Direct Research Journal of Biology and Biotechnology
Vol. 9(7), Pp. 66-73, November 2023
ISSN: 2734-2158
DOI: https://doi.org/10.26765/DRJBB89156274
Article Number: DRJBB89156274

https://journals.directresearchpublisher.org/index.php/drjbb

Consumer Preferences for Quality Attributes of Pest Resistant Genetically Modified Cowpea in Northern Nigeria

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Received 4 October 2023; Accepted 27 October 2023; Published 14 November 2023

ABSTRACT: This study elicited consumer preferences for the quality attributes of pest resistant genetically modified cowpea in Kaduna and Sokoto states, Northern Nigeria. Using choice-based sampling technique, a total of 208 respondents were randomly selected as sample size for the study. Choice data collected were analyzed using conditional logit and mixed logit discrete choice models. The models were estimated using maximum likelihood estimation procedure. The pooled conditional logit results revealed that the coefficient for cowpea large grain size (0.464) relative to small grain size was positive and statistically significant at 5% level both in the study areas, meaning that in general consumers preferred cowpea large grain size than small sized cowpea grains in the study area. The results also indicated that consumers placed a relatively high level of importance on safety attribute of Bt cowpea in the study area. The pooled results from mixed logit revealed that the coefficient of cowpea large grain size was positive, normally distributed and statistically significant at 5% level with an estimated mean of 0.742 and estimated standard deviation of 1.457. This implies that two third of the consumers had positive preference while one third had negative preference for cowpea large grain size. The coefficient of safety attribute was positive and statistically significant at 5% level with an estimated mean of 4.625 and estimated standard deviation of 2.608 in the study area. The study concluded that consumers significantly preferred safer cowpea varieties, and cowpea large grain size attributes in the study area. Finally, the coefficient of insect damage was also normally distributed with an estimated mean of -0.464 and estimated standard deviation of -1.208, indicating that 36 percent of the distribution was above zero and 64 percent below. This means that 36 percent of consumers preferred cowpea with insect damage, while 64 percent avoided cowpea with insect damage. The study also concluded consumers significantly discounted cowpea with insect damage in the study area. It is recommended that research should ensure to modify and protect the new Bt cowpea from insect damage. Furthermore, there is need for crop breeders to keep improve cowpea large grain size when introducing new varieties of Bt cowpea in the study area.

Keywords: Consumer preferences, mixed logit, genetically modified cowpea, pest resistant

Citation: Abubakar, M.I. and Abdullahi, A.N.(2023). Consumer Preferences for Quality Attributes of Pest Resistant Genetically Modified Cowpea in Northern Nigeria. Direct Res. J. Biol. Biotechnol. Vol. 9(7), Pp. 66-73. https://doi.org/10.26765/DRJBB89156274.

INTRODUCTION

Nigeria is the world's largest producer and consumer of cowpea (Mishilli et al., 2007). It is estimated that due to cowpea consumption, Nigeria has more than 400,000 metric tons (MT) in deficit. *In* the past decade, the deficit in cowpea supply has been a major issue in cowpea production in West Africa in general, and especially in Nigeria. In Nigeria, there is concern that the deficit has increased between the year 2000 and 2013. Hence, there is an urgent need to increase cowpea production in the region, but production in Nigeria is also faced with many constraints/challenges including insect pests, diseases, poor soil and, so far, resistance to the Maruca insect pest(an insect pest affecting leguminous crops) has been limited (IAR/Institute for Agricultural Research, 2012). Cowpea is of great value in the Nigerian plant protein food sources but two specific problems of concern to its supply and production are first, the huge cowpea deficit, and second, how to increase the pest resistance (Abubakar *et al*., 2018). It is against this background the policy focus on cowpea is therefore not only on the need for increased production, but also the necessity of aiming at varieties with higher pest resistance. This justifies the need for genetically modified (GM) technologies to develop cowpea seeds that can control the attack by pests, technologies which are resistant to pests and diseases in Nigeria. Pest resistant *Bt* cowpea varieties

are sets of new technology developed by scientists in a laboratory in Australia under public-private partnership using biotechnology and genetic engineering techniques through national and international research consortium to confer resistance to an insect pest known as *Maruca vitrata.* The genetic modification involves the insertion of deoxyribonucleic acid (DNA) from the organism Bacillus thuringiensis (Bt) into the genome of traditional cowpea *to confer* the resistance to the Maruca spp. This genetic modification would allow the cowpea plant to produce Bt toxin within its own cells that are toxic to certain insects, but have no negative effects on humans. Bt cowpea varieties would thereby resist attacks by Maruca vitrata without the application *of pesticides* (Dofonsu et al., 2008; Institute for Agricultural Research, 2012). In the agricultural economics literature, there are very few studies on consumer preferences for the new pest resistant Bt cowpea. Dofonsu et al. (2008) is the only study that was conducted on consumer preferences and willingness to pay of Bt cowpea in Northern Nigeria and Republic of Benin. The study was principally motivated by issues on ethics of cowpea genetic modification, health hazards of Bt cowpea and consumer views on perceived potential toxicity and safety of Bt cowpea compared to the conventional cowpea. Furthermore, the previous studies by Dofonsu *et al.* (2008) and Dofonsu *et al.* (2010) used the expected utility theoretical framework for eliciting consumer preferences for Bt cowpea.

Literature review

Choice experiments (CEs) and conjoint choice methods have been used in a variety of settings to test for *consumers' choice preferences on specific attributes, Bt cowpea in particular.* Dofonsu et al. (2008) used CE based on quality alone without applying the trade-off economic principle. *Unlike the previous studies in* the choice experiments that measure the economic impacts of new Bt cowpea technology, this present study used choice experiments to estimate the trade-off of Bt cowpea quality attributes based on conditional and mixed logit analysis in Kaduna and Sokoto states, Northern Nigeria.

Concept of consumer preferences

Consumer Preferences is a concept in economics that is greatly used in traditional preference theory, discrete choice methods and microeconomics theory of consumer behavior. In traditional preference theory, given two consumption bundles, (x1, x2) and (y1, y2), the consumer can rank them as to their desirability. That is, the consumer can determine that one of the consumption bundles is strictly better (x1, x2) > (y1, y2) than the other, or decide that he or she is indifferent (x1, x2) ~ (y1, y2) between the two bundles. If the consumer prefers one bundle to another, it means that he or she would choose one over the other, given the opportunity. Thus the idea of preference is based on the consumer's behavior. If the consumer always chooses(x1, x2) when (y1, y2) is available, then it is natural to say that this consumer prefers (x1, x2) to (y1, y2).

If the consumer is indifferent between two bundles of goods $(x_1, x_2) \sim (y_1, y_2)$, it means that the consumer would just be as satisfied, according to his or her own preferences, consuming the bundle (x_1, x_2) as he or she would be consuming the other bundle, (y_1, y_2). If the consumer prefers or is indifferent between two bundles, we say that he or she weakly prefers $(x_1, x_2) \geq (y_1, y_2)$. These relations of strict preference, weak preference, and indifference are not independence concepts, the relations are themselves related (Varian, 2010).

The traditional economic model of consumer behavior has disappointingly few implications for empirical research. The theoretical underpinnings of discrete choice models contain elements of the traditional microeconomic theory such as formal definition of rational choice and other assumptions of traditional preference theory. However, the essential point of departure from the traditional theory, germane to the subject matter of discrete choice models, is the postulate that utility is derived from the *properties* of things, or as in the now classical work of Lancaster (1966) from the characteristics, (in objective dimension) which goods possess, rather than the goods *per se.* Goods are used either singly or in combination to produce the characteristics that are the source of consumer's utility (Louviere *et al*., 2000).

Random utility theoretical framework

Unlike the previous studies, this present study used the random utility model developed by McFadden (1974) in order to estimate the parameters of the indirect, attribute-based utility function, V_{ij} (systematic utility), that can be used to estimate willingness to pay for specific cowpea quality attributes and to calculate the market share for each different options of Bt and conventional cowpea varieties. According to Morrison (2009) the central idea of random utility theory (RUT) is that the probability of choosing one product alternative over another depends on the magnitude of the utility of each alternative, and the utility of each alternative depends on its attributes. Following the random utility framework introduced by McFadden (1974), it is assumed that individual *i*'s indirect utility from consuming Bt cowpea option j is:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad \text{.....} \quad (1)$$

Where U_{ij} ,is the i[th] consumer's utility of choosing option j, V_{ij} is the systematic portion of the utility function determined by attributes of the alternative j and potentially individual-specific characteristics, and ε_{ij} is a

stochastic element, which represent unobserved idiosyncrasies of taste. Consumers are assumed to choose the Bt cowpea alternative that provides the highest utility.

METHODOLOGY

Study area

The study was conducted in Kaduna and Sokoto States, Nigeria. The study areas are situated in northern Nigeria, an area of limited rainfall). Kaduna State lies between latitudes 09^0 2' and 11^0 32' north of the equator and longitudes 06^0 15' and 80^0 50' east of prime meridian. The climate varies from the North to the Southern part of the states. The vegetation is divided into the Northern Guinea Savanna in the South while the mean annual temperature varies between 24^0C and 27^0C (Banta, 2011). The main crops grown are: cowpea, groundnut, soya bean, maize, sorghum, yam and vegetables (Abdul Rahman, 2001). Cotton/ cowpeas/ sweet potatoes, and millet/sorghum/groundnuts/ cowpeas. Sokoto State on the other hand, is located within the Sudan Savanna zone in the North western part of Nigeria, and lies within longitudes 3^0 and 6^0 E and latitudes 8^0 and 13^0 N (Obiora, 2014).The State is also divided into 23 Local Government Areas (LGAs). The state has a total land area of 25,973 square kilometers (10,028 square miles). Sokoto state has a total population of 4,244,399 people with a density of 170 per square kilometers, which is about 440 per square miles. Sokoto state is essentially an agrarian state with traditional mode of production predominating and more than 90 percent of the population engaged in subsistence farming. The main crops produced in the state are cowpea millet, guinea corn, maize, rice, wheat, cassava, potatoes, groundnut, cotton, sugarcane, and tobacco. Fruits and vegetables grown in the state include oranges, mangoes, cashew, bananas, lettuce, onions, spinach, okra, cabbage, pawpaw and guava (Obiora, 2014). Both Kaduna and Sokoto States have high concentration of cowpea farmers. Cowpea has great potential to increase production and farmers income in the study areas (Mohammed and Mohammed, 2014).

Sampling procedure and sample size

The study used choice-based sampling technique. The classification of consumer population into subsets to be sampled was based on the choices between Bt, conventional cowpea and none options. For each option a random sample was selected of those individuals who chose that option. A total of 208 respondents were randomly selected as the sample size of the study.

Data collection

Data were collected using choice experiment (CE) designed questionnaires. The designed questions were asked in a CE to elicit preferences of consumers on Bt cowpea. The experimental design of the CE comprises of two options, namely Bt cowpea, and "none" option. The full factorial design was initially constructed to obtain 144 possible combinations of the attributes while orthogonal fractional factorial was later designed to reduce the number of combinations to 12. *In a CE, people make a* series of repeated choices between different products defined by multiple attributes. In this CE, Bt cowpea was described by key attributes such as price, safety, color, grain size and insect damage. These attributes are potentially applicable in explaining choices between wide ranges of cowpea products in order to estimate consumer preferences.

Data were collected by the researcher and assisted by trained enumerators in Zaria, Giwa, Sabon Gari, Chikun and Kaduna South Local Government Areas of Kaduna State. Also Sokoto ADP trained enumerators assisted in the data collection in Wurno, Sokoto North, Gwadabawa, Tambuwal, Sabon Birni and Bodinga Local Government Areas of Sokoto State.

This survey used interviews and literature review in collection of data which centre on identification of appropriate attributes of Bt cowpea such as price, color, safety from insecticide misuse, grain size, Genetically Modified Organisms (GMO) and insect damage. Information on consumers' awareness / perception regarding Bt cowpea was collected.

Awareness is the first stage consumers go through in the process of adopting a new product. Initially, the consumer must become aware of the new product. A new product is a good, service or idea that is perceived by some potential customers as new (Kotler and Armstrong, 2008).

This study examined consumer awareness for the new Bt cowpea because genetic transformation of cowpea with *Bacillus thuringiensis (Bt)* genes to control pod boring insects has many advantages, but little is known about the potential consumer response on genetically modified (GM) products in Nigeria. Hence, awareness was investigated to better understand potential consumer response to Bt cowpea in the study area. Information on socio-economic characteristics such as age, gender, education and income were collected.

Analytical techniques

The tools used for data analysis to achieve the objectives of the study are: descriptive statistics, conditional logit and mixed logit models.

Conditional Logit model

Conditional logit describes a model in which the choices are described by the attributes of the choice **not** by the characteristics of the individuals. In this study, conditional logit was used to estimate the random utility model. The conditional logit is based on the assumption that the error term, ε_{ij} is independently and identically distributed with the extreme value distribution. The conditional logit also assumes that all individuals share the same parameters for all individuals, which indicates that individuals have the same preferences for quality attributes.

The conditional logit model can be expressed as follows:

$$\Pr(Y_i = j) = \pi_{ij} = \frac{\exp(x_i \beta_j)}{\sum_{J=1}^{K} \exp(x_i \beta_k)} \quad \text{..... (2)}$$

Where,

Pr = the probability of choice,
exp= exponential function
B= the marginal utility parameter, which is fixed, or is the same for everyone and is not a random parameter
$Y_{i,=}$ the choice dependent variable between several discrete outcomes that takes one of the values from 1 to J (total number of categories),
J=total number of categories (options chosen by consumers)
x_i= the vector of observed explanatory variables for observation i,
i=1……n individual consumers
j= the vector of coefficients for category j

Mixed logit

Mixed logit is a fully general statistical model for examining discrete choices and a highly flexible model that can approximate any random utility model to any degree of accuracy (McFadden and Train, 2000). The mixed logit assume that the parameter in the model varies over decision makers and unobserved portion of utility can be correlated over alternatives, and exhibit heterogeneous preferences. Because of the concern for bias in the violations of behavioral assumptions in conditional logit (CL), it can be extended to the mixed logit (mlogit) considering respondent heterogeneity.
The mixed logit allows the parameters of attributes to vary across population and relaxes the Independence of Irrelevant Alternatives (IIA) assumption. It obviates the three limitations of standard logit by allowing random taste variation, unrestricted substitution patterns, and correlation in unobserved factors over time. It should be noted that in a logit model, each variable takes a different value in each alternative. Unlike CL, simulation was performed in mixed logit using one thousand random halton sequence draws for each sampled consumers, and mean and standard deviation for each attribute were reported.

In mixed logit model, the estimated mean and standard deviation statistics of the random coefficients provides important information on a share of the population that places positive value on the cowpea attributes and the share that places negative value. The mean and standard deviation obtained from the mixed logit were used to determine market share above and below zero for each attribute. The share of the respondents was computed using the mean divided by the standard deviation, which is assumed to follow the standard normal (Z) distribution. The formulae namely, Normsdist(Z) and 1-Normsdist(Z) were used to compute market share above and below zero, respectively.
Mixed logit model can be expressed as follows:

$$P_{ni} = \int L_{ni(\beta)} f(\beta) d\beta \quad (3)$$

Where ,
P_{ni}= the probabity of individual n choosing option I

$L_{ni(\beta)} = \frac{e^{V_{in(\beta)}}}{\sum_{j=1}^{J} e^{V_{in(\beta)}}}$, which is he logit probability evaluated at random parameters βs, which are different for each person (i.e, each decision maker)

$f(\beta)$ = density function, which is a function of parameters βs that represent the mean b and covariance W of βs in the population. Using maximum likelihood estimation framework, the mean and covariance are considered fixed and were estimated on a sample of consumers drawn from the population.

$V_{in(\beta)}$= the observed portion of the utility, which is linear in parameters

$d\beta$= integration over β

n = individual consumers
i = consumer i
For the mixed logit model, the utility specification is:

$$Uni = \beta_n \chi_{ni} + \varepsilon ni \quad \text{..... (4)}$$

With *εni* ~ iid extreme value. With nonzero error component, utility is correlated over alternatives giving rise to no IIA

$\beta_n \sim f(\beta_n / \theta)$

This specification is generalized by allowing β_n to be random.

Where, Θ are the parameters of the distribution over the population, such as the mean and covariance of β_n.

β_n = random parameter and not known. It allows the slope of utility (i.e, marginal utility) to be random. The coefficient or random parameter can be decomposed into mean and standard deviation

Bt Cowpea attribute-based utility function

Each participant indicated which of the three choices (Bt, conventional cowpea, "None") they most preferred in each of the 12 CE questions. It is assumed that choices between Bt and conventional cowpea are driven by an attribute-based utility function, which is specified as follows:

$$V_{ij} = \alpha PR_j + \beta_1 WH_j + \beta_2 BR_j + \beta_3 SA_j + \beta_4 SL_j + \beta_5 GMO_j + \beta_6 IND_j + \beta_7 Bt_j + \beta_8 Con_j \quad (7)$$

Where, PR_j is the price for alternative j, WH_j is the dummy variable equals to 1 if the alternative j has white color, BR_j is the dummy variable equals to 1 if the alternative j has brown color, SA_j is the dummy variable equals to 1 if the alternative possesses safety, SL_j is the dummy variable equals to 1 if the alternative has large grain size, GMO_j is the dummy variable if the alternative has GMO, IND_j is the dummy variable equals to 1 if the alternative has insect damage, Bt_j is the dummy variable equals to 1 if the alternative is the Bt cowpea, and Con_j is the dummy variable equals to 1 if the alternative is the conventional cowpea, α is the marginal utility of income (or marginal disutility of price), and β_k are marginal utilities to be estimated.

RESULTS AND DISCUSSION

Consumer preferences using conditional logit analysis

Table 1 presents the results from the econometric estimation of consumer preferences for cowpea attributes using conditional logit analysis with discrete choice as the dependent variable. The results in (Table 1) in both the pooled and States revealed that the price coefficients showed the expected negative signs and were statistically significant at 5% level, meaning that options with lower prices were more likely to be chosen by cowpea consumers as compared to options with higher prices. This implies a negative relationship between the price and demand for cowpea attributes. From the pooled data, it can be interpreted that one unit increase in price was associated with 0.005unit decreases in utility.

The coefficient for cowpea large grain size (0.464) relative to small grain size was positive and statistically significant at 5% level both in the study areas meaning that in general consumers preferred cowpea large grain size than small sized cowpea grains in the study area.. A one unit increase in cowpea large grain size is associated with 0.464 unit increase in utility. This finding is in agreement with Faye *et al*. (2004), Langyintuo *et al*. (2004) and Mishilli *et al*. (2007) who found that most consumers prefer cowpea large grain size in Ghana, Cameroon and Senegal, respectively.

Safety from pesticides misuse in cowpea is the most important attribute to the consumers as indicated by the relative size of its coefficient (0.886), meaning that consumers placed a relatively high level of importance on safety attribute of Bt cowpea in the study area. This implies that consumers' level of utility decrease by 0.886 units as the safety attribute increases by 1 unit. A possible explanation for this could be the respondents' believe that pesticides misuse in cowpea may be harmful to human health.

The coefficient for insect damage (-0.361) relative to no insect damage was negative, indicating that consumers were more likely to purchase preferred cowpea without insect damage as compared to cowpea with insect damage. A possible explanation for this is that consumers seem more sensitive to insect damage in their purchasing decisions. The relevance of this finding indicated that consumers would be willing to buy or were more likely to buy Bt cowpea enhanced through biotechnology if protected from insect damage.

The coefficient for white colored (0.094) relative to red colored cowpea was positive both in Kaduna and Sokoto States indicating that in general, consumers in the surveyed areas preferred white colored cowpea. This finding is in agreement with Mishilli *et al*. (2007) who found that cowpea consumers in the surveyed Monday market in Borno State, Dawanau market in Kano State, and Iddo market in Lagos state, Nigeria seem to prefer white grain cowpea to other colored grains. Also, their study found that white skin colored cowpeas was positive and statistically significant in these surveyed markets in Nigeria. However, the coefficient for brown colored (-0.083) compared to red colored cowpea was negative, implying that the sampled consumers preferred red colored cowpea.

Table 1: Conditional Logit estimates of consumer preferences across states and location.

Independent variables	Kaduna	Sokoto	Combined	Pooled Urban	Pooled Rural
Price	-0.009***	-0.002**	-0.005**	-0.006**	-0.004**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Wc vs Rc	0.309*	-0.003	0.098	0.094	0.100
	(0.132)	(0.108)	(0.080)	(0.106)	(0.122)
Bc vs Rc	-0.096	-0.092	-0.076	-0.083	-0.075
	(0.119)	(0.104)	(0.074)	(0.098)	(0.115)
Safety(yes vs no)	1.811***	0.404***	0.952**	0.886**	1.047**
	(0.153)	(0.107)	(0.083)	(0.108)	(0.129)
Large Size(large vs small)	0.659***	0.482***	0.474**	0.464**	0.491**
	(0.179)	(0.135)	(0.102)	(0.132)	(0.160)
GMO(yes vs no)	0.254**	0.031	0.143**	0.182**	0.094
	(0.077)	(0.072)	(0.051)	(0.067)	(0.077)
Insect Damage(yes vs no)	0.126	-0.504***	-0.216**	-0.361**	-0.028
	(0.111)	(0.101)	(0.072)	(0.096)	(0.110)
Bt vs none	1.603***	1.693***	1.667**	1.788**	1.540**
	(0.195)	(0.179)	(0.129)	(0.171)	(0.201)
Conven vs none	2.128***	1.451***	1.767**	1.854**	1.688**
	(0.193)	(0.180)	(0.130)	(0.172)	(0.202)
Log likelihood at zero	-1450.168	-1463.352	-2913.520	-1674.285	-1239.235
Log likelihood at convergence	-1006.442	-1247.896	-2357.21	-1378.26	-982.27
Pseudo R^2	0.30	0.14	0.193	0.184	0.212
N	108	100	208	108	100

Source: Field Survey, 2013
Numbers in parentheses are standard errors, *** P<0.01, **P<0.05, *P<0.10, Wc = white color, Bc= brown color

The coefficient for genetically modified organism (GMO) yes (0.182) relative to no GMO was positive and statistically significant at 5% level indicating that the respondents preferred cowpea with GMO in the study area. A likely reason for this was that they believe that cowpea with GMO can protect it against maruca insect damage. The coefficient for Bt cowpea (1.788) relative to "none" option is positive and significant at 5% level. This indicates that consumers preferred Bt cowpea relative to "none" option both in the combined data as well as in Kaduna and Sokoto States. This means that at the average levels used in the choice experiment design, respondents were more likely to choose Bt cowpea than "none" option. This result is attributed to the importance of safety. That is, for options with high levels of safety attribute, people frequently selected Bt cowpea option, resulting in a positive coefficients across the states and location. This finding is in agreement with Dofonsu *et al*. (2010) who found that in an ex ante baseline study cowpea growers and consumers in Republic of Benin, Niger and northern Nigeria preferred Bt to conventional cowpea because they believe that with Bt cowpea they will be able to avoid the health hazards related to chemical insecticide misuse. Similarly, the coefficient for conventional cowpea (1.854) relative to none option is significant at 5% level indicating that the respondents preferred conventional cowpea than a 'none' option. In general, the result indicates that quality attributes are very important in West African food markets including Nigeria. The combined conditional logit results in (Table 1) also indicated that the price coefficient (-0.005) had the expected negative sign and was significant at 5% level in the study area. The result further revealed that price coefficient (-0.009) for Kaduna State was negative and statistically significant at 1% and 5% level, respectively. This finding is in agreement with Gbegbelegbe *et al*. (2010) who found the negative relationship between price and quantity demanded of Bt cowpea seeds in Republic of Benin. The combined results also revealed that the coefficients for safety (0.952) and cowpea large grain size (0.474) were positive and significant at 5% levels, respectively, indicating that consumers in the study area preferred safer cowpea and cowpea large grain size attributes. The coefficients for white color (0.0309) and Bt cowpea (1.603) were positive and significant at 1% and 5% levels, respectively, in Kaduna state, while the coefficient for insect damage was negative (-0.216) and statistically significant in Sokoto state. This implies that consumers in Kaduna preferred white color and Bt cowpea, while consumers in the surveyed Local Government Areas of Sokoto state significantly discounted cowpea with insect damage. More important than the absolute magnitude of these coefficients is the relative comparison of the coefficients

Table 2: Mixed logit results of choice of attributes on Bt cowpea.

		States				Combined	
		Kaduna		Sokoto			
Independent variable	**Parameter**	**Coefficients**	**SE**	**Coefficients**	**SE**	**Coefficients**	**SE**
Price		-.018**	0.005	-0.006**	0.002	-0.08**	0.002
White color versus Red color	Mean of coefficient	-0.183	0.355	0.087	0.220	0.050	0.129
	Standard deviation	1.337	1.051	2.817**	1.037	1.681**	0.676
Brown color versus Red color	Mean of coefficient	-.099**	0.374	-0.136	0.180	-0.082	0.121
	Standard deviation	3.727**	0.951	0.044	2.574	0.286	0.571
Safety Yes (yes versus No)	Mean of coefficient	4.625**	1.067	0.828***	0.245	1.353**	0.271
	Standard deviation	2.608**	0.931	0.532	1.033	-0.045	1.172
Large size (large versus small)	Mean of coefficient	2.064**	0.680	0.744**	0.253	0.742**	0.216
	Standard deviation	4.331**	0.881	-0.699	0.777	1.457**	0.350
GMO Yes(Yes versus No)	Mean of coefficient	0.172	0.223	0.244	0.150	0.252*	0.096
	Standard deviation	-0.526	1.848	-0.001	1.694	0.051	1.167
Insect Damage Yes(Yes versus No)	Mean of coefficient	0.090	0.323	-0.925***	0.216	-0.464*	0.149
	Standard deviation	-0.040	1.401	2.179***	0.530	-1.208**	0.373
Bt cowpea versus None	Mean of coefficient	3.531	0.712	2.603***	0.435	2.224**	0.305
Conventional cowpea versus None	Mean of coefficient	4.704	0.847	2.228***	0.399	2.288**	0.297
Log-likelihood at convergence		-978.69		-1234.9Z		-2341.8	

for Bt cowpea and conventional cowpea. The results **in** (Table 1) suggest that holding constant other factors, safety attribute was highly preferred relative to no safety by consumers in the study areas. Thus, the results indicated that, holding other factors constant, consuming safer cowpea rather than no safety increases utility. Table 1 presents the results from the econometric estimation of consumer preferences for cowpea attribute from conditional logit (CL).

Consumer preferences using mixed Logit analysis

The analysis of mixed logit is presented in (Table 2). The combined result in (Table 2) revealed that the price coefficient showed the expected negative sign (-0.08) and was statistically significant at 5% level. This indicated that as the price of an attribute falls (and the prices of other attributes remain the same) the probability of that attributes being chosen increases. The combined results in (Table 2) showed that the coefficient of white color attribute is normally distributed with mean (0.050) and standard deviation (1.681). This indicated that about 49% of the respondents were estimated to dislike white colored attribute. The result means that slightly more than half of cowpea consumers (51%) preferred white colored attribute and the other half dislike white color in the study area. The coefficient of cowpea large grain size in (Table 2) was normally distributed with an estimated mean of 0.742 and estimated standard deviation of 1.457, meaning that 70% of the distribution is above zero and 30% below. This implies that two third of the consumers had positive preference while one third had negative preference for large grain size. Finally, the coefficient of insect damage was also normally distributed with an estimated mean of -0.464 and estimated standard deviation of -1.208, indicating that 36 percent of the distribution was above zero and 64 percent below. This means that 36 percent of consumers preferred cowpea with insect damage, while 64 percent avoided cowpea with insect damage. The standard deviation for white color, large grain size, and insect damage were also statistically significant, meaning that these coefficients do vary in the population. Individual results for the states were also reported as shown in (Table 2). The price coefficient was negative (-0.018) as expected, and significant at 5% level in kaduna State. Also, the coefficient was negative (-0.006) as expected, and significant in Sokoto State. This implies an inverse relationship between price and attribute-based demand.

Coefficients for safety (4.625) and large grain size (2.064) in (Table 2) were positive and significant at 5% level across the two states, indicating that consumers preferred safer cowpea and large grain size attributes. The coefficient for brown cowpea relative to red cowpea was negative and significant, implying that red cowpea was more preferred than brown cowpea in Kaduna State. The coefficient for insect damage was negative and significant, indicating that consumers in Sokoto State significantly pay lower price (discount) cowpea with insect damage. Thus, in Kaduna State, the standard deviation for brown cowpea relative to red cowpea, safety and large grain size were significant, while in Sokoto State, the standard deviation for white cowpea relative to red cowpea and insect damage were statistically significant. This indicated that these attributes do vary within the population thereby expressing preference heterogeneity for these attributes.

In Kaduna State , safety attribute had a mean 4.625 and standard deviation of 2.608 and large grain size had

a mean 2.064 and standard deviation of 4.331. This means that 96.18% of consumers preferred to have safer cowpea while 3.82% consumers avoided safe cowpea. Also the result in (Table 2) indicated that large grain size was preferred by 68.32% of consumers and avoided by 31.68% in the study area. In Sokoto State, safety had a mean of 0.828 and a standard deviation of 0.532, while large grain size had a mean of 0.744 and standard deviation 0.699. This means that 94.02% of consumers in Sokoto State preferred safer cowpea while 5.98% shunned it; while large grain size is preferred by 85.64% of consumers and avoided by 14.36% of them.

The value or importance that consumers place on each attribute of the alternative varies, in general, over decision makers. For instance, in the combined result in (Table 2), consumers were probably more concerned about the safety (1.681), large grain size (0.742) attributes, relative to other attributes like genetically modified organism (0.252), and probably less concerned on cowpea with insect damage (-0.464) in the study area. However, consumers in Kaduna State were probably less concerned about brown colored cowpea (-1.099), and more concerned about safety (4.625) and large grain size (2.064), relative to other attributes, than consumers in Sokoto State.

Conclusions and Recommendations

The study concluded that consumers significantly preferred safer cowpea varieties and large grain size attributes. The study also concluded consumers significantly discounted cowpea with insect damage in the study area. There is the need to incorporate a few regulatory steps on safety into the regulatory approval as well as assess the safety of Bt cowpea to be introduced in the study area. It is recommended that research should ensure to modify and protect the new Bt cowpea from insect damage. Furthermore, there is need for crop breeders to keep improve cowpea large grain size when introducing new varieties of Bt cowpea in the study area.

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