, and others close to an individual (Heshizer and Wilson, 1995). According to Mathieson (1991), attitude to behavior is defined as an individual's desirability to purchase a given good or service. It is determined by the sum of the expected outcomes of alternatives of a good/service.

In the current study, TPB was considered as an appropriate theoretical framework. This is because it offers a clearly defined structure that allows the assessment of the influence that attitude, preferences, personal and cultural determinants and volitional control have on consumer's intention to perform the behavior of interest, in this case, WTP for chicken meat derived from insect-based feed.

3.2 Conceptual Framework

The study concentrated on the relationship between consumer preferences for chicken meat derived from insect–based feed and their WTP. Hence, if the consumer prefers chicken meat derived from insect-based feed, this is attributed to consumer's attitude, believes and perceptions

on the use of insect-based feed. In addition, the relationship between the social economic factors, consumer preferences and consumers awareness can in turn determine whether a consumer is willing to pay for chicken meat derived from insect-based feed or not. Figure 3.2 shows interactions of factors hypothesized to influence consumer WTP for chicken meat derived from chicken fed on insect-based feed

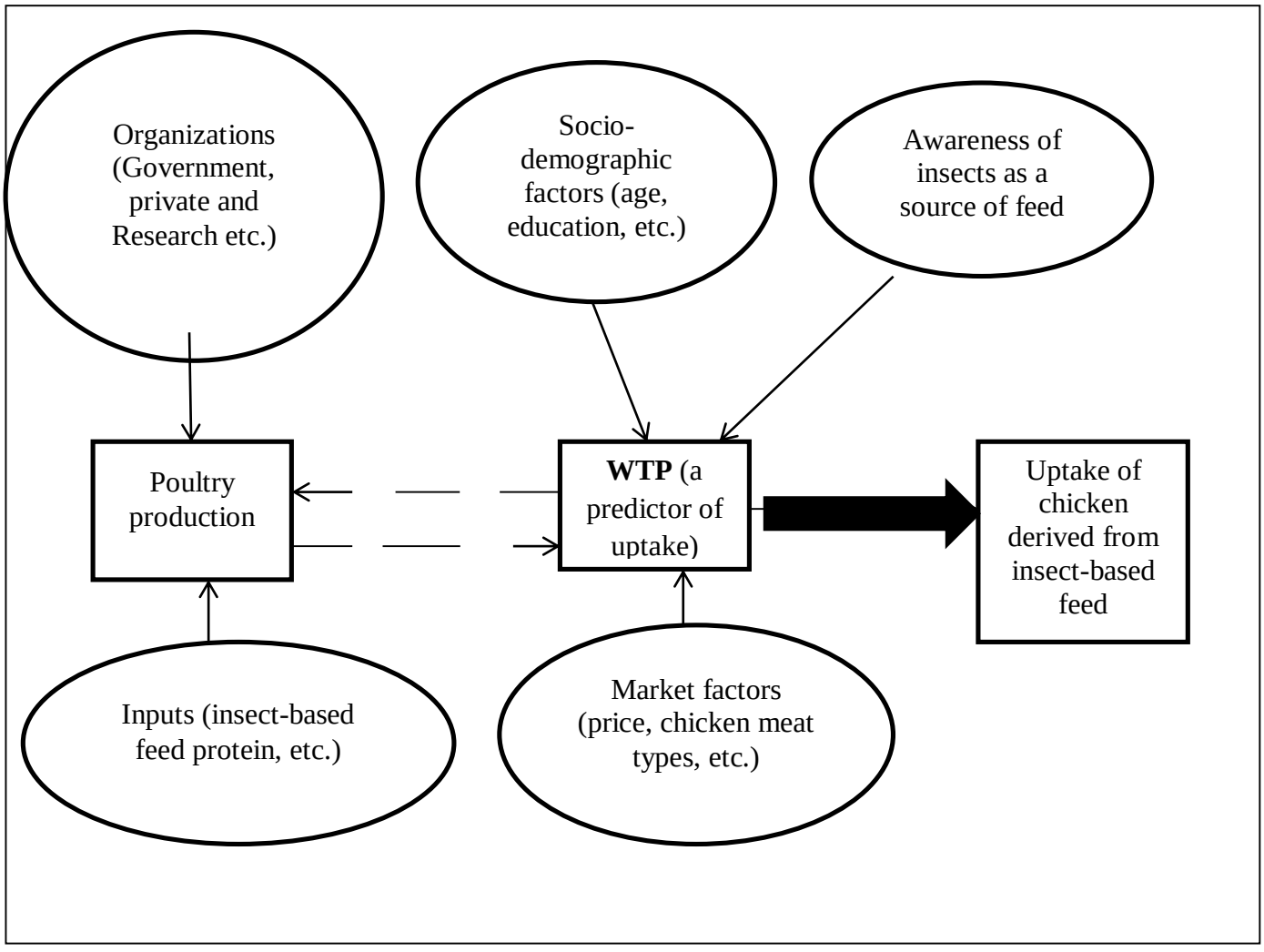


Figure 3.2: Conceptual framework showing interactions of factors hypothesized to influence consumer WTP for chicken meat derived from insect-based feed

Source: Author

3.2 Analytical Framework

This section describes how the study objectives were met. The study objectives included; assessment of consumer preferences for chicken meat derived from insect-based feed and awareness; WTP estimation and determination of factors influencing consumer WTP.

3.2.1 Assessment of consumer preferences for chicken meat derived from insect-based feed and awareness of insect types

To assess consumer preferences for chicken meat derived from the insect-based feed, the Principal Component Analysis (PCA) was used. PCA is a data reduction technique that converts a large number of variables into a smaller and more rational set of uncorrelated factors or principal components (Rao, 1964). Consumer preferences for poultry meat derived from insect-based feed, was measured on a Likert scale (where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree). These responses were subjected to PCA to obtain a communality of attributes that coherently described respondents' preferences for chicken meat derived from insect-based feed. PCA has been used to convert large number of variables in a data set into a smaller and more logical set of uncorrelated factors or principal components (Rao, 1964). The principal components explain much of the difference among the set of the original variables. Each principal component is a linear weighted combination of the initial variables, with coefficients equal to the eigenvectors of the correlation or covariance matrices (Lwayo and Obi, 2012).

The principal components were ordered in such a way that the first component generally accounted for the largest possible amount of variation in the original variables. The second component accounted for the maximum that is not accounted by the first and is completely

uncorrelated with the first principal component (Rao, 1964). The third component accounted for the maximum that the first and the second did not account for and so forth. The first principal component can indirectly be computed as follows;

$$PC_n = f(a_{ni}X_i, \dots a_{1k}X_k) \tag{3.1}$$

If the number of principal components is greater than 1, say *n* numbers, then each principal component is a continuous factor related to the products of the values of the constituent factors and their respective weightings or component loading. Therefore, the value of the principal component can be obtained by addition of the products as shown below:

$$PC_n = f(a_{11}X_1 + a_{12}X_2 +, \dots a_{1k}X_k) \tag{3.2}$$

where PC1 is the first principal component, a_{1k} is the eigenvector of the covariance matrix between the variables, and X_k is the value of the *k*th variable. Kim and Muellar (1987) justify the use of ordinal data such as a Likert scale data in the condition that PCA is used to find general clustering of variables for empirical purposes and where variable correlations are believed to be less than 0.6. The current study used PCA to reduce the perception variables. The factor coefficients generated from PCA were used to generate consumer perception index (CPI) for preference for chicken fed on insect-based feed. The index was constructed using weights chosen by principal components as proposed by Filmer and Pritchett (1998). The index was a weighted linear and was constructed as indicated in Equation 3.3 (Ahuja et al., 2002).

$$A_{ij} = \sum_k fk \frac{a_{ijk} - a_{jk}}{s_{jk}} \tag{3.3}$$

where A_{ij} is value of the index for the *i*th respondent in the *j*th county, fk the factor score coefficient for the *k*th variable as determined by the principal component procedure, $a_{ijk}$the

value of the *k*th variable for *i*th respondent in *j*th county and a_{jk} and s_{jk} are the mean and standard deviation of the *k*th variable over all respondents in the *j*th county (Ahuja et al., 2002).

3.2.2 Estimation of consumer WTP for chicken meat derived from insect-based feed

3.2.2.1 Application of Contingent Valuation (CV) and Elicitation of Consumer WTP

The CV method was used to elicit consumer WTP for chicken meat derived from insect-based feed. This method is called "contingent" because the provision of the good or service is hypothetical (Whittington, 1998). There are different types of elicitation techniques in CV. These include payment cards, bidding games, open-ended questions, closed-ended single-bound dichotomous choice questions, and closed-ended double-bound dichotomous choice questions (Umberger et al., 2002). The bidding technique was used which gave the consumer an opportunity to choose two bids hence, double-bounded questions.

The elicitation of contigent values uses either of two approaches: single or double-bounded CVM. In the single-bounded approach, the respondent is asked only one dichotomous choice question and the money amount is treated as a threshold bid (Hanemann et al.,1991). If the good or service is valued more highly than the threshold bid, the respondent answers "yes ", otherwise "no". The questionning process stops immediately after the respondent indicates his/her preferred bid. The double-bounded approach engages the respondent in two rounds of bidding; responding to a first bid and then to a higher or lower follow-up bid depending on the responses to the first question. Thus, the level of the second bid is contigent upon the response to the first bid. The questionning process stops immediately after answering to the follow-up bid. This is the

bidding approach that was adopted in the study to elicit consumer WTP for chicken meat derived from insect-based feed.

Assuming a consumer is confronted with the possibility of obtaining a change in chicken meat (good q), from q^o referring to the normally fed commercial broiler chicken with lower breast yield and higher fat content to q^1 fed on insect-based feed as a source of protein with less fat, better texture, better taste, and more calcium as demonstrated in ICIPE (2016). Then chicken meat q^1 is better and more nutritious than q^o, hence; $q^1 > q^o$ resulting in giving rise to an expression of an indirect utility (Ain et al., 1996). The indirect utility function arises from the substitution of the Marshallian demand function which is made up of respective prices and income into the direct utility function. The indirect utility is given by $V(q^o, y, z, \varepsilon)$ (Martinez, 1991) where y is income, z is a vector of characteristics of both the commodity and the consumer and ε is an unobservable stochastic component. If the consumer views the change as an improvement, then $q^1 > q^o$ and the associated utility is given as:

$$V(q^1, y, z, \varepsilon) \geq V(q^o, y, z, \varepsilon); \tag{3.4}$$

If the consumer is told this change will cost KSh C, and if s/he is a utility maximize, then s/he will only pay KSh C (i.e. reply "Yes") only if $V(q^1, y\text{-}C, z, \varepsilon) \geq V(q^o, y, z, \varepsilon)$ but will not be willing to pay that amount otherwise (Martinez, 1991). The compensating variation[2] measure, C, is the value that solves Equation 3.5 that shows the maximum WTP for the change from q^o to q^1 (Cook, 2011).

$$\Delta V(C, q^1 q^o, y, z, \varepsilon) = V(q^1, y\text{-}C, z, \varepsilon) - V(q^o, y, z, \varepsilon) = 0; \tag{3.5}$$

Given this solutions, WTP=C $(q^1, q^o, y, z, \varepsilon)$ where y-C represents, y which is income and C which is the compensating variation therefore, C is deducted from the consumer's income and V

is the indirect utility showing y which is income, z a vector of features of both the commodity and the consumer and ε is an unobservable stochastic component at the initial utility q^o and final utility q^1. Hence, the WTP for the change was the difference between the final utility level from the initial utility level at the new prices or the compensating variation (de Groote and Kimenju, 2008).

$$\text{WTP} = V(q^1, y\text{-}C, z, \varepsilon) - V(q^o, y, z, \varepsilon) \tag{3.6}$$

The combination of income and the change in the characteristics of the good/service, in Equation 3.6 allows for the definition of WTP as the economic value of the change in well-being resulting from increase in the quality of the good/service (Cook, 2011). If the person is indifferent to the good/service or sees it as an improvement, then the WTP is bounded from below by 0 and above by the income (Joseph, 2001). This is the case because the income does influence the WTP and zero bound represents non-negative distribution of WTP (Kanninen, 2007). Taking the two bounds together, the WTP ranges between zero and y:

$$0 \leq \text{WTP or } C(q^1, q^o, y, z, \varepsilon) \leq y \tag{3.7}$$

The WTP can be expressed in a probability framework. The likelihood of obtaining a 'no' or a 'yes' response in a bidding game is a function of the amount of the bid (B) offered, and the individual's maximum WTP (Loomis et al., 1991). That is,

$$\Pr(\text{No to B}) = \Pr(\text{B} \leq \max \text{WTP}) \tag{3.8}$$

and

$$\Pr(\text{Yes to B}) = \Pr(\text{B} \geq \max \text{WTP}) \tag{3.9}$$

Mathematically, the distribution of maximum WTP can be expressed in a probability framework. A cumulative density function (CDF) of the bid, B, and a vector of parameters, θ, $G(B;\theta)$, where

G(.) represents a suitable statistical distribution function (Hanemann et al.,1991). Hence, the probability that a consumer will reject the bid equals the prospect that her maximum WTP is less than *B* as shown in 3.10 Equation.

$$\pi^{n}(B)=\text{Prob}\,(\max \text{WTP}< B)=G(B;\theta) \tag{3.10}$$

The likelihood of the consumer accepting the bid, *B*, is the inverse, and is shown in 3.11 Equation: i.e.,

$$\pi^{y}(B)=\Pr(\max \text{WTP} > B)=1-G(B;\theta) \tag{3.11}$$

Using an appropriate functional form of *G*(.), the probabilities of the two outcomes can be stated mathematically as a logistic function (Hanemann and Kanninen, 2001) as shown in Equation 3.12:

$$G(.)=1+\exp(-v) \tag{3.12}$$

Where *v* is an index function representing the indirect utility function and is usually assumed to be linear in the bid (De Groote and Kimenju, 2008). It follows that the probability of the bid being greater than WTP is derived from the logistic function, i.e.,

$$\text{Prob}(B> \max \text{WTP})=\frac{1}{(1+\exp\left(-(\propto-\rho B)\right)} \tag{3.13}$$

where coefficient ρ represents mean amount of WTP, and is necessarily positive, to form a down-sloping *S*-curve ranging from 1 to 0, and α is the intercept of the linear indirect utility function and *B* is the bid. Equation 3.13 is operationalized using double bounded dichotomous questions in elicitiation of WTP.

Assuming that *N* individuals participated in a double-bounded dichotomous choice trial with a set of bids denoted as B_i^s , where s=L represents the lower bid and s=U represents the upper bid offered to *i*th individual. Then, if the individual responds "yes" to the first bid, the second bid B_i^U was some amount greater than the first bid, i.e. $B_i^L, < B_i^U$. If the individual responds "no" to the first bid, the second bid, B_i^L, was some amount smaller than the first bid, i.e., $B_i^L, < B_i^U$ (Haab and McConnell 2002). Thus, there were four possible outcomes; "yes-yes", "yes-no", "no-no" and "no-yes". Accepting the first bid showed that consumer maximum WTP was higher than the initial bid, while accepting the first bid and rejecting the second implied that the WTP fell between the bids. Rejecting the first bid and accepting the second implied that the WTP fell between the bids. A dichotomous choice model was used to estimate the probabilities of occurrence of the four outcomes and by denoting the likelihoods of these outcomes as π^{yy} π^{yn} π^{ny} π^{nn}. Assuming that the individual is utility-maximizing, the likelihoods of the four outcomes were given as (Hanemann et al., 1991):

when both answers are "yes" "yes", $B_i^U > B_i$

$$\pi^{yy}\left(B_i, B_i^U\right) = \Pr\left(B_i^U \leq \max WTP_i\right) = 1\text{-}G(B_i^U i;\theta) \tag{3.14}$$

when "yes" is followed by a "no", $B_i > B_i^U$

$$\pi^{yn}\left(B_i, B_i^U\right) = \Pr\left(B_i \leq \max WTP_i \leq B_i^U\right) = G(G_i^U;\theta) - G(B_i;\theta) \tag{3.15}$$

when both answers are "no" "no", $B_i > B_i^L$

$$\pi^{nn}\left(B_i, B_i^L\right) = \Pr\left(B_i > \max WTP \text{and } B_i^L > \max WTP\right) = G\left(B_i^L;\theta\right), \tag{3.16}$$

when a "no" is followed by a "yes", $B_i > B_i^L$

$$\pi^{ny}\left(B_i, B_i^L\right) = \Pr\left(B_i \geq \max \text{WTP} \geq B_i^L\right) = G(B_i;\theta) - G(G_i^L;\theta) \quad (3.17)$$

where $G(B;\theta)$ is the cumulative density function (cdf), assumed to be logistic, of the consumer's true maximum WTP, with parameter vector θ. The cdf is related to Equation 3.13 in that it shows indirect utility function which is usually assumed to be linear in the bid. Equation 3.18 shows the log likelihood function of the four outcomes (Hanemann et al., 1991).

$$\text{In } L(\theta) = \sum_{i=1}^{N} \{d_i^{yy} \ln \pi^{yy}\left(B_i B_i^U\right) + d_i^{yn} \ln \pi^{yn}\left(B_i \beta_i^U\right) + d_i^{nn} \ln \pi^{nn}\left(B_i B_i^L\right) + d_i^{ny} \ln \pi^{ny}\left(B_i B_i^L\right)\} \quad (3.18)$$

where d_i^{yy}, d_i^{yn}, d_i^{nn} and d_i^{ny} are binary indicator variables such that $d_i^{yy}=1$ if both answers are "yes" "yes" and zero otherwise, d_i^{yn}, =1 if "yes" if followed by "no" and zero otherwise d_i^{nn} =1 if both answers are "no" "no " and zero otherwise, and d_i^{ny} =1 if a "no" is followed by "yes" and zero otherwise. The maximum likelihood estimator, θ, is given by the solution to the Equation 3.19 (Irungu, 2011).

$$\frac{\partial \ln L(\theta)}{\partial \theta)} = 0 \quad (3.19)$$

Equation 3.19 was estimated using a double-bounded logit model to determine consumer WTP for chicken meat derived from insect-based feed in Kenya. Econometric modeling of the data generated by the double bounded format relied on the formulation given by:

$$WTP_{ij} = u_i + \varepsilon_{ij} \quad (3.20)$$

where WTP_{ij} represents the j^{th} respondent's willingness to pay and i=1, 2 denoting the first and the second question. Following Haab and McConnell (2002), the j^{th} contribution to the likelihood function is given as:

$$L_j(\mu/t) = \Pr(\mu_1 + \varepsilon_{1j} \geq t_1, \mu_2 + \varepsilon_{2j} < t_2)^{YN} * \Pr(\mu_1 + \varepsilon_{1j} \geq t_1, \mu_2 + \varepsilon_{2j} \geq t_2)^{YY} *$$

$$\Pr(\mu_1 + \varepsilon_{1j} < t_1, \mu_2 + \varepsilon_{2j} < t_2)^{NN} * \Pr(\mu_1 + \varepsilon_{1j} < t_1, \mu_2 + \varepsilon_{2j} \geq t_2)^{NY} \quad (3.21)$$

where u_1 and u_2 are the means for the first and the second responses. Setting $u_{ij} = X'_{ij}\,\beta_i$ allows the means to be dependent upon the characteristics of the respondents. YN=1 for a yes-no answer, 0 otherwise, YY for a yes-yes answer, 0 otherwise, NN=1 for a no-no answer, 0 otherwise, and NY for a no-yes answer, 0 otherwise. WTP was estimated using a double bounded logit model specified:

$$WTP = \beta_0 + \beta_1 1stBID + \beta_2 AGE + \beta_3 INC + \beta_4 GND + \beta_5 EDU + \beta_6 PREF + \beta_7 HELTH + \beta_8 ETHC + \beta_9 HH\ SIZE + \beta_{10} AWRNS + \beta_{11} LET + \varepsilon_j \quad (3.22)$$

WTP was measured by the two bids and their responses. The first bid response was either 'Yes' or 'No'; if 'Yes' the second bid was higher with a response of 'Yes' or 'No', and if 'No' the second bid was lower with a response of 'Yes' or 'No'. The first bid and the response to the first bid were renamed as bid one and answer one. The second bid which was higher and its response were renamed as bid two and answer two (Fieldman, 2012). The missing values in the second bid and answer two were replaced by the second lower bid and its' response respectively. The double bounded logit model uses maximum likelihood estimation which directly estimates $\tilde{\beta}$ and σ where; $\tilde{\beta}$ is the estimated beta and σ is a scalar (Fieldman, 2012). The WTP formula is $\hat{z}/\tilde{\beta}$ where; $\hat{z}$ refers to the estimated control or independent variables and $\tilde{\beta}$ is the constant (Haab and McConnell, 2003). There are two ways in which WTP can be estimated using this model. First, is in the case where independent variables are not included in the model. The WTP is given by the constant and this is approximately equal to the amount in KShs that consumers are willing to pay. In the second case, the model is estimated with independent variables, the WTP is evaluated

using the average values for the explanatory variables which result in the mean amount WTP in KShs (Fieldman, 2012).

3.3.3 Description of hypothesized variables and their expected signs

The hypothesized independent variables that were used to assess the factors that affect WTP for chicken meat derived from insect-based feed and their direction of influence are as outlined in Table 3.1. The dependent variable was the WTP mean amount for chicken meat derived from chicken fed on insect-based feed.

Table 3.1: Summary of variables hypothesized to influence consumer WTP for poultry meat derived from insect-based feed and their expected signs

Variable	Meaning	Unit of measurement	Expected sign
1st BID	The initial bid given(Current market price)	Continuous	+
INC	Amount of income earned by the consumer in KShs,	Continuous	+
AGE	Number of years of the consumer	Continuous	-/+
GND	Gender of consumer (Male – 1, Female – 0)	Dummy	+
HHSIZE	Household size of the consumer	Continuous	+
EDU	Number of years of formal schooling completed by consumer	Continuous	+
AWRNS	Awareness of insect-based feed and the types of insects that can be used in poultry production (1=Aware 0=Otherwise)	Dummy	+
PREF	Consumer perceptions and feelings on chicken meat derived from insect-based feed.	Ordinal	+/-
HELTH	Consumer perceived health risk on the use of insect-based feed in poultry production	Ordinal	-/+
ETHC	Consumer ethical related perceptions on the use of insect-based	Ordinal	+
LET	Market outlet(Supermarkets, Butcheries, Wet markets and Farms)	Categorical	-/+

Source: Survey Data

The initial bid variable was measure as a continuous variable indicating the amount that consumers are willing to pay**.** Its' role is to indicate whether consumers are willing to pay more or less price of the new good/service compared to the market price. According to Skuras and Vakrou (2002) study on consumer WTP for table wine, consumers were willing to pay a price of $3.23 which was more than the original price $2.95 for unprocessed new table wine; hence this showed that there was a room for price increase in the final consumer price of the wine in Greece. Hence it was hypothesized that initial bid would influence WTP positively in the current study. It is expected that the higher the income that a consumer has, the higher would be his/her ability to pay and hence the higher would be his/her WTP, *ceteris paribus* (Irungu, 2011). Kimenju and De Groote (2005) found that the WTP for genetically modified maize meal among consumers in Nairobi was positively influenced by income. An indeterminate relationship was expected for AGE variable. Past literature is not clear on the influence that AGE has on WTP for goods and services. For instance, Kamuanga et al. (2001) found that respondents' willingness to contribute money to tsetse fly control in Burkina Faso was positively associated with the age. On the other hand, Onwujekwe et al. (2005) established that age was negatively related to the residents' WTP for indoor house spraying and insecticide-treated nets for malaria control in Gezira and Khartoum States of Sudan.

Gender variable (GND) has the capability to influence respondents' acceptance and WTP for new commodities. Beardsworth et al. (2002) found that men were more oriented towards traditional cuisine as the basis of healthy eating, while women on the other side appeared more reflective about food and health issues, and more inclined to accept novel food items in Spain. Loureiro and Lotade (2005) found that female respondents were more likely to pay a premium price for fair trade, shade grown and organic coffee, unlike male respondents in Spain.

Education level (EDU) is vital in WTP studies, for instance, Huang (1996) showed that more educated consumers were willing to pay extra for organic produce and were aware of organic products unlike the uneducated. Huang (1996) also found that more health conscious consumers were willing to pay more for organic produce because they perceived it to be nutritious and healthy. Hence health (HELTH) conscious consumer will carefully consider a new product in the market before paying for it. However, Batte et al. (2007) found that the level of health concerns did not affect the magnitude of premia the consumer was willing to pay for processed organic products in US because the organic products had moderate levels of more than 70 percent and less than 95 percent of organic ingredients.

According to de Groote et al. (2008), attitude towards a new product influences consumer WTP; this is because the perception the consumer has on a good/service influences their attitude, hence preferences and WTP. Melton et al. (1996) found that consumer food safety concerns on fresh food items significantly affected consumer preferences for pork chops and hence their WTP in America. Verbeke et al. (2015) found that ethical and believe backgrounds did influence acceptance of insect-based feed in animal feed among citizens and agricultural stakeholders in Belgium. For instance, respondents with diverse backgrounds believed that "larvae of flies are a suitable source of protein for use in animal feed in Belgium (Verbeke et al., 2015). Therefore, ethical concerns (ETHC) play a part in WTP for insect-based feed.

Household size (HHSIZE) variable does influence WTP and acceptance of new products in the market. According to Loureiro et al. (2001), households with a high number of children had a higher likelihood of consuming organic products in Spain. Alemu et al. (2015) found that households with more members valued nutrition the highest and therefore had found palatable

insects to be a viable source of protein in Kenya. The types of insects considered in this study include; cockroaches, housefly maggots, termites “kumbekumbe” and crickets.

Consumer awareness (AWRNS) of the insects generally influences the WTP for insect-based feed use in chicken production. Angulo and Gil (2007) found a positive association between the consumer awareness measures for safety measures on beef and therefore WTP in Spain. Alemu et al. (2015) found that one-third of respondents were not concerned with the type of insect used and quality of insect-based feed in Kenya. A similar proportion was concerned about the quality of the feed and insect types used as feed. However, according to Yiridoe et al. (2005) consumer knowledge and awareness was found to be not consistent with consumer interpretation of what is organic, and this held consumers back from purchasing organic products in Canada. Place of purchase (LET) influences consumer WTP either positively or negatively. According to Hui (2013), half of consumers that frequented to purchase organic products in specialty stores and supermarkets or hypermarkets were WTP for organic products in Malysia. According to Alemu et al. (2015) consumers in Kenya gained positive utility from shopping in either supermarkets compared with shopping in local markets.

3.3.2.1 Diagnostic tests

Diagnostic tests were carried out both to assess how well the model fitted into the data. Generally, cross-section data are prone to multicollinearity and heteroscedasticity problems. Accordingly, tests were carried on the data to assess the presence/absence of these problems.

(a) Testing for Multicollinearity

Multicollinearity is a state of very high intercorrelations or inter-associations among the independent variables. It arises when there is an approximate linear relationship among two or more independent variables. This results in a change in the signs as well as in the magnitudes in independent variables of partial regression coefficients from one sample to another sample. Multicollinearity makes it tedious to assess the relative importance of the independent variables in explaining the variation caused by the dependent variable. In the presence of high multicollinearity, the confidence intervals of the coefficients tend to become very wide and the statistics tend to be very small (Gujarat, 2009). It becomes difficult to reject the null hypothesis of any study when multicollinearity is present in the data under study. Multicollinearity was tested using Variance inflation factor (VIF) and Pearson correlation matrix. Table 3.2 shows the VIF which was of less than 5 in all the variables and hence this indicated less correlation in the model variables. There was no presence of multicollinearity in the variables in the current study.

Table 3.2: VIF results for variable correlation

Variable	**VIF**	**1/VIF**
Income	1.23	0.816
Gender	1.05	0.953
Household size	1.29	0.775
Awareness	1.08	0.924
Age	1.38	0.727
Health Concerns	1.4	0.714
Ethical concerns	1.21	0.828
Preference for insect feed	1.33	0.755
Supermarkets	1.62	0.618
Farm	1.58	0.632
Wet markets	1.54	0.648
Mean VIF	**1.32**	

Source: Survey Data

(b) Testing for heteroscedasticity

Heteroscedasticity refers to the circumstance in which the variability of a variable is unequal across the range of values in observations. Heteroscedasticity arises when there is a large difference among the sizes of the observations. The effect of heteroscedasticity is having estimators that do not have the property of minimum variance; hence the variance of the error term is not constant. There are different ways of solving this problem for instance, for linear models the use of White's general heteroscedasticity test which involves auxiliary regression can be applied (Gujarati, 2009). The current study was a logit model and the maximum likelihood estimates were considered to crosscheck the presence of heteroscedasticity as this would result in parameters that are inconsistent. The Lagrance multiplier test for the likelihood estimates was applied and showed that there was no bias and inconsistence in parameters' variances. The Wald chi^2 was 2.62 which was small and the p value was 0.11; hence the heteroscedasticity problem was minimal in the model.

(c) Test for goodness of fit

The model fitness was displayed by the log likelihood estimates. Kiambu and Nyeri Counties had a higher log likelihood compared to Kakamega and Uasin Gishu and this indicated the probability of a fit model in the first two counties unlike the latter. Prob > chi^2 is the likelihood of attaining the chi-square statistic (71.05) if there is in fact no effect of the independent variables on the dependent variable (Stata, 2017). This is the p-value, which is likened to a critical value, possibly .05 or .01 to determine if the overall model is statistically significant (Gujarati, 2009). The current model is statistically significant since the p-value is less than .000

in the full model. In all the four study sites counties the p-values were less than .05 hence also statistically significant.

3.5 Research design

This study used inductive research which was quantitative and was executed through a consumer survey using questionnaires. Face to face interviews were done between trained enumerators and the consumers in respective chicken meat buying points. The questionnaires provided a means to elicit the amount that consumers were willing to pay based on a hypothetical scenario. The hypothetical scenario was framed like this: "*There is a growing demand for poultry meat in Kenya; however, the supply is not enough to meet the demand. Hence, in order to meet the demand, there is a current project at ICIPE planning on the introduction of quality, affordable source of protein in poultry production for increased supply to meet the growing demand. The poultry meat produced from insect-based feed will be of less fat, with high calcium content, better texture, and better taste. Suppose this poultry meat is to be introduced in the market and you are to purchase it using your own cash, would you purchase it if it is offered at the current market price of Ksh.400/kg?"*

The questionnaire provided bidding procedure in which the initial bid was KShs 400, based on the prevailing price of a kilo of "normally produced" chicken meat in the respective county market. For instance in Kiambu County the prevailing market price was KShs 400. If the consumer response was a "Yes" to the first bid increment of KShs.30 or KShs.50 were offered as the second bid. If the consumer says "Yes " or "No" to the second bid the questioning process stopped immediately after the respondent indicated his/her preferred bid. If the consumer

response was a "No" to the first bid, then decrement of KShs.30 or KShs.50 were offered as the second bid and this was given an amount the consumer was willing to pay. If the consumer said "Yes" or "No" to the second bid the questioning process stopped immediately after the respondent indicated his/her preferred bid. Protest answers were taken care of by first asking the consumer if they were willing to pay for the product and if not, the reason for not willing to pay any amount. The average amount the consumers were willing to pay for chicken meat derived from insect-based feed were estimated and recorded. The bidding process gave "yes-yes", "yes-no", "no-no" and "no-yes" categories of outcomes. The questionnaire also enabled the collection of the respondent's socio-demographic characteristics. This procedure was repeated in the other three counties respectively.

3.6 Sample size and Sampling procedure

The study assumed that over half of the residents in the four selected counties consume chicken meat. To establish appropriate sample size for each study site, the Cochran (1963) sample size formula was used (Equation 3.23):

$$n_0 = \frac{Z^2 pq}{e^2} \tag{3.23}$$

where n_0 is the sample size, Z^2 is the abscissa of the normal curve that cuts off an area α at the tails (1-α equals the desired confidence level, e.g., 95%), e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is 1-p. The value for Z is found in statistical tables which contains the area under the normal curve. In this study Z, p, q, and e^2 are assumed to be 1.96, 0.5, 0.5 and 0.075 respectively based on the assumption that at least half of the population does consume chicken meat and there is a lower margin of error.

Plugging these values in Equation 3.24 gives a sample size of 150 respondents in each county. Thus, a total of 600 respondents were sampled in the four counties.

$$n_0 = \frac{1.96^2(0.5*0.5)}{0.08^2} \quad (3.24)$$

3.7 Data collection methods

Primary data were collected using a pre-tested questionnaire. The questionnaire targeted chicken meat consumers in four study sites. It was written in English and administered in the local language in each of the study site. A pretest was conducted by the researcher in Kiambu County in chicken meat butcheries and supermarkets to test the questions and consumer responses. The pre-tested questionnaire was administered purposively to consumers by five enumerators trained and supervised by the researcher. The questionnaire was administered to buyers of chicken meat as they shopped in selected butcheries and supermarkets. The data collection exercise lasted for 28 days.

At each outlet, every third consumer buying chicken meat was sampled between 1600hrs to 1900hrs. Once a potential respondent was identified, were requested to take part in the interview by first explain to them the rationale of the survey. The permission to conduct interviews in each outlet was previously sort from the management of respective market outlets.

3.8 Study area

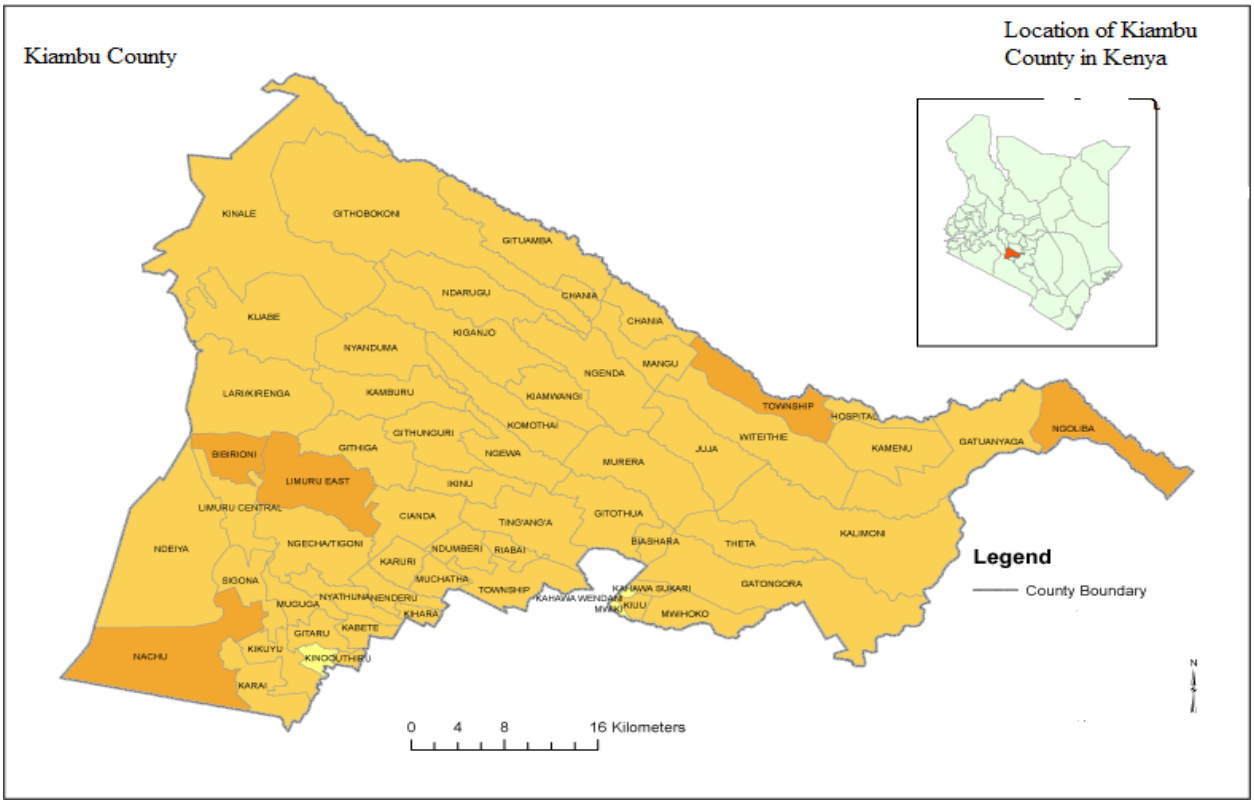
The study was carried out in Kiambu, Nyeri, Kakamega and Eldoret towns. The four areas were selected because they are among the leading sources of poultry meat in Kenya with a high number of poultry farms and households that keep poultry (FAO, 2008). These study areas were also targeted by the ILIPA project at ICIPE.

(a) Kiambu County

The economy of Kiambu County is dominated by smallholder agriculture which employs about 75 percent of the population (Okello et al., 2010). Some of the major economic activities include livestock production (dairy, sheep, goats, pigs, and poultry), crop production (for example coffee, tea, and horticulture), small and large scale businesses and real estate development. In the 2009 livestock census, Kiambu County had the highest commercial chicken population compared to other counties in the Kenya (GOK, 2010). About 85 percent of the poultry produced in Kiambu County is exotic (Okello et al., 2010). The commercial chicken population in 2010 was at 1,831,427 (GOK, 2010).

Kiambu County is located in the previous Central Province, close to Kenya's capital, Nairobi. It covers an area of 2,543.42 square kilometers; it is also considered one of the wealthiest counties in Kenya. The county enjoys a warm climate with temperatures ranging between 12°C and 18.7°C. The rainfall aggregate for the county is 1000 mm each year (Mithamo, 2013). The cool climate makes it favorable for farming. June and July rank as the coldest months while January-March and September-October are the hottest months. It is a leading innovative commercial hub that shares its borders with five other counties; Nakuru and Kajiado to the West, Murang'a and Nyandarua to the North and Nairobi to the South (Mithamo, 2013). Kiambu County was selected

because it has many small scale farmers in poultry production. The county has 6773 poultry farms and 12,633 households that keep poultry for consumption purposes (FAO, 2008). Map 3.1 displays geographical characteristics and administrative boundaries for Kiambu County.



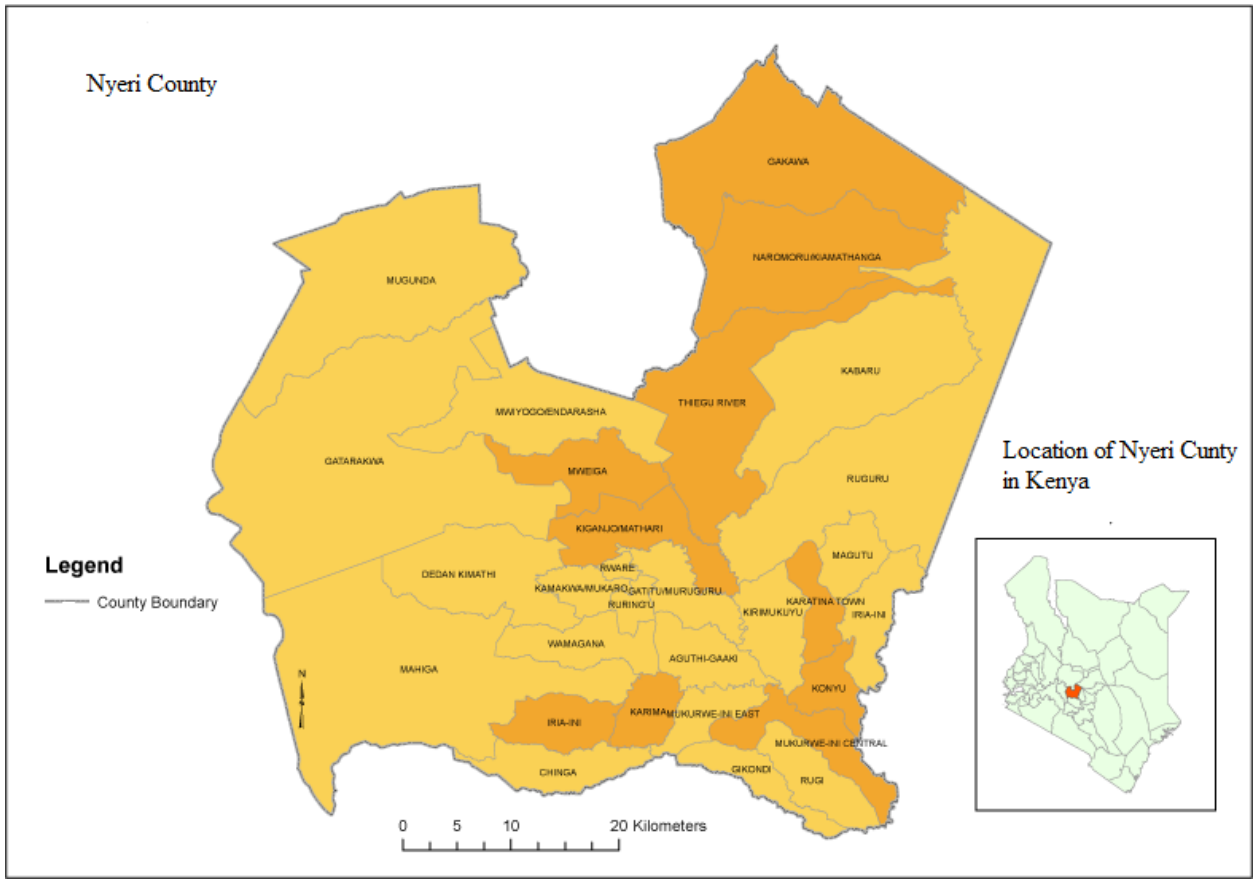
Map 3.1 Kiambu County

Source: http://krb.go.ke

(b) Nyeri County

Poultry is second to dairy production as an economic mainstay in Nyeri County, the small size of the farms and high human population density favor poultry production (Owuor et al., 2009). According to the Nyeri County government website (2016), the estimated earnings from poultry enterprise through the sale of meat and eggs were KShs 238,890,000 million in 2013. Nyeri County is home to 693,558 people according to the 2009 Kenyan National Census (Odhiambo et

al., 2013). The county has some of the lowermost temperatures in Kenya which range between 12º C in the cold months (June and July) and 27ºC in the hot months (January- March and September -October) with high precipitation all year round (Odhiambo et al., 2013). The rainfall average lies between 500mm and 1 600mm during the short and long rains periods making it favorable for its diverse agricultural activity (Ngecu et al., 2004). This area was selected for the study because most of the household keep poultry for consumption purposes. According to FAO (2008) 20,003 households keep poultry and the county has 280 poultry farms. Map 3.2 parades geographical characteristics and administrative boundaries for Nyeri County.

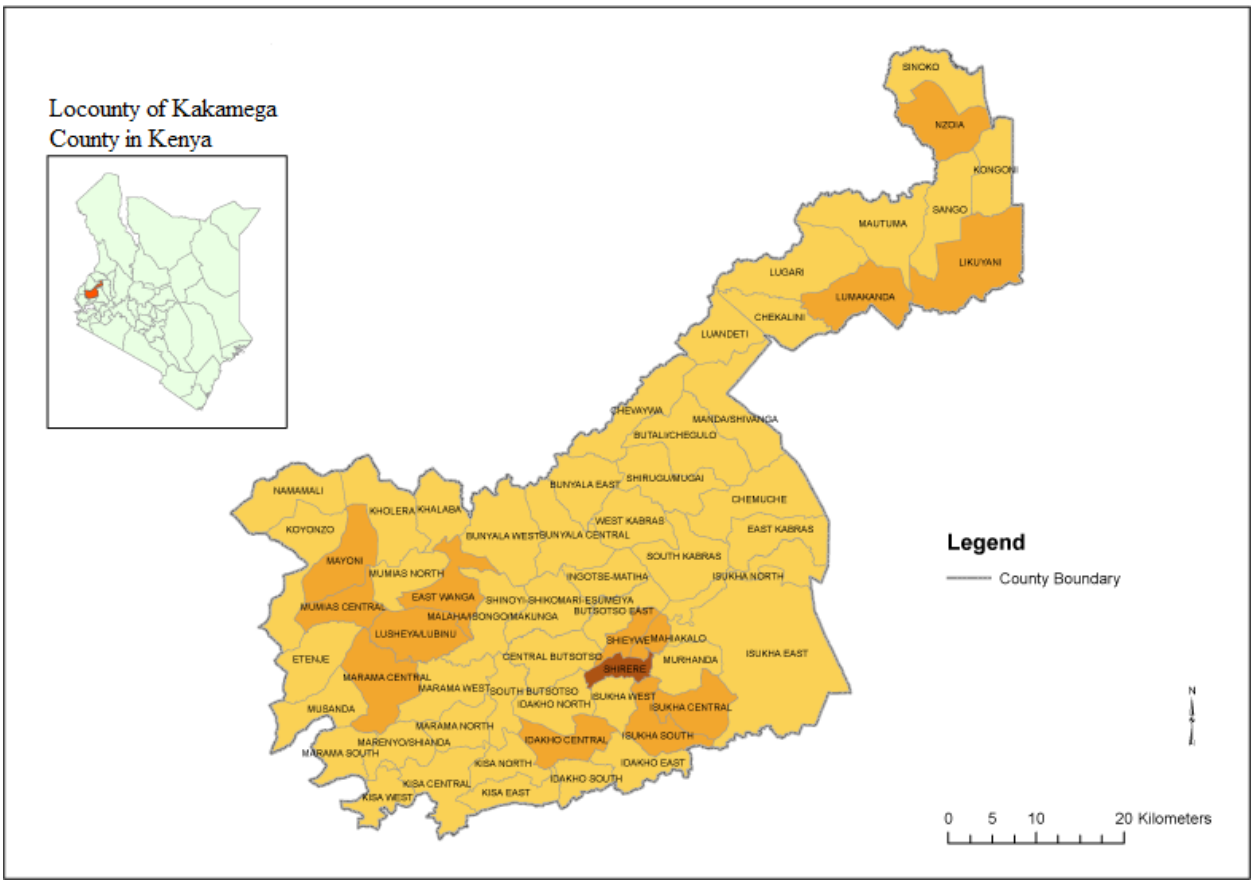


Map 3.2 Nyeri County

Source: www.krb.go.ke

(c) Kakamega County

Kakamega County has a likely population of 1.6 million people (ASDP, 2016). According to the 2009 Kenya Population and Housing Census, the population was 1,660,651 with a population density of 515 people per Km^2 and an annual growth rate of 2.12% (KNBS, 2010). Kakamega County is situated in Western Kenya bordering Bungoma County to the North, Trans Nzoia County to the North East, Uasin Gishu County and Nandi County to the East, Vihiga County to the South, Siaya County to the South West and Busia County to the West (ASDP, 2016). The major economic activity in this area is agriculture and livestock production. The livestock production activities include small-scale dairy farming, poultry production, and mixed farming. Temperatures range from a minimum of 10.3°C to a maximum of 30.8°C with an average of 20.5°C. The rainfall ranges between 1,250 – 1,750 mm per annum (Maloba, 2016). This area was selected because most of its households keep poultry for consumption purposes. According to FAO (2010), 26,505 households keep poultry and the site has 132 poultry farms. Map 3.3 displays geographical characteristics and administrative boundaries for Kakamega County.



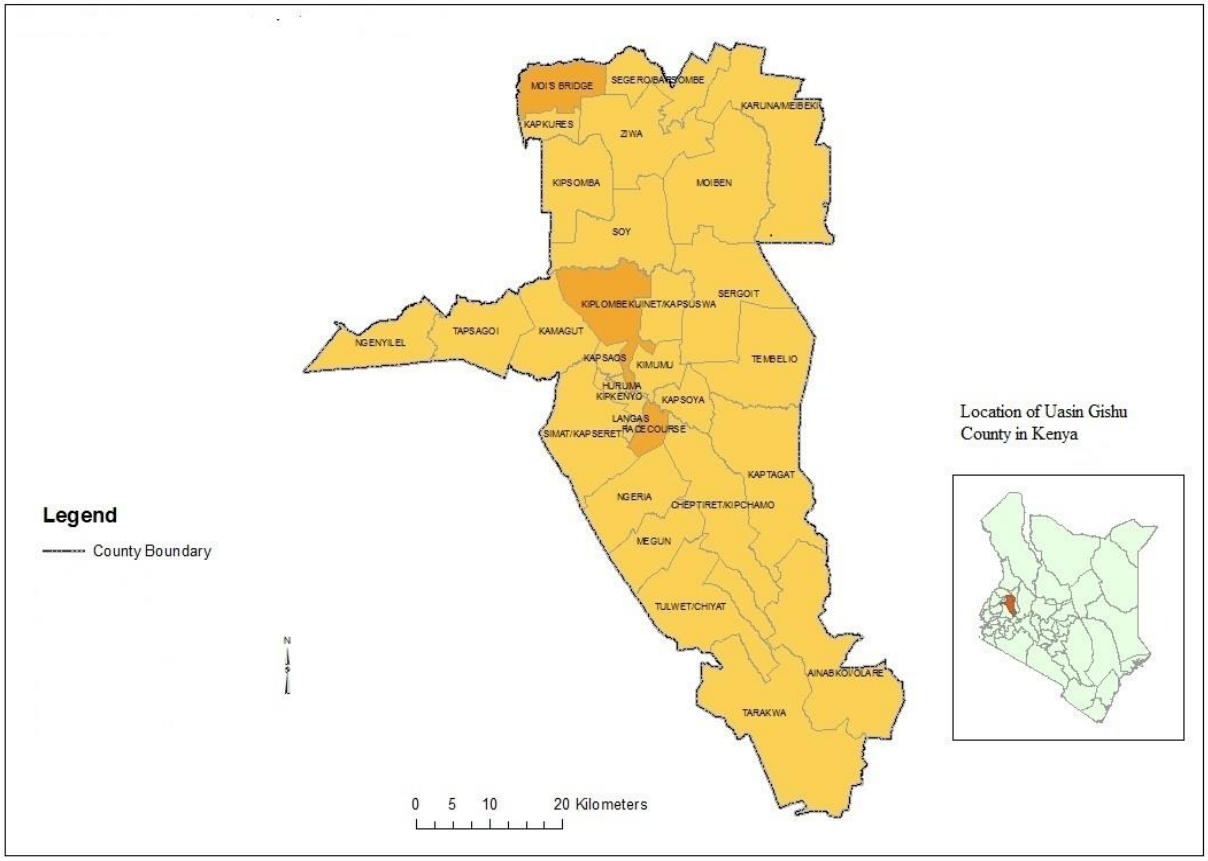
Map 3.3: Kakamega County

Source: www.krb.go.ke

(d) Uasin Gishu County

Uasin Gishu County and is located in Rift Valley region of Kenya. According to the 2009 Population and Housing census, the county has a population of 894,179, with a population growth rate of 3.8 percent (Korir, 2011). Uasin Gishu borders with Trans Nzoia County to the North Elgeyo Marakwet County to the East, Baringo County to the South East, Kericho County to the South, Nandi County to the South West and Kakamega County to the North West. It covers a total area of 3,345.2 km² (Korir, 2011).

The livestock sector is a source of livelihood for over 160,000 households in Uasin Gishu County. There are 375,287 dairy animals of which 81,838 are high grade. The County also has 93,611sheep, 27,216 goats, 140,703 exotic birds, 400,000 local birds and 7,292 pigs (Wanjala, 2014). This study site has 29,953 households that keep poultry for consumption and 426 poultry farms (FAO, 2008) hence the inclusion of the site in the study. Map 3.4 indicates geographical characteristics and administrative boundaries for Uasin Gishu County.



Map 3.4: Uasin Gishu County

Source: www.krb.go.ke

3.9 Data Analysis

Descriptive statistics were computed for consumer preferences and other socio-economic attributes. This involved the computation of means, frequencies and standard errors. Consumer preference for chicken meat derived from insect-based feed objective was achieved by employing PCA. The results are presented in tabular and graphical formats. Regression analysis was undertaken in Stata to estimate the mean WTP while controlling for the factors hypothesized to influence consumer WTP.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Respondents' socio-economic and demographic characteristics

4.1.1 Kiambu County

Table 4.1 presents socio-economic characteristics of respondents in Kiambu County. The proportion of male respondents in this county was 65. The average age of respondents was 32 (s.e. = 10.64; range =18-75), and this implied that many young people live in Kiambu town. This result agrees with statistics that show most urban areas in Kenya are populated by young people (18-35 years of age) (Kenya Bureau of Statistics, 2017). Almost all consumers had attained a secondary level of education. However, Orregard (2013) findings in a study on quality of raw milk along the value chain of the informal milk market in Kiambu disclosed that most respondents in the study were less educated and had attained primary level of education. The current study results differ as with Orregard (2013) findings and this could be so due to the involvement of urban residents in the interviews conducted who were more likely to be educated unlike those in rural setup. Most households in Kiambu County had 3 members (s.e. = 1.96; range =1-12) and an average monthly income of KShs.32, 986 (s.e. =32,577; range =KShs.6, 000-200,000). Murage and Ilatsia (2011) study which assessed factors that determine the use of breeding services by smallholder dairy farmers in central Kenya, differ on household size with the current study by two members. The difference could be as a result of the current study not interviewing rural households which have a high likelihood of having many household members. About 72 percent of the respondents were household heads.

Table 4.1: Socio-economic characteristics of respondents in Kiambu County

Variable	Value	Std. Error	Min	Max
Age of the consumer (Years)	32.11	10.64	18	75
Education level of the consumer (Years)	11.99	3.14	3	21
Household size of the consumer(No.)	3.41	1.96	1	12
Household head consumer (1=Yes 0=No)	0.72	0.45	0	1
Income of the consumer (KShs)	32986.34	32577.4	6000	200000
Employed Consumers (%)	0.5	0.5	0	1
Non-employed Consumers (%)	0.04	0.19	0	1
Consumers in own business (%)	0.46	0.5	0	1
Consumers that purchase in supermarkets (%)	0.23	0.42	0	1
Consumers that purchase in farms (%)	0.22	0.42	0	1
Consumers that purchase in wet markets (%)	0.27	0.44	0	1
Number of times buying chicken meat (Mean No./month)	3.95	3.71	1	12
Quantity of chicken meat bought (Kgs)	1.39	0.77	0.25	4
Gender of the consumer (1=Male; 0=Not male)	0.65	0.48	0	1
Gender of the consumer (1=Female; 0=Not female)	0.35	0.29	0	1
Marital Status (1=Married; 0=Not married)	0.61	0.49	0	1
Marital Status (1= Unmarried; 0= Not unmarried)	0.39	0.21	0	1

n=150

Source: Survey data

Half of the consumers were formally employed and the other half were unemployed. However, out of the unemployed respondents 46 percent owned businesses, while in actual only 4 percent were completely not engaged in any source of income activity. This statistic concurs with results of a study by Mburu (2015) on empowerment tools for youth entrepreneurs in the informal sector, in which the levels of unemployment were high in Kiambu County and people depended on small enterprises for a livelihood. Some respondents (23 percent) preferred buying chicken meat in supermarket outlets while 28 percent preferred butchery as their point of purchase. Other consumers, 22 and 27 percent preferred buying chicken meat from wet markets and farms respectively. Moreover, on average respondents bought chicken meat four times in a month and purchased one and a quarter of chicken at the time of the interview.

4.12 Nyeri County

Out of the 150 respondents in Nyeri County, 63 percent were male. Consumers in this County were older than those of Kiambu County with a three year difference as displayed in Table 4.2.

Table 4.2: Socio-economic characteristics of respondents in Nyeri County

Variable	Value	Std. Error	Min	Max
Age of the consumer (Years)	35.40	11.95	19	70
Education level of the consumer (Years)	12.66	2.92	5	18
Household size of the consumer(No.)	3.55	2.92	1	12
Household head consumer (1=Yes 0=No)	0.79	0.41	0	1
Income of the consumer (KShs)	35167.01	30958.50	5000	160000
Employed Consumers (%)	0.5	0.5	0	1
Non-employed Consumers (%)	0.05	0.21	0	1
Consumers in own business (%)	0.45	0.5	0	1
Consumers that purchase in supermarkets (%)	0.22	0.42	0	1
Consumers that purchase in farms (%)	0.12	0.32	0	1
Consumers that purchase in wet markets (%)	0.20	0.40	0	1
Number of times buying chicken meat (Mean No./month)	5.01	3.89	1	18
Quantity of chicken meat bought (Kgs)	1.16	0.81	0.25	4
Gender of the consumer (1=Male; 0=Not male)	0.63	0.48	0	1
Gender of the consumer (1=Female; 0=Not female)	0.37	0.26	0	1
Marital Status (1=Married; 0=Not married)	0.67	0.47	0	1
Marital Status (1= Unmarried; 0= Not unmarried)	0.33	0.22	0	1

n=150

Source: Survey data

Sixty seven percent of interviewed respondents in Nyeri were married and most households had 6 members (s.e. = 2.25; range =1-12). This result is similar to findings by Kalunda (2014) on financial inclusion impact on small-scale tea farmers in Nyeri County, in which each household in the survey had six members. Respondents interviewed were likely to be household heads (79 percent). On average most consumers had a monthly income of KShs. 35,167 (s.e. = 30, 959; range =5, 000-160,000). Half of the consumers were formally employed, 45 percent owned business and only 5 percent lacked any source of income. This result agrees with Kenya's statistics that about 40 percent of the working force is engaged in small enterprises for a livelihood (Kenya Bureau of Statistics, 2016). The supermarket was one of the points of purchase that almost a quarter of respondents had preference for. Another quarter preferred butcheries and only a few of the consumers interviewed (12 percent) preferred buying chicken meat from wet markets and 22 percent preferred farms. According to a study by Hui (2013), respondents preferred supermarkets as point of purchase because of ease to shop and also for convenience. Hence, Nyeri urban consumers' preference for supermarkets and butcheries as point of purchase could be due to convenience both in accessibility and availability of the products that these points of purchase guarantee to consumers. Most consumers in Nyeri County bought chicken meat at least five times in a month and at the time of interview consumers purchased an average of one kilogram of chicken meat.

4.1.3 Kakamega County

Table 4.3 presents respondents socio-economic characteristics for Kakamega County. The proportion of male consumers in Kakamega County was similar to the previous two counties Nyeri and Kiambu as most (68%) of the respondents were male. Therefore, this might be

insinuating that on most occasions men are involved in purchase of chicken meat unlike women. The average age of a respondent was 31 (s.e. = 9.01; range =19-69), and about half were married. Three quarter of consumers were household heads and each household had 6 members, on average (s.e. =2.74; range =1-17). This is comparable to Githiga and Mburu (2008) study on factors influencing local communities' satisfaction levels with different forest management approaches of Kakamega forest, Kenya, in which households interviewed, had 6 members.

Table 4.3: Socio-economic characteristics of respondents in Kakamega County

Variable	Value	Std. Error	Min	Max
Age of the consumer (Years)	31.02	9.01	19	69
Education level of the consumer (Years)	12.24	3.30	5	21
Household size of the consumer(No.)	4.51	2.74	1	17
Household head consumer (1=Yes 0=No)	0.70	0.46	0	1
Income of the consumer (KShs)	29269.43	27273.03	5000	131000
Employed Consumers (%)	0.30	0.46	0	1
Non-employed Consumers (%)	0.14	0.35	0	1
Consumers in own business (%)	0.57	0.50	0	1
Consumers that purchase in supermarkets (%)	0.28	0.45	0	1
Consumers that purchase in farms (%)	0.31	0.46	0	1
Consumers that purchase in wet markets (%)	0.32	0.47	0	1
Number of times buying chicken meat (Mean No./month)	2.87	2.37	1	12
Quantity of chicken meat bought (Kgs)	1.29	0.66	0.25	4
Gender of the consumer (1=Male; 0=Not male)	0.64	0.47	0	1
Gender of the consumer (1=Female; 0=Not female)	0.36	0.21	0	1
Marital Status (1=Married; 0=Not married)	0.64	0.49	0	1
Marital Status (1= Unmarried; 0= Not unmarried)	0.36	0.23	0	1

n=150

Source: Survey data

Almost all consumers in this county had attained secondary level of education (12 years of schooling) (s.e. = 2.91; range =5-21). This is similar to Bett et al. (2013) findings in a study on the demand for meat in the rural and urban areas of Kenya, in which almost all respondents had attained a secondary level of education. On average, consumers in Kakamega County had a monthly income of KShs. 29,269 (s.e. =27,273; range =KShs 5,000-131,000). Some consumers were formally employed (30 percent), most owned businesses (57 percent) and only 14 percent did not have any source of income. Many consumers, 70 percent, were not formally employed. According to Kenyan statistics, about 56 percent of the population lives under poverty line. Hence, it is not surprising that Kakamega County had a high percentage of unemployed consumers in this survey. Some respondents (32 percent) preferred buying chicken meat in wet markets and farms unlike supermarkets and butcheries. This could be due to the ease in access of the birds in Kakamega County which is one of the leading counties in chicken meat production and almost all households keep poultry for consumption purposes (FAO, 2010). A number of consumers preferred supermarkets as their point of purchase (28 percent), while others preferred farms (31 percent) and only nine percent of the respondents preferred the butcheries. Consumers in Kakamega County purchased chicken meat at least four times in a month and bought 1 kg of chicken meat at the time of the interview.

4.1.4 Uasin Gishu County

Out of 150 respondents in Uasin Gishu County, 68 percent were male as indicated in Table 4.4. On average consumers were 31 years of age (s.e. = 9.04; range =19-65) and only 58 percent were married. Most consumers had attained secondary level of education (12 years of schooling) (s.e.

= 2.90; range =5-20). This is similar to the other three study sites, which is evidence of Kenya's strategy to prioritize education for development.

Table 4.4: Socio-economic characteristics of respondents in Uasin Gishu County

Variable	Value	Std. Error	Min	Max
Age of the consumer (Years)	31.13	9.04	19	65
Education level of the consumer (Years)	12.66	2.90	5	20
Household size of the consumer(No.)	3.35	2.08	1	12
Household head consumer (1=Yes 0=No)	0.80	0.40	0	1
Income of the consumer (KShs)	35315.13	35450.8	5000	200000
Employed Consumers (%)	0.46	0.5	0	1
Non-employed Consumers (%)	0.07	0.26	0	1
Consumers in own business (%)	0.47	0.5	0	1
Consumers that purchase in supermarkets (%)	0.35	0.48	0	1
Consumers that purchase in farms (%)	0.20	0.40	0	1
Consumers that purchase in wet markets (%)	0.20	0.40	0	1
Number of times buying chicken meat (Mean No./month)	3.27	3.37	1	12
Quantity of chicken meat bought (Kgs)	1.19	0.62	0.15	3
Gender of the consumer (1=Male; 0=Not male)	0.68	0.47	0	1
Gender of the consumer (1=Female; 0=Not female)	0.32	0.21	0	1
Marital Status (1=Married; 0=Not married)	0.58	0.49	0	1
Marital Status (1= Unmarried; 0= Not unmarried)	0.42	0.22	0	1

n=150

Source: Survey data

Furthermore, 80 percent of interviewed consumers were household heads. The family size for most consumers was made up of 3 members (s.e. = 2.08; range =1-12). This result is slightly short compared to statistics carried in 2016 which reveal that the average family size in Kenya is of 4 persons (Esri, 2018). Interviewed respondents in Uasin Gishu County reported a monthly income of KShs.35, 315(s.e. = 35,450; range =5,000-200,000). Almost half of consumers were employed (46 percent), some owned businesses (47 percent) and only 7 percent were completely unengaged in any income generating activity. This result is similar to Uasin Gishu integrated development plan for 2013 to 2018 which indicate that 44 percent of the population is in labor force in which they own businesses and are engaged in small enterprises for livelihood. Different market outlets of purchase were preferred by consumers as 35 percent preferred supermarkets, 30 percent preferred wet markets, 20 percent preferred farms and only 12 percent preferred butcheries as their point of purchase for chicken meat. Uasin Gishu chicken consumers purchased chicken meat at least 3 times in a month and most consumers bought 1 kg of chicken meat at the time of interview.

4.1.5 Comparison of respondents' socio-economic and demographic characteristics across the four Counties

Majority of the consumers in all the study sites were men (66 percent). Of the 668 respondents interviewed, three-quarter were men in Kakamega and Uasin Gishu counties, however, there were more women in Kiambu and Nyeri Counties. The presence of women interviewed in these two counties could be as a result of the interaction of gender roles in the central part of Kenya unlike in the western region (Alunga, 2013). There was no significant statistical difference between male and female respondents among the four counties. On average the age of consumers

was 32 (s.e. = 10.37; range =18-75). Consumers in Kiambu County were oldest at 35 years, followed by Nyeri, Kakamega and Uasin Gishu in that order. The years of age for all the study sites indicated that majority of the respondents were young people. This concurs with previous finding that most urban towns in Kenya are populated with young people unlike rural areas (Ali-Olub et. al., 2011). There was a statistical difference of the consumer's age in the four counties as Kiambu County registered respondents who were slightly older (35 years) by three years than the other three counties.

About, 62 percent of the respondents were married. At county level, married consumers' proportion was almost similar however; Nyeri County had the highest number of married consumers. Besides, there was no statistical difference in the four counties on marital status. The highest level of education for consumers was secondary education which conquers with basic indicators that show that at least 50 percent of Kenyan population has secondary level of education (World data atlas, 2014). Consumers from Nyeri and Uasin Gishu counties reported to have achieved a college level of education which is marginally higher than secondary. Education level among the four counties was statistically significant with Nyeri County having more significant learned respondents. On the other hand consumers in Kiambu and Kakamega counties had completed their secondary level of education. The difference in education between the first two counties and the latter could be due to social-economic class, in which that the latter counties reported low levels of income in the current study. Therefore, this explains the disparity in education levels, as least educated population tend to have less income (Hall, 2007). In addition, there was a statistical difference for education among the four counties.

Three quarters of the consumers interviewed were household heads. The average size of the household in the four counties was about four members (s.e. = 2.32; range =1-17). This result tallies with Machiyama et al.'s (2017) finding, that the average number of household size in Kenya is 4.4 members. Kakamega County recorded the largest average household size of 5 members. This agrees with Dose (2007) study which also found that the average household size for Kakamega County was five to six members. The family size variable was statistically different among the four counties.

Nearly all respondents (93 percent) had livelihood activities from which they earned an income. Overall, 44 percent of the consumers were employed and the rest (56%) unemployed. However, 49 percent of the unemployed consumers owned businesses and only 7 percent did not actually have a source of income as they were neither employed nor owned businesses. This result is similar to Trading Economics website (2017) which confirms that over 40 percent of Kenyan population is unemployed and hence invests in small businesses for livelihood. The county that registered a huge number of non-employed and least earning monthly incomes for consumers was Kakamega. This is reflected by statistics which show that about 58 percent of population in Kakamega County lives below poverty line (Republic of Kenya, Central Bureau of Statistics, 2014). The average monthly income for all consumers was KShs. 33,190 (s.e. = 31,725; range =KShs 5,000-200,000). Uasin Gishu and Nyeri County reported a slightly higher monthly income of about KShs.35, 315 compared to Kakamega and Kiambu counties. This can be explained by previous findings in this survey, which showed that the first two counties had a less number of unemployed consumers compared to the latter ones.

The results further reveal that consumers had different market outlets as their preferred point of purchase for chicken meat. Almost half of the consumers preferred buying chicken meat which was raw from butcheries, other consumers bought from farmers (24 percent) and others from the supermarket (27 percent). Uasin Gishu County reported the highest number of consumers that preferred supermarkets as their point of purchase (35 percent). This result is comparable to Alemu et al.'s (2015) study on consumer preference for insects as food in Kenya findings; in which consumers prefer supermarkets since they gain positive utility from shopping in them. Nyeri County registered the highest number of consumers that preferred butcheries as their point of purchase for chicken meat (46 percent). Most consumers in Kakamega County, (31 and 32 percent) preferred wet-markets and farms as their point of purchase for chicken meat. There was a statistical difference for point of purchase among the four counties.

On average, most consumers bought chicken meat at least four times in a month. Nyeri County registered the highest number of times of purchase of chicken meat by consumers (five times in a month). Kiambu County consumers bought chicken meat at least four times a month. The least number of times for purchase of chicken meat was registered by Uasin Gishu and Kakamega counties (3 times a month), which is contrary to a popular assumption in Kenya that, chicken meat is a delicacy in the western part of Kenya, (Kenya Food Facts website, 2017). Moreover, there was a statistical difference for frequency of purchase among the four counties. On average, all the consumers from all the four study sites bought at least one kilogram of chicken meat at the time of interview. Kakamega and Kiambu Counties reported the highest amount of chicken meat bought in Kilograms (1.29; 1.39 respectively). The occasional purchase of chicken meat among

the four counties is as a result of chicken meat not being a luxury for many Kenyans since the staple food is maize and other cereals such as beans.

Table 4.5: Socio-economic characteristics for the whole study and the four counties comparisons

Variable	Pooled	Kiambu	Nyeri	Kakamega	Uasin Gishu	Anova
	n=600	n=150	n=150	n=150	n=150	
Age of the consumer	32.43	32.11	35.40	31.02	31.13	1.514***
(Years)	(10.37)	(10.64)	(11.95)	(9.01)	(9.04)	
Education level of the consumer	12.39	11.99	12.66	12.24	12.66	55.47*
(Years)	(3.08)	(3.14)	(2.92)	(3.30)	(2.90)	
Household size of the consumer	3.70	3.41	3.55	4.51	3.35	10.348***
(No.)	(2.32)	(1.96)	(2.25)	(2.74)	(2.08)	
Income of the consumer	33189.82	32986.34	35167.01	29269.43	35315.13	2.640
(KShs.)	(31725.78)	(32577.35)	(30958.50)	(27273.03)	(35450.8)	
Employed Consumers	0.44	0.50	0.50	0.30	0.46	4.743***
(%)	(0.50)	(0.50)	(0.50)	(0.46)	(0.50)	
Non-employed Consumers	0.07	0.04	0.05	0.14	0.07	1.055***
(%)	(0.26)	(0.19)	(0.21)	(0.35)	(0.26)	
Consumers in own business	0.49	0.46	0.45	0.57	0.47	1.378
(%)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	
Consumers that purchase in supermarkets	0.27	0.23	0.22	0.28	0.35	1.790**
(%)	(0.44)	(0.42)	(0.42)	(0.45)	(0.48)	
Consumers that purchase in farms	0.24	0.22	0.12	0.31	0.33	4.477***
(%)	(0.43)	(0.42)	(0.32)	(0.46)	(0.47)	
Consumers that purchase in wet markets	0.25	0.27	0.20	0.32	0.20	1.660**
(%)	(0.43)	(0.44)	(0.40)	(0.47)	(0.40)	
Frequency of buying chicken meat	3.78	3.95	5.01	2.87	3.27	29.874***
(No. of times monthly)	(3.48)	(3.71)	(3.89)	(2.37)	(3.37)	
						5.23**
Quantity of chicken meat bought	1.25	1.39	1.16	1.29	1.19	
at the point of interview (Kg)	(0.73)	(0.77)	(0.81)	(0.66)	(0.62)	

Variable	Pooled	Kiambu	Nyeri	Kakamega	Uasin Gishu	Anova
	n=600	n=150	n=150	n=150	n=150	
Categorical variables						**Chi2**
Gender of the consumer (Male)	0.66	0.65	0.63	0.68	0.68	1.282
	(0.47)	(0.48)	(0.48)	(0.47)	(0.47)	
(Female)	0.34	0.35	0.37	0.32	0.32	
Marital Status (Married)	0.62	0.61	0.67	0.64	0.58	2.77
	(0.48)	(0.49)	(0.47)	(0.48)	(0.49)	
(Single)	0.38	0.39	0.33	0.36	0.42	

Note: ***Numbers in brackets represent the standard errors***

Source: survey data

4.2 Respondents awareness of the use of insect as a source of chicken feed

About 54 percent of respondents had knowledge on the use of insects as a chicken feed in the whole study **(**Figure 4.1). In terms of counties, Nyeri County had the highest percentage (60) of respondents that were aware of insect as a source of feed for chicken. This was followed by Kiambu County at 54 percent and Kakamega and Uasin Gishu County had only 52 percent of respondents aware of insects as feed for chicken. The fact that, more than half of the consumers were aware that insects are a source of chicken feed shows that some of these respondents are well acquainted with the fact that insects are a source of feed for chicken. This finding somewhat tallies with Macharia et al.'s (2017) who reported that almost all farmers interviewed in Kenya were aware that chicken feeds on insects. The difference in consumer and farmer awareness of insects as feed could be due to the consumers interviewed being urban residents and hence assumption that might have less acquaintance with poultry farming. In addition, consumers were more aware of some insects unlike others. For instance, consumers were most conversant with termites and were aware that chicken ingest them. Alemu (2015) found that consumers in Kenya eat termites as food and consider then nutritious. Hence, consumer awareness of termites as a source of chicken feed could be attributed to their experience as a food source among many communities in Kenya.

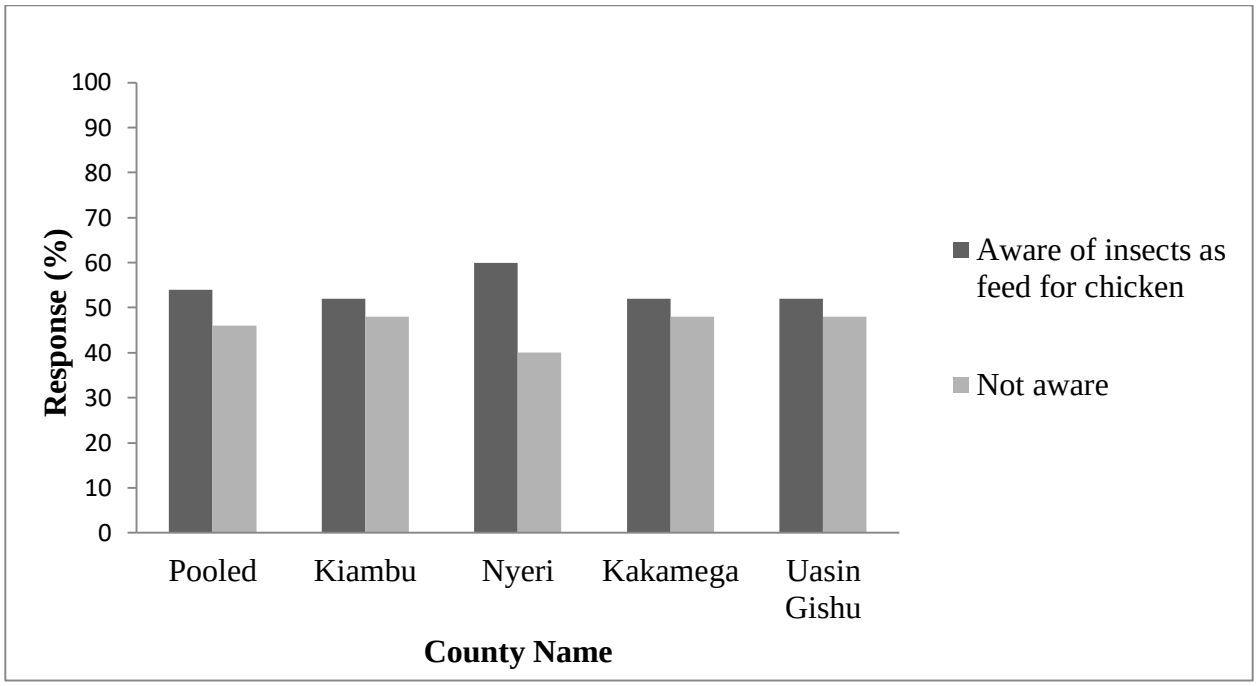


Figure 4.1: Percentage of respondents aware of use of insects as chicken feed

Source: Survey data

Overall, only 28 percent of 600 respondents were aware about the use of housefly maggots as a source of chicken feed as shown in Figure 4.2. Most respondents, 60 percent, aware of housefly maggots related them to common insect maggots that free range chicken feed on. Respectively, 44 and 50 percent of respondents were aware of use of crickets and grasshoppers as chicken feed. Additionally, 60 percent of respondents were aware of use of termites as a source of chicken feed while only 30 percent had similar feeling for black soldier flies. Many consumers (60 percent) were aware that termites are a source of protein for chicken as Figure 4.2 displays. However, fewer consumers (30 percent) were aware that black solder flies are a source of chicken feed. Consumers trust and accept edible insects for ingesting if they get information from particular commercial breeders (Alemu et al., 2015; Verbeke et al., 2015). However, in the current study, insect-based feed has not yet been channeled into the market, consumers in Kenya

are not yet aware of the commercial breeders of these insects. Hence there is a high likelihood that in the future, consumers will trust the producers of insects as feed, such as ICIPE.

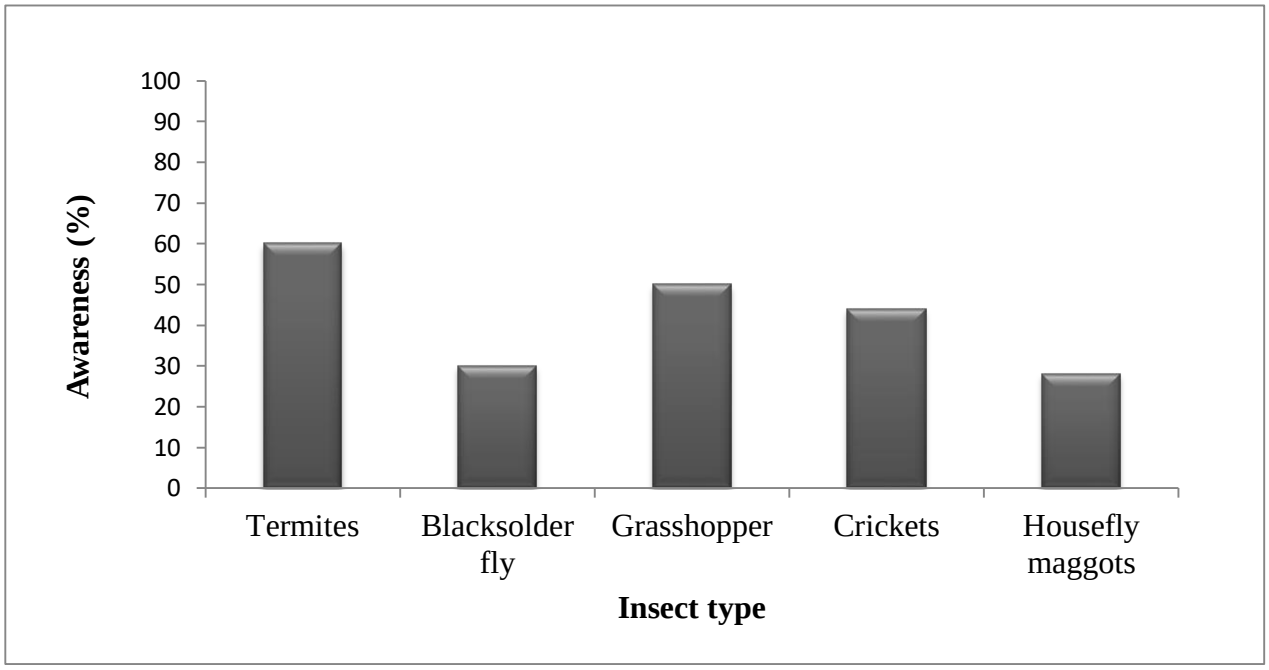


Figure 4.2: Percentage of consumers aware of different insects as chicken feed

Source: Survey data

The source of awareness for different insect types as feed is shown in Figure 4.3, 4.4, 4.5, 4.6 and 4.7 for Black solder flies, grasshopper, termites, crickets and Housefly maggots respectively. for .Very few consumers had their source of awareness of different insects as chicken feed from extension workers, neighbors, and the media. However, most consumers were aware of different insects' types as feed from their own experience. In addition, consumers were more aware of some insects unlike others. For instance, consumers were most conversant with termites and were aware that chicken ingest them. This result agrees with Alemu (2015) study which found that consumers in Kenya eat termites as food and considered them nutritious. Hence, consumer's

awareness for termites as feed for chicken could be owing to the fact that termites are food to many communities in Kenya. Nevertheless, some respondents were not aware of black solder flies and housefly maggots' insects as chicken feed. This could have been due their lack of interest in finding out what chicken feeds on. During the interviews many consumers admitted to not being concerned about what feed the chicken are fed on.

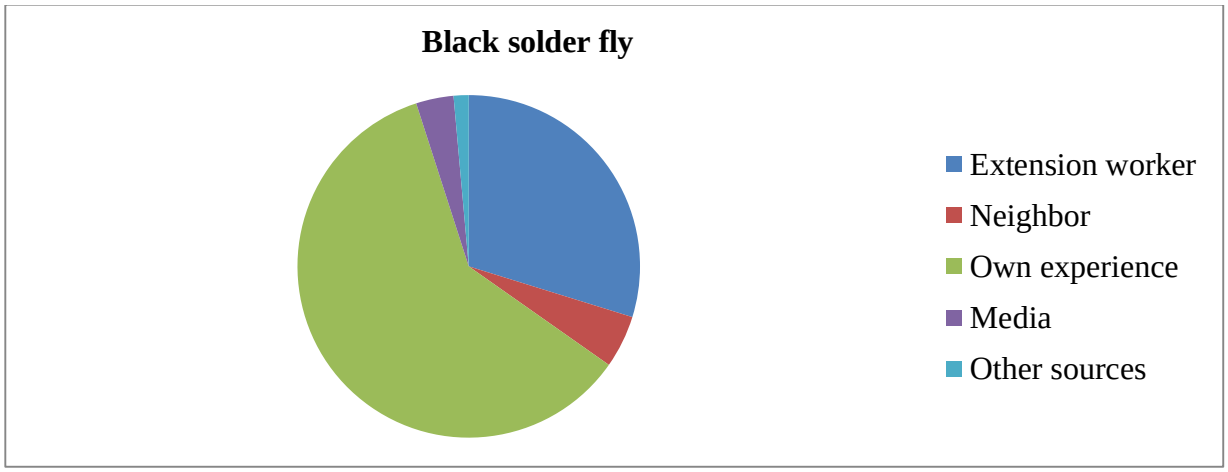


Figure: 4.3 Source of awareness for Black solder fly

Source: Survey data

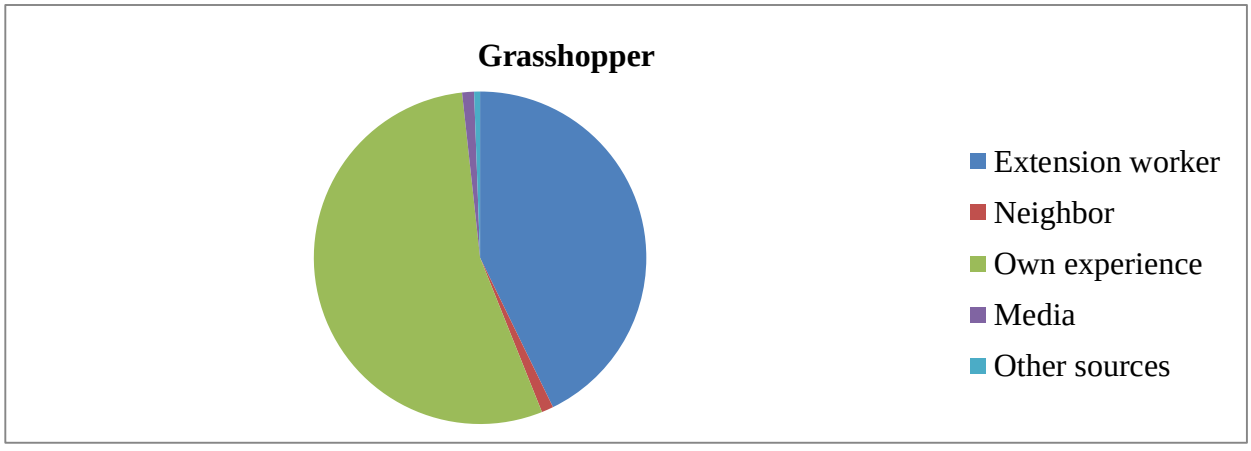


Figure 4.4: Source of awareness for Crickets

Source: Survey data

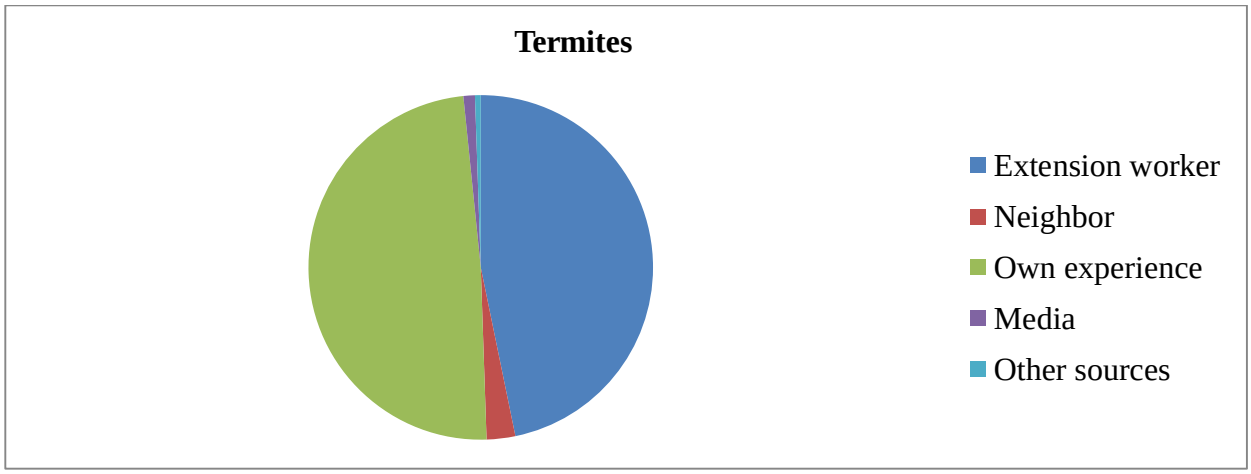


Figure: 4.5: Source of awareness for Termites

Source: Survey data

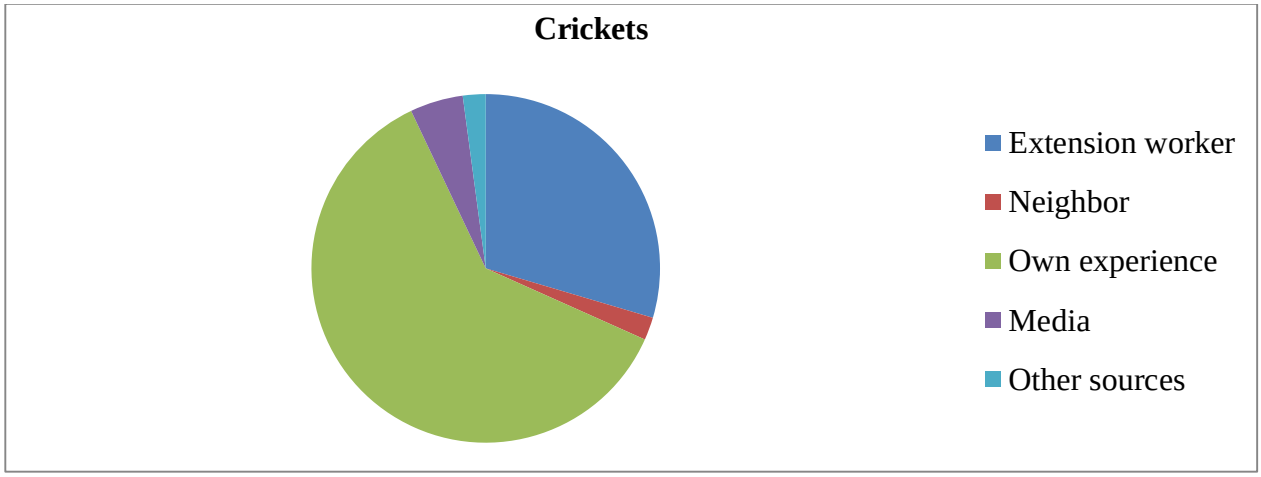


Figure: 4.6: Source of awareness for Crickets

Source: Survey data

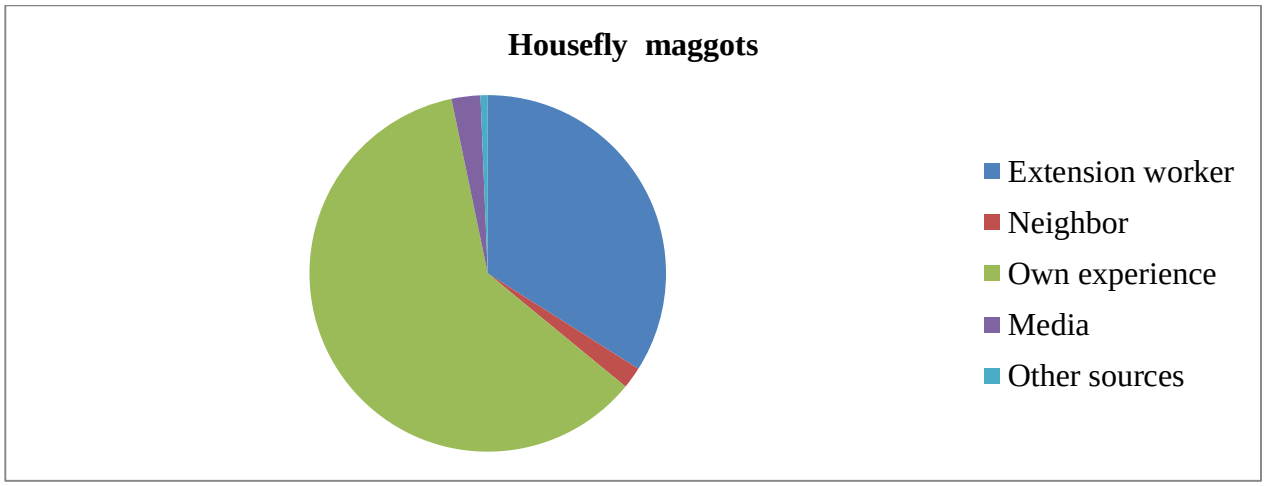


Figure: 4.7: Source of awareness for Housefly maggots

Source: Survey data

Consumers' source of awareness for insects as feed was from their own experiences and not media or learning from school and extension workers. This can be expounded by the supposition that most consumers have other professional experiences, depending on their livelihood activities, which they concentrate to learn about and hence, have less interest in knowing what chicken is feed on.

4.3. Consumer preferences for chicken meat derived from insect-based

4.3.1 Consumer preferences for different types of meat

About 68 percent of respondents preferred white to red meat as shown in Figure 4.8. White meat was most preferred as respondents attached high nutritional value to it. Respondents that preferred white meat proportion was highest in Nyeri county (77) followed by Kiambu County at 67 and Uasin Gishu and Kakamega was least at 64 and 63 respectively. White meat was most preferred as consumers attached nutrition value to it. Red meat was less preferred however, most consumers approved that it was easily available in the market on most days unlike white meat.

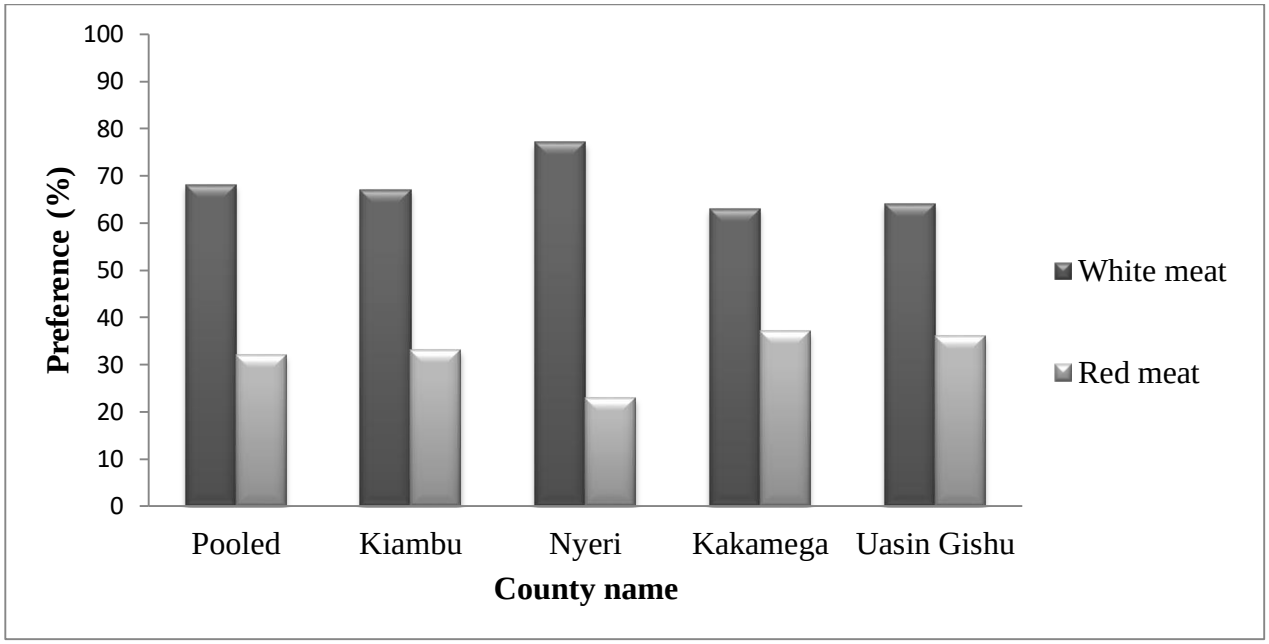


Figure 4.8: Consumer preference for white and red meat in the four study sites

Source: Survey data

Nearly, all consumers (96%) preferred free range chicken to commercially produced chicken. Kakamega County was leading (98 percent) on the proportion of consumers that preferred free range chicken. Most consumers surveyed (68 percent) preferred white meat to red meat. This result is similar to Wezemael et al. (2010) study which found that consumers in developing countries preferred white meat to red meat. White meat demand is alleged to be on the rise as it is a leaner source of protein with lower fat content (Bett et al., 2012). The results also show that almost all consumers (96 percent) preferred free range chicken to commercially produced chicken. This finding is similar to Padhi (2016) study findings that all respondents (more than 90 percent) preferred indigenous chicken to exotic. Indigenous chicken is highly preferred as it doesn't feed on processed feed.

4.3.2. Consumer preferences for chicken meat derived from Chicken fed on insect-based feed

This study used a composite index based on individual preference for chicken meat derived from insect-based feed to generate consumer preference index. The index was constructed using weights chosen by PCA as proposed by Filmer and Rritchett (1998). The index uses 6 variables which were divided into five categories of a likert scale. These variables were questions which were asked as indicated; Is insect feed use a good thing? (Good thing); do you think chicken meat derived from insect-based feed is more nutritious than 'normal' chicken? (More nutritious); would you purchase chicken meat derived from insects-based feed? (Purchase); do you think chicken meat derived from insect-based is of better texture than 'normal' chicken? (Better texture); do you think chicken meat derived from insect-based feed is of better taste than 'normal' chicken? (Better taste); and do you think that this chicken meat will be of a higher quality? (Superior quality). Table 4.6 presents the factor coefficients used as weights and the summary statistics for the counties as a whole.

Table 4.6: Factor coefficients and summary statistics for the variables used in constructing the consumer preference index

Variable	Kiambu Factor coefficient	Mean	S.D	Nyeri factor coefficient	Mean	S.D	Kakamega factor coefficient	Mean	S.D	Uasin Gishu Factor coefficient	Mean	S.D
Good thing	0.43	1.186	0.81	0.469	1.22	1.00	0.447	1.14	0.66	0.616	1.14	0.7511
More nutrition	0.551	1.046	0.65	0.673	1.2	0.82	0.751	1.033	0.59	0.860	0.986	0.79
Purchase	0.291	0.767	1.13	0.459	0.813	1.18	0.436	0.493	1.11	0.616	0.5	1.25
Better texture	0.638	0.64	0.82	0.573	0.753	0.77	0.836	1.033	0.64	0.927	1.08667	0.84
Better taste	0.638	0.82	0.85	0.632	0.98	0.81	0.845	1.08	0.65	0.923	1.06	0.89
Superior quality	0.212	-0.393	1.11	-0.153	-0.68	1.11	0.540	-0.29	1.19	-0.173	-0.72	1.09

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0.756; Approx. Chi² (df) 334.24 P = 0.0000

Source: Survey data

The interpretation of the index on consumer preference is weighed by $f_k/s_k$where f_k refers to the factor score coefficient determined by PCA procedure and s_k is the standard deviation of all respondents. The mean value of the index is zero by construction in the whole sample and had a range from 0.0066 to -0.1239 across the study sites. The standard deviation was 2.321 for the whole study and ranged from 2.738 to 3.601 across the study sites. Table 4.7 presents summary statistics for Consumer preference for chicken meat derived chicken fed on insect-based feed index.

Table 4.7: Consumer Preference index; Summary Statistics

Summary Measure	Pooled	Kiambu	Nyeri	Kakamega	Uasin Gishu
Mean	-0.000	0.0066	0.1402	-0.1239	0.06344
Standard deviation	2.321	2.755	2.738	3.3601	3.4889
Minimum	-11.378	-7.4893	-10.0357	-14.6727	-13.2984
Maximum	4.044	4.222	3.3475	5.46793	4.37351

Source: Survey data

Table 4.8 presents summary statistics for the variables used in constructing the index across the study sites. All the variables took a value that was of a range of 2 to -2.The index produces minor differences across the counties on the variables used to explain consumer preference. Only one variable on quality of the chicken did have noticeable differences across the counties. For example, in all the four counties respondents agreed that consumption of chicken meat derived from insect-based feed is a good thing. Also, respondents in all the four study sites agreed that chicken meat derived chicken from insect-based feed was of better texture and taste. Similar results can be seen across all the variables in all four counties.

Table 4.8: Variables used in constructing the consumer preference index and the index disaggregated by county

Variable	Kiambu	Nyeri	Kakamega	Uasin Gishu
Good thing	1.000	0.906	0.999	1.128
More nutritious	0.999	1.000	1.000	1.000
Purchase	1.000	1.000	1.000	1.000
Better texture	1.000	0.999	0.999	0.965
Better taste	0.744	0.772	0.923	1.035
Superior quality	1.000	-1.000	-0.173	-0.999

Source: Survey data

However, sharp difference on quality variable is noticed across the counties as three counties, Nyeri, Kakamega and Uasin Gishu consumers disagreed that chicken fed on insects is of superior quality but Kiambu County consumers agreed that it is of superior quality. This result differs from what previous studies on acceptance of insects as feed and food show. Consumers have been said to trust and accept edible insects for ingesting if they get information from particular commercial breeders (Alemu et al., 2015; Verbeke et al., 2015). However, in the current study insect-based feed has not yet being channeled into the market, the consumers in Kenya are not yet aware of the commercial breeders of these insects. Hence in the future, there is a high likelihood that consumers will trust the producers of insects as feed, such as ICIPE.

4.3.3 Consumer preferences for different insect type

Figure 4.9 shows the results for consumer preference for different insect types. About 95 percent of respondents preferred termites as chicken feed. Termites were more preferred to other insects because respondents perceived them to be edible and clean. Next in line were grasshoppers and crickets, as reported by 84 and 64 percent of respondents respectively. Black solder flies were

the least preferred perhaps because respondents were not acquainted with them. Similarly, 48 percent of respondents expressed preference for housefly maggots perhaps due to their perception that they were dirty and unhygienic for consumption and therefore for use as a source of chicken feed.

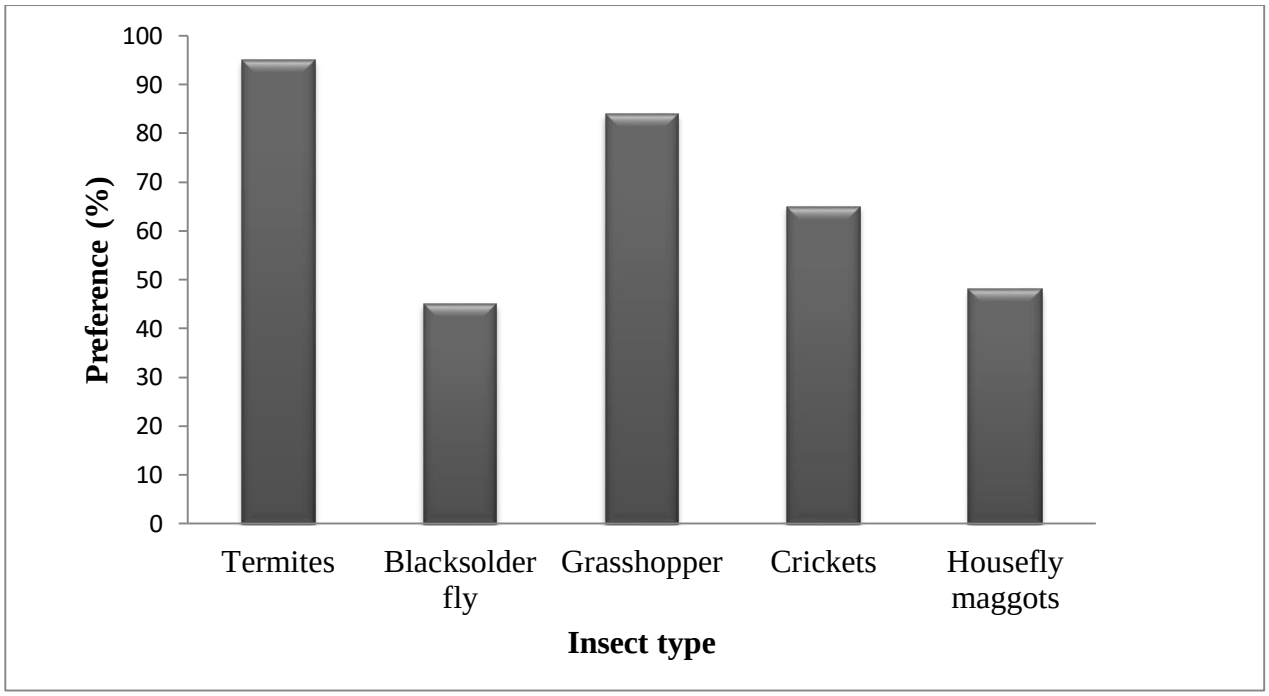


Figure 4.9: Proportion of respondents who expressed their preference for use of different types of insects as a source of chicken feed

Source: Survey data

Nearly all consumers (95 percent) preferred termites as chicken feed in all the study areas. This is also reflected in each county as shown in Table 4.9. This concurs with a study by Kinyuru et al. (2013) which found that almost all ethnic communities enjoy termites as a delicacy in Kenya. Grasshoppers and crickets were also preferred by some consumers; for instance in all the four counties a proportion of 80 and above of respondents preferred grasshopper and termites.

Table 4.9: Proportion of consumer preference for different insect types in the four study sites

Variable	Kiambu		Nyeri		Kakamega		Uasin Gishu	
	Prefer	Don't Prefer	Prefer	Don't prefer	Prefer	Don't prefer	Prefer	Don't prefer
Termites	90	10	91	9	99	1	99	1
Grasshopper	82	18	83	17	84	16	93	7
Crickets	47	53	69	31	67	33	81	19
Black solders	26	74	41	59	41	59	71	29
Housefly-maggots	39	61	49	51	35	65	70	30

Source: Survey data

Black solder flies however, were preferred by a lesser number of consumers (45 percent) in the wholes study. This is because some consumers (30 percent) were not acquainted with this insect type and others (45 percent) reasoned that this insect was dirty despite it being easily accessible. In all the four different study sites; black soldiers were preferred by a less proportion of consumers in Kiambu Nyeri and Kakamega counties (26, 41, 41 respectively.) This result agree with Lessard (2016) study which found that consumers had less preference for poultry products derived from black solder fly protein since they could not detect the difference in the taste or smell of the products. However, in the current study when consumers taste chicken fed on insect-based feed it is expected that they might like black solder flies and even go ahead to produce

them as feed for poultry. This is for the reason that; chicken fed on insect feed is expected to have a better taste. Housefly maggots were less preferred too, as over half of consumers (52 percent) considered them dirty and unhygienic for consumption and use as chicken feed. This was also observed among the four counties as the respondents the proportion of respondents that preferred housefly maggots use was less. This result is confirmed by Van Huis (2015) study on the use of insects as feed in Belgium which found that consumer preference for some insects is based on personal and situational factors. Hence, less preference for housefly maggots and black solder flies.

4.4 Willingness to pay for chicken meat derived from insect-based feed

4.4.1 Respondents' expression of willingness to pay

Figure 4.10 shows the percentage of respondents that were willing to pay for meat derived from chicken fed on insect-based feed. Overall, 91 percent of respondent were willing to pay for chicken meat derived from insect-based feed. Majority (95 percent) of these were in Uasin Gishu County. This was followed by Kakamega and Nyeri counties 93 and 91 percent respectively. Kiambu County reported the least proportion (85) of respondents willing to pay for chicken meat derived from chicken fed on insects. Those who were not willing to pay indicated that such chicken was not fit for human consumption and could harm their health.

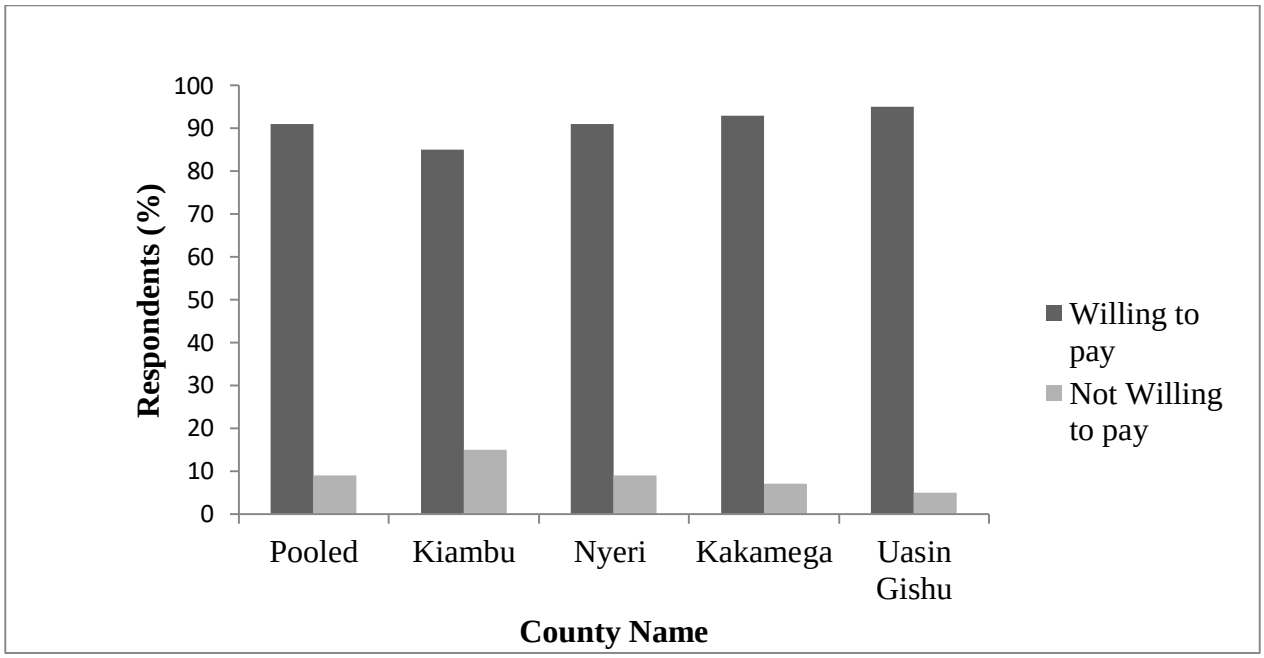


Figure 4.10: Proportion of respondents who expressed WTP for chicken meat fed on insect-based feed

Source: Survey data

4.4.2 Willingness to pay different bid prices

Table 4.10 shows the proportion of respondents that expressed their willing to pay premium or discount prices for chicken meat derived from insect-based feed. In the whole study a proportion of 61 respondents were willing to pay a premium while 19 a discounted price. Kakamega and Uasin Gishu counties registered the highest number of consumers (67 and 76 percent) respectively, that accepted the second highest bid in purchase of chicken meat derived from insect-based feed. Only a few consumers rejected all the bids availed to them in these two counties. On the other hand, Kiambu County recorded the highest proportion of consumers (9) that were not willing to pay at all for chicken meat derived from chicken fed on insect-based feed. Nyeri County results for the bidding processes were almost similar to Kiambu County

however; the number of consumers that rejected all the bids was lower than that of Kiambu County by 4 percent.

Table 4.10: Proportion of respondents who expressed WTP for chicken meat derived from chicken fed on insect-based feed

		Respondents (%)			
County	**Current Market Price (CMP)**	**CMP+12% and 7%**	**CMP**	**CMP-12% or and 7%**	**Not willing to Pay**
Kiambu	400	59	18	9	14
Nyeri	450	58	26	6	10
Kakamega	400	67	21	5	7
Uasin Gishu	500	75	13	7	5
Pooled	436	61	11	19	9

Source: Survey data

In all the four study sites, above half of consumers were willing to pay an amount slightly higher than the market price for chicken meat derived from insect-based feed. This perhaps could be due to the respondents being aware of the benefits of chicken fed on insect-based feed which were explained to them. These benefits include; high nutritional quality, low fat content, better texture and taste. This result is similar to Loureiro et al. (2002) study which found that respondents were willing to pay a premium for eco-labeled and conventional apples. This was so because the consumers perceived the apples to be nutritious and good for their health. In the

current study, respondents probably, were willing to pay a higher amount of money for chicken derived from insect-based feed since they perceived it to be of high nutritional quality.

Another study on consumer WTP for insects as food by Alemu (2015) found that individuals were willing to pay a greater amount than the market price for insects as food due to the nutrient benefits attached to them. According to Sethuraman and Cole (2014), their study suggested that in categories where consumers believed that there is a strong price-quality inference, they would pay a higher premium for national brands. In the current study only a few of respondents were willing to pay the market price as they considered that chicken meat derived from insect-based feed will not be different from any other chicken.

4.4.3 Respondents' mean willingness to pay for chicken meat derived from chicken fed on insect-based feed

Table 4.11 presents respondents' WTP values while controlling for possible confounders. In all the four counties, WTP mean of KShs. 537.50, with confidence interval of Ksh511.79-560.2 was obtained. Respondents in Uasin Gishu had a higher mean amount for WTP of KShs. 605.60. This was followed by Nyeri County respondents' WTP which was KShs. 505.60. Kakamega County mean WTP came third at KShs. 473.66 and the least amount was recorded in Kiambu County (460.85). Kakamega and Kiambu Counties had the same market price however; their WTP differed as Kakamega recorded a higher amount than Kiambu by KShs 13.

Table 4.11 Mean WTP for chicken meat derived from chicken fed on insects in the four counties with no independent variables

County	WTP (KShs)	Current price (KShs)	Std. Err.	Z	P>z
Kiambu	460.85	(400)	9.55	48.24	0.00
Kakamega	473.66	(400)	9.26	51.11	0.00
Nyeri	505.56	(450)	7.08	71.33	0.00
Uasin Gishu	605.57	(500)	15.77	38.39	0.00
Pooled WTP	537.59	(436)	7.69	69.89	0.00

n= 150 for each site n=600 for all study sites

Source: Survey data

The mean WTP values did not change substantially even after controlling for possible confounders (Table 4.12). For instance the WTP mean amount registered in the full model without independent variables was KShs. 537.59 which varied with the model with independent variables by KShs. 3.46. The WTP mean amount for the specific counties was almost similar in the two set ups of the model. This means that WTP estimated directly in the model gives the same value as the mean values for the explanatory variables. Therefore, there was less difference on WTP mean amounts as WTP mean amount is also a summation of the mean values of the independent variables of the model.

Table 4.12 Mean WTP for chicken meat derived from chicken fed on insects in the four Counties with independent variables

County	WTP (KShs)	Current price (KShs)	Std. Err.	Z	P>z
Kiambu	460.63	(400)	9.53	48.35	0.00
Kakamega	473.67	(400)	9.27	51.11	0.00
Nyeri	505.56	(450)	7.09	71.33	0.00
Uasin Gishu	604.65	(500)	15.65	38.64	0.00
Pooled WTP	541.05	(436)	13.50	40.08	0.00

n= 150 for each site n=600 for all study sites

Source: Survey data

All registered means for WTP were higher amounts than the market mean price. The implication of high levels of average WTP amounts is that respondents will buy chicken meat derived from chicken fed on insects when availed in the market. This perhaps could be due to perceiving of this meat as of better nutrition and healthy. These results agreed with a recent study by Alemu et al. (2017) on Kenyan consumer preference and demand for cricket flour buns found that consumers were also willing to pay more for cricket flour buns than for fortified buns. This implied that it is most likely that there will be a market for bread products with cricket flour since the demand is present. Hence, this signaled that insect-based food products can be used as an alternative source of food in Kenya where food insecurity and malnutrition is still prevalent. Also, Colson and Huffman (2012) study on consumers' WTP for genetically modified foods with product-enhancing nutritional attributes found that participants were willing to pay a premium for products with transgenic enhanced nutrients GM as they perceived the product to be of

enhanced vitamin C and antioxidant content. The study further documented that participants that received pro-biotech information had higher levels for WTP unlike those that did not have as they were informed of the nutritional benefits of the products. In the current study respondents' high levels of WTP average amounts is an indication that consumers value nutritional aspects of chicken fed on insects that they were informed about.

4.5 Factors influencing respondents' WTP for chicken meat derived from insect-based feed in the four counties

Table 4.13 gives the results of the factors hypothesized to influence consumer WTP for chicken meat derived from chicken fed on insects in the whole study. The double bounded logit model used was fit as diagnostic tests indicated that prob>Chi² was of 0.000 for the full model. The wald test verified the null hypothesis that the hypothesized set of parameters are equal to some value. The wald test gave a value of 181.26 in the full model and a value of 23.89, 22.34, 21.56, and 18.90 for Kiambu, Nyeri, Kakamega and Uasin Gishu respectively. Hence, the null hypothesis was rejected as this suggested that the variables in the model were of value greater than zero and fit of the model. Out of the eleven explanatory variables evaluated, only five were statistically significant in the full model. The results showed variables such as respondents' first bid, income, gender, preference for chicken fed on insect-based feed and supermarket as a preferred market outlet were significant.

Table 4.13: Maximum likelihood estimates of factors influencing respondent's WTP for the whole study

Variable	Coef.	Std. Err.	t-value
Initial Bid	1.2350	.09823	11.98***
Income (Ksh '000)	-0.0950	.05129	-2.14**
Age(Years)	0.0043	0.0064	0.66
Gender (male)	0.2181	0.1240	1.78*
Household size (No.)	-0.0297	0.0276	-1.08
Education (Years)	0.0154	0.0204	0.75
Awareness of insects as feed 1= Aware 0=Not aware	0.1232	0.1177	1.05
Preference for insect feed indices	0.2956	0.0886	4.40***
Health concerns indices	0.0766	0.0537	1.43
Ethics concern indices	-0.0093	0.0480	-0.19
Market Outlet			
Farm	Reference	0	0
Supermarkets	0.4204	0.1711	2.12**
Butcheries	-0.0072	0.1689	-0.04
Wet markets	0.0034	0.1668	0.02
_Constant	4.960	0.377	14.2*

n=563 Prob>Chi²=0.000 Waldchi²= 181.26 Log likelihood= -596.062

Note: Numbers in brackets represent the t values: *, **, *** Significant at 10, 5 and 1% respectively.

Source: Survey data

Initial bid amount positively influenced the WTP for chicken meat derived from chicken fed on insect-based feed. This showed that if the initial bid amount was increased, the respondent mean WTP would also increase. From an economic theory, when a bid of a good increases, considering a real market situation, the demand of that product decreases (Wattage and Simon, 2008). This shows that the respondents believed that the initial bid amount presented to them could be the right amount to pay for chicken meat derived from chicken fed on insects hence their valuation on that amount. Therefore, there is a likelihood of occurrence of starting point bias and this explains the influence of initial bid amount on the WTP amounts.

Respondent's income was statistically significant but with a negative effect on WTP. Hence, a one percent increase in income would lead to a 9 percent reduction in WTP. This specified that as respondents' income rises there was a less probability of paying a higher price for chicken derived from insect-based feed. Therefore, this suggests that the demand for chicken fed on insect-based feed decreases as income increases and this perhaps could be due to consumers considering this chicken to be not of superior quality to 'normal' chicken. Earlier studies have found that income is a vital negative factor on WTP, and that price elasticity is reduced by income (Rubey and Lupi, 1997; Tschirley et al., 1996). The result for the current survey is similar to Loureiro and Umberger (2003) study which found that, consumers with higher income were not willing to pay for certified meat products in U.S. Hence, also a negative effect of income on WTP may suggest that wealthier consumers already consider their chicken supply safe and do not place much value on the use of insect-based feed. The results for this variable contradict the initial hypothesis that the effect was expected to influence consumers' WTP positively. In the current study consumers with higher income not only had lower WTP for

chicken meat derived from insect-based feed, but also were not as sensitive to reduced prices as the lower income earners were.

Male respondents interviewed had an affirmative influence on WTP as gender variable was statistically significant. This showed that an increase in WTP price will result in men paying more for chicken meat derived from chicken fed on insect-based feed unlike women. This result was confirmed by Schosler et al. (2012) study on constructing consumer-oriented pathways towards meat substitution findings; in which male gender was more receptive to the use of insects unlike female, who were found to be more fearful of insects. Beardsworth et al. (2002) study on the significance of gender for nutritional attitudes and choices also found that males were more oriented towards traditional cuisine as the basis for healthy eating, while females in contrast appeared more reflective about food and health issues and hence men inclined to accept novel food items in Spain. The findings of Beardsworth et al. (2002) agree with the current study that male gender, like well-known foods over time and would pay more if the food is more nutritious and healthy. The result for this variable is not different with the initial hypothesis that the effect would be positive since male respondents were expected to positively influence consumer WTP.

Preference for chicken meat derived from insect-based feed was significant and had a positive influence on consumer WTP. This could be due to perceptions of respondents' that chicken fed on insects will be more nutritious of better taste and texture. Yeboah et al. (2012) study on consumer preference for fish attributes showed that consumer preferences for fish attributes such as filets, freshness, eco-labeling and domestic production were heterogeneous and important in consumption choices. This implied that consumer preference had insights into the market impact, especially demand for the use of insects as animal protein in Europe. Therefore, consumer

preferences' positive influence on the demand for chicken fed on insects in the current study is important as a predictor of demand for insect-based feed in poultry production in Kenya.

Respondents that preferred shopping for chicken meat from supermarket outlet had a positive influence on WTP. Hence, these respondents' showed a likelihood of paying a higher amount for chicken meat derived from insect-based feed. This could have been so, as a result of most consumers interviewed having access to supermarkets as they were particularly urban residents. Odera (2011) findings are similar to the current study as it documents that supermarkets provide quality and safe products and hence consumers have confidence while buying food products from them. Therefore, respondents that purchased chicken meat from supermarkets were willing to pay for chicken meat derived from insect-based feed since they were confident of safety and quality products. These consumers were also aware that the supermarkets accept only certified products unlike retail or open market outlets. The results for this variable confirm the initial hypothesis that the effect would be positive as consumers that shop in supermarkets were expected to influence WTP positively.

The results obtained from the four counties show disparity in variables' significance. For instance, Kiambu County had most significant variables, seven, while Uasin Gishu County registered three variables that were significant out of eleven factors postulated to have effect on consumer WTP. Consumer's income was significant in Kiambu County and had a negative effect on WTP. Therefore, as respondents' income increased this resulted in a declined demand for chicken meat derived from insect-based feed. Probably the reason why Kiambu respondent's income was significant and not significant in the other three counties could be as a result of the the proximity of this county to the capital city, Nairobi. Therefore, consumers have more alternatives for their choice of different white meat preferences. Despite age and household size

being among the hypothesized variables, these variables were only significant in Kiambu County. Table 4.14 represents the maximum likelihood estimates of factors influencing respondent's WTP in the four study sites.

Table 4.14: Maximum likelihood estimates of factors influencing respondent's WTP in the four study sites

Variable	Kiambu Coef.	Nyeri Coef.	Kakamega Coef.	Uasin Gishu Coef.
Initial Bid	0	0	0	0
Income (Ksh '000)	-0.179 (-1.99)**	0.0712 (0.82)	-0.037 (-0.39)	-0.056 (-0.46)
Age(Years)	0.009 (1.08)	0.002 (0.26)	0.007 (0.68)	-0.007 (0.52)
Gender (male)	0.165 (1.91)*	0.146 (1.19)	-0.32 (0.748)	-0.213 (-1.02)
Household size (No.)	-0.077 (-1.73)*	-0.035(1.16)	0.0319 (1.15)	-0.0037 (-0.06)
Education (Years)	-0.0003 (0.21)	0.101(0.78)	0.5353 (3.35)***	-0.083 (-0.43)
Awareness of insects as feed 1= Aware 0=Otherwise	0.299 (1.66)*	-.074 (-0.57)	-0.112 (-0.84)	0.536 (2.81)**
Preference for insect feed indices	0.346(2.93)*	0.153(1.67)*	0.265(2.71)**	-0.199 (-1.35)
Health concerns indices	0.1783 (1.66)*	-0.087(1.08)	-0.0311(-0.30)	0.305 (1.75)*
Ethics concern indices	-0.0346 (-0.33)	0.072(1.00)	-0.1138 (-1.25)	0.273 (1.83)*
Market Outlet				
Farm	Reference	0	0	0
Supermarkets	0.24244 (0.97)	0.569(2.65)**	0.3732(2.07)**	-0.108 (-0.50)
Butcheries	-0.0876 (-0.37)	0.199(1.09)	0.5248 (2.02)**	0.234 (0.70)
Wet markets	-0.395 (-1.69)*	0.4465(2.08)**	0.4131(2.49)**	0.147 (0.55)
_Constant	4.56(10.51)***	4.71(16.87)***	4.34(4.77)***	6.73 (5.44)***
	n=147 Prob>Chi²=0.021 Waldchi²= 23.89 Log likelihood = -152.7972	n=141 Prob>Chi²=0.036 Waldchi²= 22.34 Log likelihood =-145.190	n=140 Prob>Chi²=0.0210 Waldchi²= 23.89 Log-likelihood =-119.51	n=135 Prob>Chi²=0.021 Waldchi²= 18.90 Log likelihood = -114.82

Note: Numbers in brackets represent the t values: *, **, *** Significant at 10, 5 and 1% respectively.

Source: Survey data

Kiambu consumers' family size had a negative influence on WTP. The larger the family was the lesser the likelihood to pay a higher price value for chicken meat derived from insect-based feed. Daria and Mathios (2005) results on household size effect on consumer willingness to pay for milk in Rhode Island is similar to the current study results. Households with higher average household size had a decreased effect on WTP for higher amounts of value for milk compared to households with lower average household size (Daria and Mathios, 2005). This could be as a result of an increase in family expenses because as the family size increases there is a tendency to purchase products of higher prices which have no rational alternatives. The results for this variable are in contrast to the initial hypothesis that the household size effect would be positive on consumer WTP.

Respondents in Nyeri and Kakamega counties had preference for chicken meat derived from chicken fed on insect-based feed. This indicated that there could be increasing demand for the chicken fed on insects in these counties as respondents' preferences' does influence insect-based feed demand. However, in Uasin Gishu County preference for chicken fed on insects was not significant but ethical related concerns on insects as feed were not of affected on their WTP. There was a positive relation between respondents' ethical concerns and WTP for chicken fed on insect-based feed. This result can be backed up by Verbeke et al. (2015) study which found that, participants with diverse backgrounds believed that larvae of flies are a suitable source of protein for use in animal feed in Belgium and hence were WTP for the use of insects as feed. Therefore, ethics related concerns owing to ethnicity or religion did not influence their WTP and this perhaps is due to diverse backgrounds of urban residents in the study sites. Urban people tend to be liberalized and are less tied to religious or culture related matters.

Respondents' awareness of insects as feed for chicken was significant and had an affirmative influence on consumer WTP for chicken fed on insect-based feed in Kiambu and Uasin Gishu Counties. This showed that consumers that were aware of insects had an increased likelihood of paying a higher amount for chicken fed on insect-based feed in the two counties. This result is similar to Kimenju and Groote (2007), study on comparison of consumer preference for color in maize in Kenya which found that consumer awareness influences WTP as unaware consumers depend on the information provided for a particular product and this might not influence their WTP. The results for this variable affirm to the initial hypothesis that awareness effect was expected to be positive on consumer WTP.

The place of purchase had an influence on consumer WTP for chicken fed on insects. For instance, wet markets as an out let of purchase, had a positive effect on WTP in Nyeri and Kakamega Counties and a negative effect in Kiambu County. This indicates that consumers that purchased their chicken meat from wet markets had an increased demand and were willing to pay a higher value for chicken meat derived from chicken fed on insect-based feed in the former two counties unlike the latter. Consumer place of purchases does influence the frequency and willingness to buy a product. For instance, a study by Padel's, (2005) on exploring the gap between attitudes and behavior for consumers on organic food, consumers were reported to be willing to buy organic food at particular market outlets because of the pleasant environment and improved range and quality of products provided. Therefore, the place of purchase result for this variable confirm the initial hypothesis that the effect would be either positive or negative depending on the respondents'' preference for markets outlet.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

The main purpose of this study was to estimate the amount of money that chicken meat consumers were willing to pay for chicken meat derived from chicken fed on insect-based feed. This was achieved using a double bounded logit model. Descriptive results showed that overall, 55 percent of consumers were aware of different feeds available in the market for chicken and poultry at large. Preference for different insects as feed indicated that almost all consumers (95 percent) preferred termites as chicken feed. Termites were preferred because consumers perceived them as clean and edible insects. The results also displayed that black solder flies were preferred by a lesser number of consumers (45 percent). This was because some consumers (30 percent) were not acquainted with this insect and others (65 percent) perceived it as dirty despite being easily accessible. According to the results grasshopper and crickets were preferred by some consumers 84 and 64 percent respectively. The least preferred (48 percent) insect was housefly maggot, as many consumers perceived it dirty and unhygienic.

The results also revealed that almost all consumers (91 percent) were willing to purchase chicken meat that is fed on insects as a source of protein. Moreover, if the cost of producing and availing insect-based feed entailed charging a premium, 59 percent of consumers were willing to pay it. This can be explained by the benefits attached to chicken meat derived from insect-based feed which the enumerators expounded to the consumers. Chicken meat derived from insect-based feed was described as of less fat, better taste, good texture and highly nutritious. The consumers that were not willing to purchase chicken meat derived from insect-based feed expressed their health concerns and stated that this chicken could harm them. The double bounded parametric formulation was used to estimate mean WTP. Generally all consumers were willing to pay a

mean amount of KShs 537.59 which is a premium of 23% from the current market price (KShs.425). Some factors had an influence on consumer WTP. Consumer's income, consumer preference for insect-based feed, consumer preference for black solder fly, consumer preference for crickets, consumer crickets' awareness and supermarket as a point of purchase were significant. These factors influenced consumer WTP either positively or negatively.

5.2 Conclusion

The study was motivated by the lack of information on consumer preference for insects as chicken feed and their WTP for chicken meat derived from insect-based feed. The study examined consumer WTP in Kenya, across four counties. The findings from the study show that some consumers were aware of insects as chicken protein source. Some insects such as termites, grasshopper and cockroaches were easily identified by consumers. On the contrary insects such as black solder flies and housefly maggots were not easily recognized by consumer. Consumers also had preference for some insects unlike others. For instance termites, grasshopper and crickets were preferred unlike housefly maggots and black solder flies. Consumers perceived black solder flies and housefly maggots as dirty insects, yet these are some of the insects considered as a rich source of protein. Therefore there is a need to create awareness of insects such as black solder flies to not only consumers of chicken meat but also to other stakeholders and the entire public. Also information on the nutritional benefits that insects contain should be disseminated to counteract the stigma that these insects are dirty and cannot be used as protein source for chicken feed.

The study concluded that almost all consumers were willing to pay for chicken meat derived from chicken fed on insect-based feed, as many consumers accepted insects as a protein source

for poultry. Consumers were willing to pay a higher price for chicken fed on insects unlike the "normal" chicken. This shows the practicality of using insects as feed since consumers are willing to pay for chicken meat derived from chicken fed on insect-based feed. In addition, empirical evidence showed that consumers' WTP was highly influenced by income, age, education, gender of the consumer, awareness of insects as feed and consumer's preferred point of purchase.

5.3 Recommendations

The study recommends the use of insects such as termites, grasshoppers and crickets as a source of protein in chicken production. These insects are well known by consumers and are most preferred. The study also recommends the need to create awareness and disseminate information on the nutritional value that insects such as black solder fly and housefly maggots add in poultry feed despite being perceived as dirty insects. Moreover, production of insect-based feed at ICIPE should progress to avail insect feed into the market to supplement the available protein feed such as small fish and soya bean. Availing of the feed in the market will be of gain for chicken producers and hence boost production which will result in increased supply to meet consumer demand for chicken meat.

There is a need for policy makers to create a favorable environment through formulation of policies that allow the use of insects as poultry feed to benefit poultry production in Kenya. Policy makers and other stakeholders in animal production should easy the protocols included in certification and introduction of commercially produced insect feed. Finally, chicken meat derived from chicken fed on insect-based feed should be promoted as almost all consumers were willing to purchase the meat if availed in the market.

5.4 Areas of further Research

There is a need for further research to capture more information on consumer preference and WTP for chicken fed on insect-based feed in the other excluded counties in Kenya as the study focused on four counties only. In addition there is need for future scientific data and research on the use of insects as feed as the current study was hypothetical and hence was restricted on stated preferences which require carefully designed survey and sampling procedures and therefore, obtaining the data needed a substantial investment of time and resources, hence expensive. Moreover, the current study was limited in knowledge on the adverse effects that prolonged uses of insects have on chicken and consumers. Also, the nutritional composition, bioactive compounds and safety for consumption of different insect species under different dietary conditions needs to be extensively investigated. While the above study provides useful insights into consumers' decisions for preference and acceptance of the use of insect-based feed in chicken production, these insights are confined by their narrow focus on an individual consumer rather than social, cultural and environmental contexts within which consumer decisions are made. Hence, the need for more research that should focus on diverse aspects that influence people decisions and preferences for insects as feed and food.

REFERENCES

Abdullah, S., and P. W. Jeanty, (2011). Willingness to pay for renewable energy: Evidence from a contingent valuation survey in Kenya: *Renewable and Sustainable Energy Reviews*, 15(6): 2974-2983.

Addisu, A. (2014). Non-Market Valuation of Cultural Heritages in Ethiopia Using Travel Cost and Contingent Valuation Methods: *An Application to Rock-Hewn Churches of Lalibela* (Doctoral dissertation, AAU).

Agea, J.G., Biryomumaisho, D., Buyinza, M. and Nabanoga, G.N., (2008). Commercialization of Ruspolia nitidula (nsenene grasshoppers) in central Uganda: *African Journal of Food Nutrition and Development* 10(8): 319-331.

Ain, B. H, P.A. Geraert, J.C.F Padilha, S.Guillaumin (1996). Chronic heat exposure enhances fat deposition and modifies muscle and fat partition in broiler carcasses: *Poultry Science* 1996, 75 (5): 505-513.

Ahuja,V., D. Umali-Deiningerb, C. Haan (2002). Market structure and the demand for veterinary services in India: *Agricultural Economics* 29 (3): 27-42

Ajzen, I. and L.D. Beverly (1992). Application of the Theory of Planned Behavior to Leisure Choice: *Journal of Leisure Research,* 24(3): 207-255.

Ajzen, I. (1991). The theory of planned behavior: *Organizational Behaviour and Human Decision Processes,* 50: 179-211.

Alemu, M. H., B. O. Søren, E.V. Suzanne, O. P. Kennedy, and O. Victor (2015). Consumer Acceptance and Willingness to Pay for Edible Insects as Food in Kenya: *Food Policy,* 37(4): 38–70.

Ali-Olub, A. M., Kathuri, N. J., & Wesonga, T. E. (2011). Effective extension methods for Increased food production in Kakamega District: *Journal of Agricultural Extension and Rural Development*, 3(5): 95-101.

Alunga, J. U., & William, M. J. (2013). Gender Roles and Agribusiness in the Kenyan Communities: The Case of Likuyani District: *Journal of Emerging Trends in Educational Research and Policy Studies*, 4(5): 733.

Anand, H., Ganguly, A. and Haldar, P., (2008). Potential value of acridids as high protein supplement for poultry feed: *International Journal of Poultry Science* 7: 722-725.

Angulo, A.M. and M. G. Jose (2007). Risk Perception and Consumer Willingness to Pay for Certified Beef in Spain: *Food Quality and Preference,* 18(8): 11–17.

Arrow, K., S. K. Robert, P. R. Paul, E. L. Edward, R. Roy, and S. Howard (1993). Report of the NOAA Panel on Cont ingent Valuation: *Federal Register*, 58(10): 10–14.

Ayieko, M. Oriaro, V. and Nyambuga, I. (2010). Processed Products of Termites and Lake Flies: Improving Entomophagy for Food Security within the Lake Victoria Region, African: *Journal of Food, Agriculture, Nutrition and Development*, 10(2): 1-14.

Bett, H.K., M.P. Musyoka, K.J. Peters, and W. Bokelmann (2012). Demand for Meat in the Rural and Urban Areas of Kenya: A Focus on the Indigenous Chicken: *Economics Research International* 20 (2): 15–16.

Batte, M.T, H. Neal, C.H. Timothy, and B. Jeremy (2007). Putting Their Money Where Their Mouths Are; Consumer Willingness to Pay for Multi-Ingredient, Processed Organic Food Products: *Food Policy*, 32(2): 145–59.

Beardsworth, A., A. Bryman, T. Keil, J. Goode, C. l.Haslam, and E. Lancashire (2002). Women, Men and Food: The Significance of Gender for Nutritional Attitudes and Choices: *British Food Journal*, 104(7): 47–91.

Blaug, M. (1997). Economic Theory in Retrospect: Cambridge university press, Cambridge.

Boyle, K. J. (2003). Contingent Valuation in Practice: In *A Primer on Nonmarket Valuation*, 23(9): 11–69.

Bukkens, S.G.F., (2005). Insects in the human diet: nutritional aspects. In: Paoletti, M.G. (ed.) Ecological implications of livestock: role of rodents, frogs, snails, and insects for sustainable development: *Science Publishers*, Enfield, CT, USA, pp. 545-577

Cattin, P., and R. W. Dick (1982). Commercial Use of Conjoint Analysis: A Survey. *The Journal of Marketing*, 7(8): 44–53.

Cowan, C., N. Riordan, and M. McCarthy (2000). Irish Consumers' Willingness to Pay for Safe Beef: *Food Policy*, 18(5): 25–36.

DeFoliart, G.R., (2005). Overview of the role of edible insects in preserving biodiversity. In Paoletti, M.G. (ed.) Ecological implications of minilivestock: potential of insects, rodents, frogs and snails: *Science Publishers*, Enfield, CT, USA, pp. 123-140

De Groote, H. and C.K. Simon, (2008). Comparing Consumer Preferences for Color and Nutritional Quality in Maize; Application of a Semi-Double-Bound Logistic Model on Urban Consumers in Kenya: *Food Policy*, 33(4):362–70.

Delgado, C. L., M. W. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. (1999). The Coming Livestock Revolution: *Department of Economic and Social Affairs, Commission of Sustainable Development, Eighth Session Background Paper* 6(1): 15-39.

Dose, H. (2007). Securing household income among small-scale farmers in Kakamega district:

Possibilities and limitations of diversification, *GIGA working papers*, 41(9): 16-33.

Erih, E. A, O. A. Oni, and K. M. Fashogbon (2015). Consumers' Willingness to Pay for Cassava Flour Inclusion in Bread, a Case Study of Lagos State, Nigeria: *Sustainable Agriculture Research*, 4(2):92-160.

Esri ,J. M. (2018). Demographics and Boundaries/Map Server: https://demographics2.arcgis.com/arcgis/rest/services/KEN_Demographics_and_Boundaries/MapServer?ts=1372977172482 (Accessed 07.08.17)

Everitt, B., and Hothorn, T. (2011). An introduction to applied Multivariate analysis with R. New York: Springer.

FAO, (2008). Poultry sector country review- http://www.fao.org/3/a-ai379e.pdf (Accessed 09.03.17).

FAO, 2011 (a). Mapping supply and demand for animal-source foods to 2030, by T.P. Robinson & F. Pozzi. *Animal Production and Health Working Paper*. No. 2. Rome

FAO, 2011(b). The Place of Urban and Peri-Urban Agriculture (UPA) in National Food Security Programs. Rome. http://www.fao.org/docrep/014/i2177e/i2177e00.pdf.

FAO, (2012). The State of World Fisheries and Aquaculture 2012. Rome: Food and Agriculture Organization of the United Nations.

FAO, (2013). Edible Insects: future prospects for food and feed security. Food and Agriculture Organization.http://www.fao.org/docrep/018/i3253e/i3253e.pdf (Accessed 09.03.18).

Farina, L., Demey, F. and Hardouin, J., (1991). Production of termites for poultry feeding in villages in Togo. *Tropicultura* 9: 181-187.

Feldman, A. L. (2012). Introduction to Contingent Valuation using Stata MPRA Paper No. 41018, posted 4. September, 2012.

Filmer, D., Pritchett, L., (1998). Estimating Wealth Effects Without Expenditure Data-or Tears: An Application to Educational Enrollments in States of India. The World Bank, Washington, DC, unpublished.

Genius, M., E. K. Hatzaki, M.K. Kouvakis, G. Nikiforaki, S. and K.P. Tsagarakis (2008). "Evaluating Consumers' Willingness to Pay for Improved PoTable Water Quality and Quantity." *Water Resources Management*, 22(12): 18–34.

Gujarati, D. N. (2009). *Basic Econometrics*. Tata McGraw-Hill Education. New York.

Guthiga, P.M, Mburu J., Holm-Mueller K. (2008). Factors influencing local communities' satisfaction levels with different forest management approaches of Kakamega forest, Kenya. *Environ Manage* 41(5): 696-706.

Hall, L. M.A, C.M. Dierikx, J. C. Stuart, G.M.Voets, M.P.V. Munckhof, A. E. Zandbergen, T. Platteel, A.C. Fluit, N.S. Bruinsma, and J. Scharinga. (2011). Dutch Patients, Retail Chicken Meat and Poultry Share the Same ESBL Genes, Plasmids and Strains." *Clinical Microbiology and Infection*, 17(6): 73–80.

Hanemann, M., and K. Barbara (2001). The Statistical Analysis of Discrete-Response CV Data147: *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU, and Developing Countries*, 302(16):18–47.

Hanemann, M., John L., and B. Kanninen (1991). Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation: *American Journal of Agricultural Economics*, 73(4): 12–63.

Herriges, J. A, L. Catherine, and J. P. Daniel (2004). What's the Use? Welfare Estimates from Revealed Preference Models When Weak Complementarity Does Not Hold: *Journal of Environmental Economics and Management,* 47(1): 55–70.

Higgs, J. D. (2000). The Changing Nature of Red Meat: 20 Years of Improving Nutritional Quality: *Trends in Food Science & Technology* 11 (3): 85–95.

Hope, R.A., Frost, P.G.H., Gardiner, A. and Ghazoul, J., (2009). Experimental analysis of adoption of domestic mopane worm farming technology in Zimbabwe. D*evelopment Southern Africa* 26 (5): 29-46.

House, J. (2018). Insects are not 'the new sushi: Theories of practice and the acceptance of novel foods. *Social and Cultural Geography* 14(4):3 -20.

Huang, C.L. (1996). Consumer Preferences and Attitudes towards Organically Grown Produce: *European Review of Agricultural Economics,* 23(3): 331–42.

Irungu, P. (2011). An Economic Analysis of Adoption Potential of a New Tsetse Fly Repellent Technology in Trypanosomosis Control: The Case of Kajiado and Narok Districts of Kenya: Unpublished PhD Thesis, University of Nairobi

Kalafatis, S. P, P. Michael, E. Robert, and H. T Markos. (1999). Green Marketing and Ajzen's Theory of Planned Behavior: A Cross-Market Examination: *Journal of Consumer Marketing,* 16(5): 441–60.

Kalunda, E. (2014). Financial inclusion impact on small-scale tea farmers in Nyeri County, Kenya: *World, 4*(1): 9-19.

Kamuanga, M., M. S. Brent, S. Hamadé, and B. Burkhard (2001). Evaluating Contingent and Actual Contributions to a Local Public Good: Tsetse Control in the Yale Agro-Pastoral Zone, Burkina Faso. *Ecological Economics,* 39(1): 115–30.

Kanninen, B. J. (2007). *Valuing Environmental Amenities Using Stated Choice Studies*. Springer, Berlin.

Kariuki.J. (2016). World-Bank-ranks-Uasin-Gishu-and-Kisumu-as-most investor friendly /https://www.businessdailyafrica.com/magazines/1248928-3379846-2sbudc/index.html (Accessed 02.07.17)

Kenya National Bureau of Statistics (KNBS), Statistical Abstracts Government Printer, Nairobi Kenya-Labor-Market-Report-(2016). (http://www.ulandssekretariatet.dk/sites/default/files/uploads/public/PDF/LMP/lmp_kenya_2014_final_version.pdf) (Accessed 07.10.17)

Kinyuru, J. J., N. M. Birundu, A. R. Chris, and W.N. Ndung'u (2015). Edible Insects—a Novel Source of Essential Nutrients for Human Diet: Learning from Traditional Knowledge." *Animal Frontiers,* 5(2): 14–19.

Korir, L. K. (2011). Risk Management among Agricultural Households and the Role of off-Farm Investments in Uasin Gishu County, Kenya: Unpublished Msc Thesis, University of Nairobi

Kragt, M. E, and W.J. Bennett. (2011). Using Choice Experiments to Value Catchment and Estuary Health in Tasmania with Individual Preference Heterogeneity: *Australian Journal of Agricultural and Resource Economics,* 55(2): 159–79.

Krystallis, A., and G. Chryssohoidis (2005). Consumers' Willingness to Pay for Organic Food: Factors That Affect It and Variation per Organic Product Type: *British Food Journal,* 107(5): 320–43.

Lancaster, K. J. (1966). A New Approach to Consumer Theory: *The Journal of Political Economy*, 14(6): 132–57.

Lekasi, J.K, J.C. Tanner, S.K. Kimani, and P.J.C. Harris. (2006). Effects of Poultry Litter Amended Steer Diets and Subsequent Manure Collecting Systems on Nutrient Recovery in Composted Manures: *Biological Agriculture & Horticulture,* 23(4):413–27.

Leung, W., Busson, W.T. and Jardin, F. (eds.), (1970) T*able de composition des aliments àl'usage de l'Afrique. FAO, Rome, Italy.*

Loomis, J., M. Hanemann, B. Kanninen, and T. Wegge (1991). Willingness to Pay to Protect Wetlands and Reduce Wildlife Contamination from Agricultural Drainage: In *The Economics and Management of Water and Drainage in Agriculture*, 2: 411–29.

Loureiro, M. L, and Justus Lotade (2005). Do Fair Trade and Eco-Labels in Coffee Wake up the Consumer Conscience?: *Ecological Economics,* 53(1): 129–38.

Loureiro, M. L., & Hine, S. (2002). Discovering niche markets: A comparison of consumer willingness to pay for local (Colorado grown), organic, and GMO-free products. *Journal of Agricultural and Applied Economics*, 34(03): 477-487.

Loureiro, M. L, J M. Jill and C .M. Ron (2001). Assessing Consumer Preferences for Organic, Eco-Labeled, and Regular Apples: *Journal of Agricultural and Resource Economics*, 17(5): 404–16.

Lusk, J. L. and Darren Hudson (2014). Willingness-to-Pay Estimates and Their Relevance to Agribusiness Decision Making: *Review of Agricultural Economics* 26(2): 2–19

Machiyama, K., Casterline, J. B., Mumah, J. N., Huda, F. A., Obare, F., Odwe, G., & Cleland, J. (2017). Reasons for unmet need for family planning, with attention to the measurement of fertility preferences: protocol for a multi-site cohort study. *Reproductive health*, 14(1): 23

Maloba, B.S.W. (2016). "Harnessing Indigenous and Scientific Knowledge to Promote Farmer Multi-Stakeholder Partnerships in Food Security in Kakamega County, Kenya. *Innovations in Achieving Sustainable Food Security in Eastern and Southern Africa*, 129(9): 99–256.

Martinez-Legaz, J.E. (1991). Duality between Direct and Indirect Utility Functions under Minimal Hypotheses: *Journal of Mathematical Economics,* 20(2): 199–209.

Mathieson, K. (1991). Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior: *Information Systems Research*, 2(3): 173–91.

Mburu, F. (2008). The viability of YEDF as an empowerment tool for youth entrepreneurs in the informal sector in Ruiru division, Thika District, Kenya. Unpublished M.A. Sociology report. University of Nairobi, Kenya.

Melton, B. E, E. H. Wallace, J. F. Sason, and A. F. John (1996). Consumer Preferences for Fresh Food Items with Multiple Quality Attributes: Evidence from an Experimental Auction of Pork Chops: *American Journal of Agricultural Economics,* 78(4): 916–23.

Mithamo, M.W. (2013). Effect of Intercropping Coffee with Fruit Trees on Coffee Eco-Physiological and Soil Factors at Coffee Research Foundation in Ruiru, Kiambu County, Kenya. Unpublished PhD Thesis, University of Nairobi

Mueller, D. C. (2004). Public Choice: An Introduction: In *The Encyclopedia of Public Choice*, 32–48.

Munguti J and H.C. Karisa (2011). Fish Feeds and Aquaculture Development in Kenya. *In:*

Samaki News: Aquaculture development in Kenya towards food security, poverty alleviation and wealth creation, 7(1): 27-29.

Mwanzia, R., (2010). Kenya Poultry Update. Kenya Poultry Partnership.Wednesday, 19, 2010. Kenya Poultry Partnership. Ed. Mwanzia Rosemary. *Kenya Poultry Updates.* (Accessed 19.09.17)

Nakagaki, B.J. and DeFoliart, G.R., (1991). Comparism of diets for mass rearing Acheta domesticus (Orthoptera: Gylidae) as a novelty food, and comparism of food conversion efficiency with values reported for livestock: *Journal of Economical Entomology* 84: 891-896.

Navrud, S. (2004). Value Transfer and Environmental Policy: *The International Yearbook of Environmental and Resource Economics*, 24(5): 89-211.

Ngecu, W. M, C.M. Nyamai, and G. Erima (2004).The Extent and Significance of Mass-Movements in Eastern Africa: Case Studies of Some Major Landslides in Uganda and Kenya: *Environmental Geology*, 46(8): 1123–33.

North, E., and D. V. Retha (2002). The Use of Conjoint Analysis to Determine Consumer Buying Preferences: *Journal of Family Ecology and Consumer Sciences/Tydskrif Vir Gesinsekologie En Verbruikerswetenskappe*, 30(1): 30-55.

Odera, M. J. (2013). Factors influencing demand of consumer products among supermarket Shoppers in Kimilili Municipal Council-Bungoma County-Kenya: Unpublished Msc Thesis, Moi University

Odhiambo, B. O., M., Hunja and I. N. W. Isabel (2013). Isolation and Characterisation of Aflatoxigenic Aspergillus Species from Maize and Soil Samples from Selected Counties of Kenya: *African Journal of Microbiology Research*, 7(34): 43–88.

Okedi, J., (1992). Lake flies in Lake Victoria – their biomass and potential for use in animal feeds. I*nsect Science and its Application* 13: 137-144.

Okello, J., Z.Gitonga, J. Mutune, M.R. Okello, A. Martin, and K.M Rich (2010). Value Chain Analysis of the Kenyan Poultry Industry: The Case of Kiambu, Kilifi, Vihiga, and Nakuru Districts: Unpublished PhD Thesis, University of Nairobi

Omiti, J.M, and S. Okuthe (2009). An Overview of the Poultry Sector and Status of Highly Pathogenic Avian Influenza *(HPAI)* in Kenya: *Background Paper*. International Food Policy Research Institute (IFPRI).

Onwujekwe, O., E. M. Mohamed, S.M. Hassan, and A. Mnzava (2005). Socio-Economic Inequity in Demand for Insecticide-Treated Nets, in-Door Residual House Spraying, Larviciding and Fogging in Sudan: *Malaria Journal*, 4(1): 100-115.

Oonincx, D.G.A.B., Van Itterbeeck, J., Heetkamp, M.J.W., Van den Brand, H., Van Loon, J.J.A. and Van Huis, A., (2010). An exploration on greenhouse gas and ammonia production by insect species suitable for animal or human consumption: *PLoS ONE* 5(2): 14-20.

Opiyo, M. A, C. M.Githukia, J. M. Munguti, and H. C. Karisa (2014). Growth Performance, Carcass Composition and Profitability of Nile Tilapia (Oreochromis Niloticus L.) Fed Commercial and on-Farm Made Fish Feed in Earthen Ponds: *International Journal of Fisheries and Aquatic Studies,* 2(1): 12–17.

Owuor, B. B. W. G. Argwings-Kodhek, and P. Colin (2009). The Role and Performance of Ministry of Agriculture in Nyeri South District. *Future Agricultures Research Paper* 18(1): 25-97)

Padel, S. and Foster, C. (2005). Exploring the gap between attitudes and behaviour: Understanding why consumers buy or do not buy organic food: *British Food Journal* , 107 (8): 606-625.

Parsons, G. R. (2003). The Travel Cost Model: In *A Primer on Nonmarket Valuation. The Economics of Non-Market Goods and Resources*, edited by Champ, P. A., K. J. Boyle, and T. C. Brown, 269–329. Dordrecht: Kluwer Academic Publishers, Netherlands.

Poor, P. J., and J. M. Smith. (2004).Travel Cost Analysis of a Cultural Heritage Site: The Case of Historic St. Mary's City of Maryland: *Journal of Cultural Economics* 28: 217–229.

Rao, C. R. (1964). The use and interpretation of principla components analysis in applied research: *The Indian journal of statistics*, 26(4): 392-348.

Rubey, L., Lupi, F., (1997). Predicting the effects of market reform in Zimbabwe: stated preference approach: *AmericanJournalofAgriculturalEconomics,*79(7): 89–99.

Rumpold, B.A., and K. S. Oliver (2013). Potential and Challenges of Insects as an Innovative Source for Food and Feed Production: *Innovative Food Science & Emerging Technologies*, 17(1): 1–11.

Ravindran, V. and Blair, R., (1993). Feed resources for poultry production in Asia and the Pacific. II. Animal protein sources. *World's Poultry Science Journal* 49(6): 219-235

Saxe, H., Larsen, T.M. and Mogensen, L., (2013). The global warming potential of two healthy Nordic diets compared with the average Danish diet. *Climatic Change* 116: 249-262

Schosler, H., J. de Boer and J. J. Boersema (2012). Can we cut out the meat of the dish? Constructing consumer-oriented pathways towards meat substitution: *Appetite,*581(6): 39-47.

Sethuraman, R., & Cole, C. (1999). Factors influencing the price premiums that consumers pay for national brands over store brands: *Journal of Product & Brand Management*, 8(4), 340 351.

Skuras, D., and A.Vakrou. (2002). Consumers' Willingness to Pay for Origin Labeled Wine: A Greek Case Study: *British Food Journal*, 104(11): 898–912.

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., & De Haan, C. (2006). Livestock's long shadow: *Environmental issues and options* conference in Rome, Italy: FAO

Taylor, L. (2003). The Hedonic Method. In A Primer on Non-market Valuation, edited by P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht: Kluwer Academic Publishers, Netherlands.

Turner, R.K., I.J. Bateman, and W.N. Adger (2001). Ecological Economics and Coastal Zone Ecosystems' Values: An Overview: In *Economics of Coastal and Water Resources: Valuing Environmental Functions*, 10(6):1–43.

USAID (2015). The 2015 CSO Sustainability Index For Sub-Saharan Africa' https://www.usaid.gov/sites/default/files/documents/1866/2015_Africa_CSOSI.pdf (Accessed 07.08,17)

Umberger, W. J, D. Thilmany, M.C. Fadden, and R. S. Amanda (2009). Does Altruism Play a Role in Determining US Consumer Preferences and Willingness to Pay for Natural and Regionally Produced Beef: *Agribusiness,* 25(2): 268–85.

Van Huis, A. (2013). Potential of Insects as Food and Feed in Assuring Food Security: *Annual Review of Entomology,* 58:563–83.

Veldkamp, T. G. and A. V. Huis (2012). Insects as a Sustainable Feed Ingredient in Pig: *Food Chemistry,* 50: 192–95.

Venkatachalam, L. (2004). The Contingent Valuation Method: A Review: *Environmental Impact Assessment Review,* 24(1): 89–124.

Verbeke, W., T. Spranghers, P. D. Clercq, D. S. Stefaan, and E. Mia (2015). Insects in Animal Feed: Acceptance and Its Determinants among Farmers, Agriculture Sector Stakeholders and Citizens: *Animal Feed Science and Technolog,* 204: 72–87.

Wanjala, T. (2014). Utilization of Information Communication Technologies (ICTS) in the Management of Transboundary Animal Diseases (Tads). The Case of Selected Counties in Kenya: Unpublished Msc Thesis; University of Nairobi.

Wezemael V., L., Verbeke, W., de Barcellos, M. D., Scholderer, J., & Perez-Cueto, F. (2010).

Consumer perceptions of beef healthiness: results from a qualitative study in four European countries: *BMC Public Health,* 10(5): 342.

Whittington, D., J. Briscoe, M. Xinming, and B. William (1990). Estimating the Willingness to Pay for Water Services in Developing Countries: A Case Study of the Use of Contingent Valuation Surveys in Southern Haiti: *Economic Development and Cultural Change,* 38(2): 293–311.

Wyse, S., E. (2014). Advantages and disadvantages of face-to-face data Collections: Retrieved from-http://www.snapsurveys.com/blog/advantages-disadvantages-facetoface-data-collection (Accessed 05.06.17)

Yiridoe, E. K., B. A. Samuel, and C. M. Ralph (2005). Comparison of Consumer Perceptions and Preference toward Organic versus Conventionally Produced Foods: A Review and Update of the Literature: *Renewable Agriculture and Food Systems,* 20(4):193–205.

Zapata, S. D., and Carpio, C. E. (2014). The Theoretical structure of producer Willingness To Pay Estimates: *Agricultural Economics,* 45(1):1-11.

APPENDICES

Appendix i:
Consumer questionnaire

UoN/ICIPE

Consumer willingness to pay for chicken meat derived from insect-based feed in Kenya

Seeking Consent

Hello. My name is _____. I am working with the University of Nairobi and ICIPE in conducting interviews with consumers in this County to investigate willingness to pay for chicken meat that has been derived from insect-based feed. The overall objective of the study is to generate information that will guide the utilization of various insects such as termites (kumbekumbe), housefly maggots, cockroaches and grasshoppers as a source of protein in the manufacture of poultry feed. This will conserve the dwindling fish (Omena) resources and help to create employment along the animal feed value chain in our country.

The information that you will provide will be treated with utmost confidentiality. May I proceed with the interview? Thank you very much.

(***If the respondent agrees continue with the interview, if s/he does not, look for another one).***

The respondent should be an individual that consumes chicken meat

Do you consume chicken meat? 1=Yes; 2=No_____

If "Yes" proceeds with the interview if "No" terminate the interview

Consumer ID: _____

Date of interview __/___/2016

Section 1

Background Information

Name of Interviewer	
County name	1=Kiambu 2= Nyeri 3= Kakamega 4= Uasin Gishu - (Write)_____
Town name	1=Kiambu 2=Nyeri 3= Kakamega 4=Eldoret (Write)_____

1. Name of the respondent _____

2. Are you the household head? 1=Yes _____ 2=No_____

3. Place of interview_____

Supermarket

Butchery

Consumer characteristics

Please provide the following information

Gender of respondent	
Age of respondent	
Highest level of formal Education achieved	
Marital status: 1=Married 2=Single	
Family size	
Number of children: Below 5yrs of age Between 5 and12years Between 12 and 18 years Above I8 years	 _____ _____ _____ _____
Household type 1=Male headed 2= Female headed	

5**.** Do **you prefer** white meat or red meat? (1= white meat 2= red meat) _____

6. **Why** do you prefer that ***(the preferred meat)*** type of meat?

1. Nutritious_____

2. Easily available_____

3. It is affordable _____

4. It is healthier _____

7. What chicken type of meat do you prefer **most**?

1. Free range (Kienyeji)

2. Commercially produced (Broiler)

Section 2: Consumer's economic activities

8. Please provide the following information:

Economic activity	**Yes/No**	**Rank(1=Most important 2= important 3= not that important)**	**Estimated monthly income (KShs)**
Formal Employment			
Agribusiness			
Off-farm (Selling labor in a farm)			
Non-farm: Petty trade(Specify) _____			
Businesses(Specify)_____			
Remittances			
Pension			
Others (Specify)			

9. How much do you spend on the following in a month on the following items?

Item	Estimated monthly expenditure
Food	
Rent	
Clothing	
Medicare	
Entertainment	

10. How many times do you buy chicken in a month? _____

11. What proportion of spending is on chicken meat? _____

12. How many minutes does it take you from home to the point of sale for chicken meat? _____

Section 3:

Consumer Knowledge, Awareness and Attitude Towards use of insects in Chicken Feed

13. Do you know what broilers are fed on? (1=Yes; 2=No)_____

14. If YES, please mention some of the feeds that you know? _____ _____ _____

15**.** Are you aware that broilers can be feed on the following protein sources?

Soya (1= Yes; 2= No) _____

Small fish (Omena) (1= Yes; 2=No) _____

Insects (cockroaches, housefly maggots, termites, crickets)
(1= Yes; 2= No) _____

16. Consumer concerns about what chicken is feed on

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
When purchasing broiler chicken;					
i.) I take into consideration what they were fed on when they were alive					

ii.) I am not bothered about what the chicken were fed on when they were alive fed on					
iii.) I think about the health risks associated with the feed they were fed on when they were alive					
iv.) I always check the labels written on the chicken meat wrapper before I buy					
v.) I take into consideration the supplier's name or company name					

17. Are you aware of the use of insects in the manufacture of chicken feed?

Insect type	**Awareness (1=aware 2=not aware)**	**Where did you learn about it? 1=Extension worker, 2= Neighbor, 3= Own experience, 4= Media, 5= Others (specify_____)**
Cockroaches		
Termites "Kumbekumbe"		
Housefly maggots		
Crickets		
Grasshoppers		

18. Consumer preference for different insect species to be used in chicken feed

Insect type	**Would you prefer this type of insect to be used in chicken feed manufacture? (1=Yes, 2= No)**	**For those which are preferred, why do you prefer them?**	**Preference Rank 1=Most preferred, 2=Preferred, 3=Less preferred, 4=Least preferred**
Cockroaches			

Termites "kumbekumbe'			
Housefly maggots			
Crickets			
Grasshoppers			

19. I'm going to read you some statements about your feelings on your consumption of chicken meat that is derived from insect-based feed. Kindly indicate whether you Strongly Agree, Agree, Disagree, Strongly disagree or if you are in between those options.

Statement	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
i.) use of insects (housefly maggots, termites "kumbekumbe", grasshoppers, cockroaches and crickets) in chicken feed is a good thing.					
ii.) meat from chicken fed on insects is more nutritious and is less fatty than broiler meat					
iii.) I am willing to purchase meat from chickens fed on insects as is not different from broilers.					
iv.) Meat from chickens fed on insects is of better texture than broiler meat.					
v.) Meat from chickens fed on insects is of better taste than broiler meat.					
vi.) Meat from chickens fed on insects is of inferior quality compared to "normal" broiler chicken.					

20. I'm doing to read you some statements about your feelings on the health effects of consuming chicken meat that is derived from insect-based feed. Kindly indicate whether you strongly Agree, Agree, Disagree, and strongly agree or if you are in between those options:

Statements	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
i.) Meat from chicken fed on insects is safe for me.					
ii.) Meat from chicken fed on insects is harmful to my health.					
iii.) Use of insects for the manufacture of chicken feed will reduce the nutritional quality of the meat.					
iv.) Meat from chicken fed on insects is just like meat from genetically modified organisms (GMO).					
v.) I expect that the insects to be used for the manufacture of chicken feed to be raised under hygienic factory conditions.					
vi.) I feel nauseated at the thought of eating meat from chicken fed on insect.					
vii.) I am satisfied with eating meat from broilers and will never eat meat from chicken fed on insects.					

21. I'm going to read you some statements about your feelings on the ethics of consuming chicken meat that is derived from insect-based feed. Kindly indicate whether you strongly Agree, Agree, Disagree, and strongly disagree or if you are in between those options:

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
i.) Use of insects as chicken feed goes against my religious beliefs					
ii) Use of insects as chicken feed goes against my culture					
iii.) Use of insects as chicken feed is acceptable in my culture.					
iv.) Sale of unlabeled chicken meat that is produced from insect-based feed is wrong.					
v.) Use of insects as chicken feed will lower the price of chicken meat.					
vi.) Chicken meat produced from insect-based feed is contaminated.					
vii.) Chicken meat derived from insect-based feed should not be placed in the same freezer or container as "normal" broiler chicken in butcheries or supermarkets.					

22. When buying chicken meat, are the following characteristics important in your decision to buy?

Characteristics	Very important	Important	Neutral	Not important	Not very important
Price					
Quantity					
Type of feed used					
Effect on my health					
Effect on my cultural beliefs					
Effect on my religion					

Section 4:

Assessment of Consumer's Willingness to Pay

***READ THE FOLLOWING PARAGRAGH TO THE RESPONDENT*:**

There are plans to use of insects as a source of chicken feed in Kenya. The chicken meat so produced is expected to be less fatty, with high calcium content, better texture and better taste than the "normal" broiler chicken. Suppose this chicken meat was introduced in the market today;

23. Would you buy it? _____ (1= Yes; 2= No)

(*If yes*)

24. Would you be willing to pay **KShs _____**/kg for the meat, which is the average market price per kg of broiler meat in this town? (1=Yes, 2=No) _____

25. ***If Yes in (Q.24),*** would you pay **KShs _____/kg** for the same chicken meat? (YES/NO)_____

26. ***If No in (Q.24),*** would you pay **KShs _____/kg** for the same chicken meat? (YES/NO_____

27. ***If answers to Q. 24 and 26 are No, No***; why wouldn't you be willing to pay for chicken meat derived from insect-based feed?

1= Insect-based feed has health risks for me

2= use of insects as chicken feed is not be different from use of genetically modified organisms GMO

3= I would want to taste it first.

4= It is against my culture.

5= It is against my religious beliefs.

6= I think that meat from chicken fed on insects is inferior to "normal" broiler meat

5= Other (Specify) _____

28. Quantity of chicken meat bought and the frequency of buying

Time	**Quantity bought**	**Frequency of buying**
Now		
In a week		
In a month		

29. Where do you **mostly** buy chicken meat?

1= Supermarket

2= Wet market

3= Hotels

4= Raw chicken meat from butcheries

5= Other_____

Section 5: Measurement of Living Standards

30. Which of these assets do you own?

Durable asset	*Owned=1* *Not owned=2*	Quantity owned
Bicycle		
Boda boda (Motorcycle)		
Personal car		
Pickup		
Tractor		
Plastic water tank		
Stone water tank		
Mobile phone		

Laptop		
Working radio		
Working TV		
Sofa set		
Fridge		
Gas cooker		
Electric cooker		
Electric ironing box		

Section 6: Consumer's Dietary and Nutritional Diversity

31. Have you or a member of your household consumed the following the last 24hrs?

Question No.	**Food group**	**Examples**	**Yes = 1** **No = 2**
1.	CEREALS	Corn/Maize, rice, wheat, sorghum, millet, or any other grain or foods made from these(e.g. bread, noodles, porridge or other grain products*)+insert local foods e.g. ugali, nshima, porridge or paste*	
2.	WHITE ROOTS AND TUBERS	White potatoes, white yams, white cassava, or other foods made from roots	
3.	VITAMIN A RICH VEGETABLES AND TUBERS	Pumpkin, carrots, squash, or sweet potatoes that are orange inside + *other locally available vitamin A rich vegetables (e.g. red sweet pepper)*	
4.	DARK GREEN LEAFY VEGETABLES	Dark green leafy vegetables, including wild forms+ *locally available vitamin A rich leaves such as spinach, kale, cassava leaves, amaranth*	
5.	OTHER VEGETABLES	Other vegetables (e.g. tomato, onion, eggplant*)+other locally available vegetables*	

6.	VITAMIN A RICH FRUITS	Ripe mango, cantaloupe, apricot(fresh or dried) ripe papaya, dried peach and 100% fruit juice made from these+ *other locally available vitamin A rich fruits*	
7.	OTHER FRUITS	Wild fruits and 100% fruit juice made from these +*other locally available vitamin A rich fruits*	
8.	ORGANIC MEAT	Liver, kidney, heart or other organ meats or blood-based foods	
9.	FLESH MEATS	Beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects	
10.	EGGS	Eggs from chicken, duck, guinea fowl or any other egg	
11.	FISHAND SEAFOOD	Fresh or dried fish or shellfish	
12.	LEGUMES, NUTS AND SEEDS	Dried beans, dried peas, lentils, nuts, seeds or foods made from these (e.g. hummus, peanut butter)	
13.	MILK AND MILK PRODUCTS	Milk, cheese, yoghurt or other milk products	
14.	OILS AND FATS	Oil, fats or butter added to food or used for cooking	
15.	SWEETS	Sugar, honey, sweetened soda or juice drinks, sugary foods such as chocolates, candies, cookies and cakes	
16.	SPICES, CONDIMENTS, BEVERAGES	Spices (black pepper, salt) condiments (Soy sauce, hot sauce) coffee, tea, alcoholic beverages	

THANK YOU SO MUCH FOR YOUR TIME