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Consumer Preference and Willingness to Pay for Meat derived from Chicken fed on Insect-based feed in Kenya

Mawia Harriet[1,2,] John Mburu [1], Patrick Irungu[1], Gracious Diiro [2], Chrysantus Mbi Tanga [2]*, S. Subramanian[2], K. K. M. Fiaboe[2], Joop J. A. van Loon [2], M. Dicke [2] and S. Ekesi [2]

1Department of Agricultural Economics, University of Nairobi, P. O. Box 29053, Nairobi, Kenya

2International Centre of Insect Physiology and Ecology (ICIPE), P.O. Box 30772, Nairobi, Kenya

*Corresponding author: *harrimawia@gmail.com*

Abstract The demand for chicken meat in Kenya has been increasing with increase in population, urbanization amidst other factors such as climate change. Chicken consumption in Kenya is projected to grow at 3.7 percent per annum through 2020. Despite the growth in demand there is a deficiency in poultry production due to expensive protein sources such as fish and soybean which compete with human consumption. Therefore, there is a need to introduce affordable feed such as insects which substitutes for expensive feed. There is little empirical analysis on the use of insects as animal feed in Kenya. Acquiring this information is of paramount importance for policy advice and ultimate success and certification on the use of commercially produced insects. This study aimed at obtaining this information to fill in gaps in knowledge on consumer WTP for chicken meat derived from chicken fed on insect-based feed.

Keywords: *WTP, Chicken meat, Insect-based feed, Consumers, Kenya*

1. Introduction

There is a rapid growing demand for food especially animal protein in the world. With the world population projected to reach 9 billion by the year 2050, the demand for animal protein is expected to increase intensely (FAO, 2011). Therefore, the world has to provide food for its populations. However, how to meet the increasing demand in the future remains an open and critical question. Access to animal protein in many developing countries is fairly limited by increasing prices and climate change. General rise in income and living standards in some developing countries and emerging economies is anticipated to lead to profound increases in the demand for animal protein (Steinfeld et al., 2006; FAO, 2011). Recently, policy makers, scientists and public organizations have called for increased production of animal protein to meet the growing demand in the face of increasing population. Animal protein such as poultry meat production is forecast to rise from nearly 118 million metric tons in 2017 to more than 131 million metric tons by 2026 globally (Zapata and Carpio, 2014). This growth will be fueled by expanding demand for white meat around the world unlike red meat according to the latest Agricultural Outlook projections by the FAO and Organization for Economic Cooperation and Development (OECD).

The demand for poultry meat in Kenya is increasing owing in part to growth in population, income, and urbanization and this calls for concerted efforts to promote poultry production (Kenya National Bureau of Statistics (KNBS), 2015). The increase in demand for poultry meat can also be linked to "livestock revolution" which refers to a massive increase in livestock production in developing

countries which is fuelled by growing demand for meat and milk (ILRI, 2000). According to a study done by ILRI, 2000, "livestock revolution" is driven by appetites of billions of people with small rising incomes. To meet the demand for poultry and eggs in 2020, the relative increase in production will need to come from modern birds which can reach slaughter weight in less than eight weeks, compared to traditional chickens which take up to one year (USAID, 2015).

The poultry value chain has exhibited slow growth over the past decade in Kenya (KNBS, 2015). National production of poultry meat has increased from 22,000 metric tons (MT) in 2005 to about 22,700 MT in 2014 ; representing a growth of 3 percent (KNBS,2015). This growth is attributed to the commercial production of poultry at small holder levels and also increasing demand for poultry meat. However, amidst the slow growth in poultry meat production, according to (USAID, 2015), Kenyan traders noted that there is a poultry meat supply problem and supplies are not reliable due to the growing demand for poultry meat and eggs. Some of the reasons that explain poultry production shortfalls include; weak supportive services whereby, market information and regulatory, financial and technical services are weak (USAID, 2015). Poultry production as a whole in Kenya is also faced by another major constraint of lack of enough 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). In the last five years, the prices of poultry feed have been increasing due to expensive protein ingredients used in feed formulation (Munguti and Karisa, 2011; Opiyo et al., 2014). The most frequently used protein-rich ingredients in poultry diet are fish and soybean, sunflower seed and rapeseed (Opiyo et al., 2014). The use of soybean and fish (*Oreochromis niloticus*) competes with human consumption as a protein source (Opiyo et al., 2014). Hence, the survey identified the need to lessen the current feed costs for increased poultry production, through the introduction of alternative protein sources which are affordable and accessible such as insects.

Insects have been suggested as a sustainable alternative source of protein for use in poultry production (Verbeke et al., 2015). Insects provide a good natural source of animal protein and a sustainable alternative to traditional protein sources for free-range poultry (Hardouin and Mahoux, 2013). Some of the insect species that have been used as alternative animal feed sources include *Hermetia illucens* (black soldier fly) and *Musca domestica*, (housefly maggots), and have been commercially produced as feed in France (Veldkamp and Huis, 2012). Studies have shown that insects have more protein and micronutrients such as iron and vitamins compared to fish and soybean (Alemu et al., 2015; F.A.O, 2012; Verbeke et al., 2015). 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 Oliver (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. Other studies indicate that generally, consumers are willing to pay for insect-based feed or food if the nutritional content from the product is high and satisfying (Alemu et al., 2015; Rumpold and Oliver 2013). Consumer preference for insects as feed and WTP information for Kenya is not yet available. In addition, the factors influencing consumer WTP for insect based feed are not known. This paper is for a study that aimed to fill in these gaps in knowledge as understanding consumer preference for insects use

and WTP for insect-based feed in Kenya was to facilitate amiable commercial introduction and use of insect-based feed in poultry production. It is expected that as the production increases this will result in increased supply for poultry meat and therefor meet the growing demand for chicken meat. 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).

2. Materials and Methods

2.1 : Theoretical framework

The theory of planned behavior (TPB) which offers a consistent theoretical basis for assessing the acceptance of the new commodity or performance of a particular behavior (Davis, 1989), was used in this study. 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). 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.

2.2: Assessment of Consumer Preferences for Chicken Meat derived from Insect-based feed

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;

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

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:

$$PC_n = f(a_{11}X_1 + a_{12}X_2 +, \ldots a_{1k}X_k) \quad (2)$$

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).

$$A_{ij} = \sum_k fk \frac{a_{ijk} - a_{jk}}{s_{jk}} \quad (3)$$

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).

2.3 Elicitation of consumer WTP

Contingent valuation method (CVM) was employed to elicit consumer WTP for chicken meat derived from insect-based feed. The elicitation of WTP values used double-bound dichotomous choice questions. Respondents were engaged in two rounds of bids. Following Addisu (2014), the study assumed that N individuals are involved in a double-bounded dichotomous choice experiment with a set of bids denoted as B_i^s, where s=1 represents the lower bid and s=2 represents the upper bid offered to *i*th individual. If the individual responds "yes" to the first bid, the second bid B_i^2 is some amount greater than the first bid, i.e. $B_i^1, < B_i^2$. If the individual responds "no" to the first bid, the second bid, B_i^1, is some amount smaller than the first bid, i.e., $B_i^1, < B_i$. Thus, four possible outcomes are realized: "yes-yes", "yes-no", "no-no" and "no-yes" for the different bid responses. A dichotomous choice model was used to estimate the probabilities of occurrence of the four outcomes via denoting the likelihoods of these outcomes asπ^{yy},π^{yn}, π^{ny} and π^{nn} (Abdullah and Jeanty, 2011). Assuming that the consumer is utility-maximizing, the probability of WTP for chicken meat derived from insect-based feed is given as follows (Hanemann and Kannninen, 1991).

When both answers are "yes" "yes", $B_i^2 > B_i$, then

$$\pi^{yy}(B_i, B_i^2) = \Pr(B_i^2 \leq \max WTP_i) = 1 - \quad (B_i^2 i; \theta) \quad (1)$$

When "yes" is followed by a "no", $B_i > B_i^2$, then

$$\pi^{yn}(B_i, B_i^2) = \Pr(B_i \leq \max WTP_i \leq B_i^2) = \quad (\ _i^2; \theta) - \quad (B_i; \theta) \tag{2}$$

When both answers are "no" "no", $B_i > B_i^1$, then

$$\pi^{nn}(B_i, B_i^1) = \Pr(B_i > \max WTP \text{and } B_i^1 > \max WTP) = \quad (B_i^1; \theta), \tag{3}$$

When a "no" is followed by a "yes", $B_i > B_i^1$, then

$$\pi^{ny}(B_i, B_i^1) = \Pr(B_i \geq \max WTP \geq B_i^1) = \quad (B_i; \theta) - \quad (\ _i^1; \theta) \tag{4}$$

where $G(B;\theta)$ is the cumulative density function (cdf), assumed to be logistic, of consumer's true maximum WTP, with parameter vector θ. The cdf shows indirect utility function which is usually assumed to be linear in the bid. The log likelihood function of the four outcomes is shown in Equation 5.

$$\text{In } L(\theta) = \sum_{i=1}^{N} \{d_i^{yy} \ln \pi^{yy}(B_i B_i^2) + d_i^{yn} \ln \pi^{yn}(B_i \beta_i^2) + d_i^{nn} \ln \pi^{nn}(B_i B_i^1) + d_i^{ny} \ln \pi^{ny}(B_i B_i^1)\} \tag{5}$$

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" and zero otherwise; d_i^{yn}=1 if "yes" is followed by "no" and zero otherwise, d_i^{nn} =1 if both answers are "no" and zero otherwise, and d_i^{ny}=1 if "no" is followed by "yes" and zero otherwise. The maximum likelihood estimator, θ, is given by the solution to the Equation 6 (Hanemann and Kannninen, 1991):

$$\frac{\partial \ln L(\theta)}{\partial \theta)} = 0 \tag{6}$$

Equation 5 was estimated using a double-bounded logit model to determine consumer WTP for poultry meat derived from insect-based feed in Kenya. The empirical model was specified as follows:

$$\boldsymbol{WTP} = \beta_0 + \beta_1 AGE + \beta_2 INC + \beta_3 GND + \beta_4 EDU + \beta_5 PREF + \beta_6 HELTH + \beta_7 ETHC + \beta_8 HHSIZE + \beta_9 INSCTYP + \beta_{10} AWRNS + \beta_{11} LET\text{-}(SUPERMARKETS) + \varepsilon_j \tag{7}$$

WTP was measured by the two bids and their responses. The double bounded logit model used maximum likelihood estimation to get estimates for ′β and **σ** that were used to estimate WTP.

2.4 Data sources

Primary data was collected through administration of a pretested questionnaire to 600 respondents in Kakamega, Uasin Gishu, Nyeri and Kiambu counties. These counties were selected for the study because many households keep poultry for consumption purposes and are among the leading counties in poultry production in Kenya (Bett, 2012). Supermarket shoppers and butchery buyers were purposively selected when shopping in particular stores. The respondents were identified as the buyers of chicken meat in the butcheries and supermarkets.

3. Results

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 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). The index was constructed using weights chosen by PCA as proposed by Filmer and Rritchett (1998). Table 1 presents the factor coefficients used as weights and the summary statistics for the counties as a whole.

Table 1: Factor coefficients and summary statistics for the variables used in constructing the consumer preference index

	Kiambu			**Nyeri**			**Kakamega**			**Uasin Gishu**		
Variable	**Factor coefficient**	**Mean**	**S.D**	**factor coefficient**	**Mean**	**S.D**	**factor coefficient**	**Mean**	**S.D**	**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 2 presents summary statistics for Consumer preference for chicken meat derived from chicken fed on insect-based feed index.

Table 2: 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 3 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 3: 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 noted 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.

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. 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: 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, and 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.

3.1 Respondents' expression of willingness to pay for chicken 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 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. Table 5 shows the proportion of respondents that expressed their willing to pay premium or discount prices for chicken meat derived from insect-based feed. For instance; 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.

Table 5: 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

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

Table 6 presents respondents' WTP values. 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 6: Mean WTP for chicken meat derived from chicken fed on insects in the four counties

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

3.1.3 Discussion

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. (2005) 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. All registered means for WTP were higher amounts than the market mean price. This implied that respondents would buy chicken meat derived from chicken fed on insects when availed in the market. This could be due to perceiving this meat as of better nutrition and healthy. 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 indicates that it is most likely that there will be a market for bread products with cricket flour since the demand is present. Therefore, 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 products 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 indicator that consumers' value nutritional aspects of chicken fed on insects that they were informed about.

3.2: Factors influencing respondents' WTP for chicken meat derived from chicken fed on insect-based feed in the four counties

Table 7 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 that 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.

3.2.1 Discussion

Initial bid amount positively influenced the WTP for chicken meat derived from chicken fed on insect-based feed. This indicates 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 for 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 increase and this 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 incomes 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.

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. (2017) 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 is 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 can be so because most consumers interviewed had access to supermarkets as they were particularly urban residents. Odera (2013) findings are similar to the current study which 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 chicken fed on insect-based feed in Kenya. 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 increase and this 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 incomes 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.

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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 proximity that this county has 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 6 represents the maximum likelihood estimates of factors influencing respondent's WTP in the four study sites.

Table 7: Maximum likelihood estimates of factors influencing respondent's WTP in the four study sites

Variable	Kiambu Coef.	Nyeri Coef.	Kakamega Coef.	Uasin Gishu Coef.	Pooled Coef.
Initial Bid	0	0	0	0	1.2350 (11.98)***
Income (Ksh '000)	-0.179(-1.99)**	0.0712 (0.82)	-0.037 (-0.39)	-0.056 (-0.46)	-0.0950(-2.14)**
Age(Years)	0.009(1.08)	0.002 (0.26)	0.007 (0.68)	-0.007 (0.52)	0.0043 (0.66)
Gender (male)	0.165(1.91)*	0.146 (1.19)	-0.32 (0.748)	-0.213 (-1.02)	0.2181(1.78)*
Household size (No.)	-0.077(-1.73)*	-0.035(1.16)	0.0319 (1.15)	-0.0037 (-0.06)	-0.0297 (-1.08)
Education (Years)	-0.0003(0.21)	0.101(0.78)	0.5353 (3.35)***	-0.083 (-0.43)	0.0154 (0.75)
Awareness of insects as feed 1= Aware 0=Otherwise	0.299(1.66)*	-.074 (-0.57)	-0.112 (-0.84)	0.536 (2.81)**	0.123 (1.05)
Preference for insect feed indices	0.346(2.93)*	0.153(1.67)*	0.265(2.71)**	-0.199 (-1.35)	0.296(4.40)***
Health concerns indices	0.1783 (1.66)*	-0.087(1.08)	-0.0311(-0.30)	0.305 (1.75)*	0.076 (1.43)
Ethics concern indices	-0.0346 (-0.33)	0.072(1.00)	-0.1138 (-1.25)	0.273 (1.83)*	-0.009 (-0.19)
Market Outlet					
Farm	Reference	0	0	0	0
Supermarkets	0.24244 (0.97)	0.569(2.65)**	0.3732(2.07)**	-0.108 (-0.50)	0.4204 (2.12)**
Butcheries	-0.0876 (-0.37)	0.199(1.09)	0.5248 (2.02)**	0.234 (0.70)	-0.0072 (-0.04)
Wet markets	-0.395 (-1.69)*	0.4465(2.08)**	0.4131(2.49)**	0.147 (0.55)	4.960 (0.02)
_Constant	4.56(10.51)***	4.71(16.87)***	4.34(4.77)***	6.73 (5.44)***	(4.960) 14.2***
	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=0.021 Waldchi²= 23.89 Log-likelihood =-119.51	n=135 Prob>Chi²=0.021 Waldchi²= 18.90 Log likelihood = -114.82	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

Kiambu consumers' family size had a negative influence on WTP. The larger the family was the lesser the likelihood was to pay a higher price for chicken meat derived from insect-based feed. Daria and Mathios (2005) results on household size effect on 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 willing to pay 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 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's 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, reported that consumers were 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.

4. Conclusion

The study examined consumer WTP for meat derived from chicken fed on insect-based feed in Kenya across four counties. The findings from the study indicated that consumers were willing to pay for meat derived from chicken fed on insect-based feed. In addition, empirical evidence indicate that consumers' willingness to pay was highly influenced by income, awareness of insect types, purchase outlet and preference for chicken meat derived from insect-based feed. The study recommends the use of insect-based feed for poultry production. Moreover, production of insect-based feed at ICIPE should progress to avail insect feed in the market to supplement the available protein feed. There is also 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. Finally, the study recommends promotion of chicken meat derived from insect-based feed as this would result in availing affordable chicken meat to meet the growing consumer demand.

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