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DIFFERENTIALS IN WILLINGNESS TO PAY FOR BIOFORTIFIED TOMATO FRUITS IN ABEOKUTA METROPOLIS, OGUN STATE, NIGERIA

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ABSTRACT
A lot of efforts have been made globally to improve the iodine content of staple foods through biofortification, but acceptance and willingness to pay (WTP) studies are limited. This paper investigates consumer's acceptance, purchase intention, preference and the factors influencing consumers' willingness to pay a premium price for iodine biofortified tomato fruits in Abeokuta, southwest, Nigeria. The study collected primary data from a sample of 240 respondents. The data were analyzed by descriptive statistics and Contingent Valuation Method (CVM). The results show that respondents are willing to pay a premium price of 72% for biofortified tomato fruits. The results show that the bid price ($p<0.05$), prior knowledge ($p<0.1$), age ($p<0.05$), household size ($p<0.01$), health status ($p<0.01$) and income ($p<0.01$) were the significant factors influencing respondents' willingness to pay. Therefore, efforts aimed at attracting and encouraging more consumers of iodine biofortified tomato fruits by policymakers, marketers and producers, should focus more on bringing down the price of the product. There is also need to increase awareness of this technology in order to increase access to information on iodine biofortified tomatoes in Nigeria.

Keywords: Contingent Valuation, Non-GM, Iodine biofortification, Price premium, and Acceptance

Introduction

McGuire, (2013) noted that, one in eight people are undernourished and more suffer from micronutrient deficiencies due to the dependence on a monotonous diet comprised of milled cereals with low micronutrients. Iodine deficiency, a well-known cause of preventable mental retardation, is still a major public health problem worldwide, with an estimated 240.9 million school aged children having low iodine intake levels, of which 24% are from Sub- Saharan Africa (Andersson *et al.,* 2012; Zimmermann *et al.,* 2008).

Micronutrient malnutrition and its adverse health outcomes are still prevalent, especially in the developing world (Ahmed *et al.*, 2012) constituting 7% of global burden of disease with a cost of US $180 billion per year (Black *et al.*, 2008). Deficiencies of the "big four" micronutrients, i.e. Vitamin A, Iodine, Iron, and Zinc, still affect billions of people, particularly women and children. Despite considerable progress in eliminating these deficiencies through supplementation dietary diversification, and fortification, which were advocated for a long time, the goal is still far from being reached (Bhutta *et al.*, 2008) This has led to discovery of new approaches to improve micronutrient intake levels via biofortification, which is a strategy to enhance micronutrient concentrations in staple crops through conventional or transgenic breeding techniques. This potential strategy could radically reverse malnutrition if adopted and accepted by consumers (De Steur *et al.*, 2015, Der Straeten *et al.*, 2010).

Biofortification has of recent attracted attention as a more sustainable approach to potentially eliminate micronutrient deficiencies. It is promoted on the premise that no single intervention strategy is self-sufficient to eradicate hidden hunger among people with one or more deficiencies (Khush *et al.*, 2012). Lyons et al., (2004) have proposed to target iodine in order to improve the effectiveness of Harvest *Plus* biofortification efforts. Increasing iodine content of staple foods is achieved through conventional plant breeding, provided that there is genetic multiplicity, or by applying nutrient rich fertilizers to soils (Zhu *et al.*, 2007; Perez-Massot *et al.*, 2013). When this is not possible, genetic engineering is a viable alternative to increasing iodine concentration in staple foods (Farre *et al.,* 2011; Yuan *et al.,* 2011). Given its multiplier potential across time and distance at a low cost in addition to the targeted approach, that is towards key beneficiaries like the rural poor, biofortification of staple crops with iodine and/or other micronutrients is a suitable control measure against micronutrient deficiencies (De Steur *et al.,* 2012a; Bouis *et al.,* 2011).

Studies have indicated that plants can accumulate iodine, and there is generally a positive correlation between applications to the soil and the final accumulation in plants (Zhu *et al.,* 2003; Dai *et al.,* 2004; Blasco *et al.,* 2008; Weng *et al.,* 2008a). The iodine biofortification of crops might thus be a cost-effective strategy for increasing iodine levels in plant-derived food, and thus improve human nutrition. Tomato fruits are an important source of nourishment for the whole world's population. Tomato (*Solanum lycopersicum* L.) is one of the most widely grown and commercially important vegetable crops, with a world-wide cultivation covering more than four million hectares (FAOSTAT, 2011). It is cultivated as an annual crop in open fields and under greenhouse conditions for both fresh consumption and industrial processing. The properties of tomato are well-known and are mainly related to the antioxidant potential of its fruits, due to the presence of a mix of bio-molecules such as lycopene, ascorbicacid, polyphenols, potassium, folate, and α-tocopherol (Basu and Imrhan, 2007).

To succeed in enlarging the domestic organic market, it is important to understand consumers' acceptance, purchase intention and preference for biofortified tomato fruits. Several studies have investigated consumers' behaviour towards environmentally friendly products in Nigeria, but there has been little academic research on willingness to pay for biofortified tomato fruits. The dearth of such information is a major impediment to the growth of biofortified tomato fruits consumption and the future development of biofortified tomato fruits in Nigeria. The objective of this paper is to estimate a price premium that consumers are willing to pay for biofortified tomato fruits and to determine the critical factors affecting consumers' willingness to pay the price difference between biofortified tomato fruits and conventional non-GM ones and compare Premium and preference levels with a conventional, non-GM tomato fruit. The results of this study will provide some insight with which marketers might improve their market potentials to enhance sale of biofortified tomato fruits and to assist farmers or producers to develop effective production strategies for biofortified tomato fruits.

Methodology

Abeokuta is the largest city and state capital of Ogun State in southwest Nigeria. It is the metropolitan capital city and the 15th largest of such in Nigeria. The population according to the last population census in 2006 was 451,607 people (NPC, 2007). At an average annual population growth rate of 2.37%, with a current population estimated to be about half a million. Being both the political and commercial headquarters of Ogun state, the home of not only the native Egba dialect speaking Yorubas, but also some Ijebus, Yewas/Aworis and Remos and other Nigerians and non-Nigerians. The major occupation of inhabitant of the city are civil servants, private sector employees (especially banks and other financial institutions) and traders. Abeokuta is also naturally endowed with the popular Olumo rock, which is an ancient monument that attracts tourists regularly to the city. It consists of two major Local Government Areas: Abeokuta North, Abeokuta South and some parts of Obafemi-Owode and Odeda Local Government Areas respectively. Traditionally, it is divided into four districts which are: Ake, Gbagura, Oke-Ona and Owu.

Primary data were used in this study. These were collected in a cross- section survey of households drawn by multi-stage sampling techniques from the study area. Questionnaire method was used to collect the data on the socio-economic characteristics of the respondents and their preference for biofortified tomato fruits among others.

Multi-stage sampling technique was used to select a cross section of 240 respondents. Ake, Gbagura, Oke-Ona and Owu were purposively selected as these made up the four major districts in Abeokuta metropolis. Sixty (60) respondents were randomly selected from each of the districts. The respondents cut across different occupations such as civil servant, artisans, traders etc.

Both quantitative (econometric) and descriptive techniques were employed to analyze the data. The socio-demographic characteristics of the farm households was analyzed by descriptive technique. The stated preference (SP) approach has been commonly used in the economic valuation of both non-market goods and services, (i.e., environmental resources and transport) marketing and in food economics. It is also widely used to estimate consumers' preference or willingness to pay (WTP) for new products and attributes (i.e., quality of food products). The SP technique use direct methods such as surveys presenting hypothetical choices to gather data from consumers. Thus, SP data can be collected for either available products or those that cannot be purchased. One advantage of the SP technique is that it allows policymakers or researchers to understand how consumers respond to novel goods and services and to predict demand for them when data from actual markets are not available. This is achieved by considering the value that consumers place on goods or services (Lee and Hatcher, 2001). The SP method is adopted in this study because iodine biofortified tomato fruits in Nigeria comprise a very small market; there are no data currently available for evaluating the monetary premium that a consumer would be willing to pay for iodine biofortified tomato fruits.

Among the SP techniques, choice modeling (CM) and the contingent valuation method (CVM) are generally accepted by researchers as the most appropriate methods to elicit consumers' WTP. These are commonly applied in marketing research because they are easy to administer and inexpensive to carry out. Both methods use the random utility model (RUM). These are based on Lancaster consumer theory, which states that, consumers make choices derived from their preferences for the particular attributes they perceive the goods to offer. These methods can thus use discrete choice models to derive the average WTP, the product attributes and factors influencing it WTP (Lusk and Hudson, 2004).

CVM has been extensively used to determine the monetary valuation of non-market goods and services, and is now widely used to evaluate the WTP for credence products. The primary objective of CVM is to obtain an accurate estimate of the benefits (or cost) of a change in the quality or quantity of non-market goods, such as environmental improvements. Because of the absence of market prices for non-market or credence goods, the CVM proposes a hypothetical market created for respondents to operate in the market by directly asking them how much they would be willing to pay, contingent on a specific hypothetical scenario. The values generated by the hypothetical questions are treated as estimates of the value of the non-market good or service. The characteristic of CVM is that it reveals consumers' preference for unavailable goods and services as a bundle of characteristics or the whole good (Carson and Hanemann, 2005). In general, CVM is a more appropriate method for evaluating the product of interest as a whole because it is improper to assume that the value of the whole product is equal to the sum of the product's attributes, as is the case with CM techniques. In contrast, CM is preferable when individual values for characteristics/attributes are required.

CVM has been a popular technique to evaluate consumers' WTP for different types of food attributes, considered as credence attributes. This is because the quality of credence goods cannot be observed either before or after the purchase of the good, and may not be widely available in the market. A number of studies have applied CVM to evaluate consumers' preferences for food safety in terms of avoidance of pesticides, residue free products (Batte *et al.*, 2007) and genetically modified products (Grimsrud *et al.*, 2004). Other CVM studies focusing on environmentally friendly products and organic products include Sanjuán *et al.* (2003), Gil *et al.* (2000), Lusk (2003) and Rodríguez *et al.* (2007).

To elicit consumers' willingness to pay for the selected iodine biofortified tomato fruits, contingent valuation method were applied, which helps to find out how much an individual respondent would be willing to pay by using hypothetical survey questions following Mitchell and Carson (1989).

Using double bounded approach, respondents were asked two questions. Question format was "Are you willing to pay an/any amount of money for organic leafy vegetable that has no chemical pesticide, no synthetic fertilizer and good for health". Each question has two choices: yes or no. If "yes" in the first question, higher amount of bid was given in the second question; otherwise, lower amount with "no". Therefore, one of the four abilities of a respondent can be: 1. Yes–Yes (YY), 2. Yes–No (YN), 3. No–Yes (NY), 4. No–No (NN). According Hanemann (1991) and Hai *et al.* (2013), the probability of answering "Yes" for both questions is expressed thus:

$$Pr_{yy}(B, B^u) = Pr[B \leq WTP, B^u \leq WTP] \quad (1)$$

$$Pr_{yy}(B, B^u) = Pr[B \leq WTP/\, Bu \leq WTP]Pr[B^u \leq WTP] \quad (2)$$

$$Pr_{yy}(B, B^u) = PrB^u \leq WTP = 1 - F(B^u) \quad (3)$$

Where,
Pr_{yy} = probability of answering "Yes" "Yes".
B = price in the first question.
B^u = higher price in the second question.
WTP = Willingness to pay.
F = Cumulative Distribution function (CDF).

The probability of answering "Yes" followed by "No" in question (2) is:

$$Pr_{yn}(B, B^u) = Pr[B \leq WTP < B^u] = F(B^u) - F(B) \quad (4)$$

Similarly, probabilities for answering "No–Yes" and "No –No" are:

$$Pr_{ny}(B, B^d) = Pr[B^d \leq WTP < B] = F(B) - F(B^d) \quad (5)$$

$$Pr_{nn}(B, B^d) = Pr[B > WTP, B^d > WTP] = F(B^d) \quad (6)$$

Where,
B^d = lower price in the second question
The maximum likelihood estimation is applied to estimate the likelihood of responses. Given a sample of 240 respondents, where; B_i, B_i^u, B_i^d are bids used for the ith respondent, the log–likelihood function is specified thus:

$$lnL = \sum_{1}^{n} \{ yy_i lnPr_{yy}(B_i, B_i^u) + yn_i lnPr_{yn}(B_i, B_i^u) + ny_i lnPr_{ny}(B_i B_i^d) + nn_i lnPr_{nn}(B_i B_i^d) \} \quad (7)$$

Where,
yy, yn, ny and nn = dummy variables. If one respondent answer yes–yes (yy) for two questions, then yy = 1, so

others will be zero. In order to elicit WTP, standard double bounded model Hanemann *et al.,* (1991) is used. Therefore, WTP is generally expressed by function:

$$WTP_{ij} = \alpha + \sigma Bid_{ij} + \lambda X_i + \varepsilon_{it} \quad (8)$$

Where,
α = intercept of the model
Bid = proposed price (hypothetical price) given to respondents
σ= coefficient of Bid
X_i = the vector of socioeconomic variables of consumer ith
λ = the coefficients of X_i
i = individual consumer (ith)
j = kind of leafy vegetables

Probit model was used to determine factors influencing WTP for iodine biofortified tomato fruits. Probit regression, also called a probit model is used widely in the modelling of dichotomous or binary variables. It transforms the sigmoid dose-response curve to a straight line that can be analyzed by regression either through least square or maximum likelihood. In probit model, the inverse standard normal distribution of the probability is modelled as a linear combination of the predictors (Gujarati, 2004). The model was used to estimate factors determining WTP and it is specified thus:

$$WTP_{ij} = \beta_0 + \beta_1 X_1 + \beta_2 X_3 + \cdots \dots \dots \dots . + \beta_1 X_1 + \varepsilon_{it} \quad (9)$$

where WTP is the binary variable that takes on the value 1 if the reference individual is willing to pay for iodine-biofortified tomato, and 0 if otherwise, β0 is the intercept, β's are the vectors of regression coefficients, X's the value of explanatory or independent variable. The explanatory variables are:

X_1 = Bid price (₦/kg)
X_2 = Prior Knowledge (dummy variable; Yes=1, No=0)
X_3 = age (years)
X_4 = gender (dummy variable;1 if female, 0 otherwise);
X_5 = level of education (dummy);
X_{51} =1 if informal education, 0 otherwise;
X_{52} =1 if secondary education, 0 otherwise;
X_{53} =1 if tertiary education, 0 otherwise.
Note: primary education serves as the reference category.
X_6 =household size (number of people);
X_7 =occupation (dummy);
X_{71} =1 if civil servant, 0 otherwise;
X_{72} =1 if artisan, 0 otherwise;
X_{73} =1 if business, 0 otherwise.
Note: other occupation serves as reference category.
X_8 =Monthly income (Naira);
X_9 =Health status (dummy variable; Hypertensive=1, otherwise = 0)
X_{10} = concern issues (dummy variable; Yes=1, No=0)

In this study, designing hypothetical prices (bids) to apply double bound dichotomous was based on the questionnaire pretest and the prices of the conventional tomatoes in the markets (₦500/kg). Bidding system was used in Table 1. Each consumer was asked to answer one of four random bids set in the table to minimize the bias of starting bids. Table 1 presents the distribution of the double-bounded WTP responses for the iodine biofortified tomato fruits. In terms of the different structure of bid prices of 50%, 25% and 20%. The bid designs captured the WTP ranges quite well. The proportion of the respondents who were willing to pay the bid generally decreased with increase in prices. This is confirmed because the higher starting, bid price was less likely to generate a "Yes/Yes" response and more likely to produce a "No/No" response. Figure 1 presents the structure of the bidding system used for this study. It is a reflection of the bid system as shown in Table 1.

Table 1: Dichotomous Choice Questionnaire for Eliciting WTP

Questionnaire version	Conventional price (₦/Kg)	First bid (₦/Kg)	Second bid (₦/Kg)	
			Higher amount	**Lower amount**
	500	750	800	625

Results and Discussion

Socioeconomic characteristics of the Respondents

The results in Table 2 show the socioeconomic variables of the respondents. Majority (70.83%) of the respondents were within the age range 36-50 years. About 80% of the respondents were up to 50 years. However, the mean age of 39 years depicts that majority were in their active working age group. Also, 38.75% of the respondents were males, while 61.25% were females. The mean household size was four (4) people, indicating that most households in the study area have small family sizes. Many (40%) of the respondents were artisans being the dominant occupation in the study area and 11.58% with no form of formal education. Results also show that 45%

received a monthly income of below ₦50,000 with mean monthly income of ₦47,500.

Table 2: Socioeconomic Characteristics of the Respondents

Variable	***Frequency***	***Percent (%)***
Age (years)		
Below 35	22	9.17
36-50	170	70.83
51 and above	48	20.00
Mean	39	
Gender		
Male	93	38.75
Female	147	61.25
Marital status		
Single	42	17.50
Married	162	67.50
Divorced	28	11.67
Widowed	8	3.33
Household size		
1-3	12	5.00
4-6	178	74.17
7 and above	50	20.83
Mean	4	
Level of Education		
No formal	35	11.58
Primary	57	23.75
Secondary	88	36.67
Tertiary	60	25.00
Monthly Income		
Less than ₦50,000	108	45.00
₦51,000- ₦100,00	82	34.17
₦100,001- ₦200,000	40	16.67
Above ₦200,001	10	4.16
Mean	47,500	
Primary Occupation		
Civil Servant	50	20.83
Artisan	96	40.00
Trading	62	25.83
Farming	23	9.58
Others	9	3.75

Source: Field Survey, 2019

Awareness of the iodine biofortified tomato fruits

Table 3 show that about 63.33% indicated no prior knowledge (heard) of iodine biofortified tomato fruits. It also revealed further that about 95.42% indicated that they had not seen (eaten) the iodine biofortified tomato fruits and 30.83% reported that they were aware of the nutritional value of the iodine biofortified tomato fruits. The results show that the share of respondents in favor of iodine biofortifed tomato fruits is substantially higher (61%) in the study area. Preference levels exclude the group of indifferent respondents.

Table 3: Knowledge and Awareness of Respondents about Iodine Biofortified Tomato Fruits

Measures	Frequency	Percent
Prior knowledge		
Yes	88	33.67
No	152	63.33
Seen Iodine Biofortified Tomato Fruits before		
Yes	11	4.58
No	229	95.42
Eaten Iodine Biofortified Tomato Fruits before		
Yes	6	2.50
No	237	97.50
Aware of nutritive value		
Yes	74	30.83
No	166	69.17
Acceptability		
Yes	146	60.83
No	94	39.17

Source: Field survey, 2019

Willingness to Pay for Iodine Biofortified Tomato Fruits

The characterization of the WTP of respondents showed that 72% of the respondents were willing to pay for iodine biofortified tomato fruits. Purchase intentions refer to the share of respondents that is prepared to pay a premium. This is very significant because respondents being queried had just been educated about the health benefits of iodine biofortified tomato fruits as an alternative of table salt. The proportion of the respondents who were willing to pay the bid generally decreased with increase in price. This might be because the higher starting bid price was less likely to generate a "Yes/Yes" response and more likely to produce a "No/No" response.

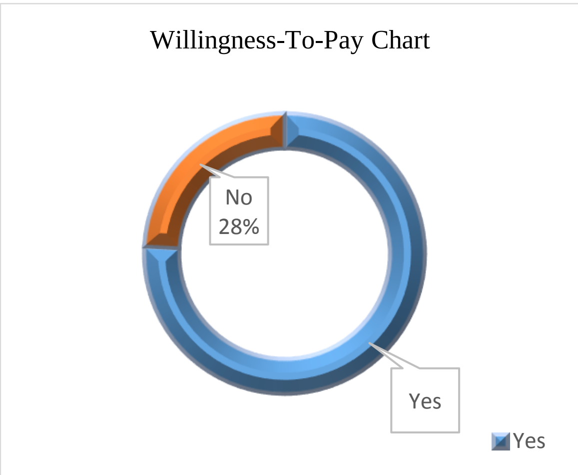

Figure 1: Willingness to Pay Dichotomous Response
Source: Field Survey, 2019

Table 4: Distribution of Willingness to Pay Responses for the Double-Bounded Dichotomous Choice

Percentage of Respondents (N=240)				
Yes–Yes	**Yes–No**	**No–Yes**	**No–No**	**Total**
30 (12.5%)	76 (31.7%)	106 (44.2%)	28 (11.7%)	240 (100%)

Source: Field Survey, 2019

Average Statistics of WTP for the Iodine Biofortified Tomato Fruits

The result of the mean/median WTP in Table 5 shows that respondents were willing to pay an average amount of ₦625.3kg for the iodine biofortified tomato fruits. This implies that consumers would pay about 22% higher for the iodine biofortified tomato fruits than conventional ones sold in the markets.

Table 5: Average statistics of WTP for the Iodine Biofortified Tomato Fruits

	WTP (₦/kg)	Lower bound (₦/kg)	Upper Bound (₦/kg)
Mean	625.42	524.14	750.04
Median	608.92	508.33	728.18
95% CI of mean WTP (±₦/kg)	622.14 - 620.76 ±2.18		

Source: Field Survey, 2019

Note: 95% Confidence interval of the WTP mean is calculated by using estimated parameters

Unit price of conventional tomato fruits per Kg is ₦500

Determinants of WTP for Iodine Biofortified Tomato Fruits

Table 6 show the probit regression estimates of factors influencing WTP for iodine biofortified tomato fruits by the respondents. The calculated χ^2value associated with the likelihood ratio test was significant ($p<0.01$) which indicates goodness of fit of the model. The percentage of right prediction was found to be 83% while the McFadden R^2 (62) also depicts goodness of fit which, however, is of secondary importance in probit model. The bid price ($p<0.05$) and concern issues ($p<0.05$) were negative and this is in conformity with the *apriori* expectation. The implication of this is that as the bid price increases, the respondent's probability of willing to pay decreases. Also, the significance and negative relationship between WTP and concern issues implies that factors other than price such as taste, odour and shelf life influence respondents WTP. The respondents' willingness to pay for iodine biofortified tomato fruits was positively related to prior knowledge. This result suggests that the higher the respondents' prior knowledge, the more likely they were willing to pay a premium price for iodine biofortified tomato fruits. This result implies that the more respondents perceived quality and health benefits from iodine biofortified tomato fruits than conventional table salt, the more likely they were willing to pay a premium price. The variable age was negative and significant ($p<0.10$). This might be because the respondents increase in age, their tendency or probability of paying for the iodine biofortified tomato fruits also decreases. This is subject to the life cycle income hypothesis stating that as age increases, there is reduction in level of innovation (Abel and Bernanke, 2001). Gender was positive and significant ($p<0.05$). This shows that females had a greater likelihood of paying for the iodine biofortified tomato fruits more than their male counterparts. This implies that female value the health benefit of iodine biofortified tomato fruits more than their male counterparts. The household size had a negative and significant effect on WTP ($p<0.01$). This implies that increase in the household size will lower the probability in the WTP for iodine biofortified tomato fruits. This might also be because smaller-sized households have higher likelihood of paying for iodine biofortified tomato fruits. This could be related to relative reduction on per capita expenditure of such households. Occupation (civil servants and business persons), was positive and significant ($p<0.05$). The implication of this is that civil servants had the tendency of higher WTP for iodine biofortified tomato fruits than the farmers (reference variable). This implies that civil servants and business persons appreciate environmental importance and health benefits of iodine biofortified tomato fruits relative to farmers. Respondent's income and health status are positively related to their willingness to pay for iodine biofortified tomato fruits. This implies that as the income of respondents increases, the increase in their likelihood to demand for iodine biofortified tomato fruits.

Table 6: Probit Regression Estimates of the Determinants of WTP for Iodine biofortified Tomato fruits

Variables	Coefficients	t-ratio
X_1 = Bid price (₦/kg)	-0.156**	2.18
X_2 = Prior Knowledge (Yes=1, No=0)	-0.056*	-1.97
X_3 = age (years)	-0.083**	-2.48
X_4 = gender (1 if female, 0 otherwise);	0.352**	2.16
X_5 = level of education (dummy);		
X_{51} =1 if informal education, 0 otherwise;	1.50	0.12
X_{52} =1 if secondary education, 0 otherwise;	-0.31	−0.35
X_{53} =1 if tertiary education, 0 otherwise.	-0.59	−0.54
Note: primary education serves as the reference category.		
X_6 =household size (number of people);	-1.12***	−2.91
X_7 =occupation (dummy);		
X_{71} =1 if civil servant, 0 otherwise;	1.34**	2.46
X_{72} =1 if artisan, 0 otherwise;	-1.52	−1.39
X_{73} =1 if business, 0 otherwise.	2.65**	2.14
Note: other occupation serves as reference category.		
X_8 =Monthly income (in Naira);	1.11***	2.65
X_9 =Health status (Hypertensive=1, otherwise=0)	0.034***	3.21
X_{10} = concern issues(Yes=1, No=0)	-0.321**	-2.03
Constant	14.38	0.74
Log-likelihood function	-48.76	
Number of observations	240	
McFadden's R2	0.62	
Percentage of right prediction	0.83	
Likelihood ratio test χ^2 (df =13)	48.14***	

Source: Field Survey, 2019. *Note: *p<0.1, **p<0.05, ***p<0.01 denote significant at 10, 5 and 1% respectively*

Conclusion

The study concludes that bid price ($p<0.05$), prior knowledge ($p<0.1$), age ($p<0.05$), household size ($p<0.01$), health status ($p<0.01$) and income ($p<0.01$) were the significant factors influencing respondents WTP a price premium for the iodine biofortified tomato fruits. In addition, policy makers can use some of the findings to frame their policies in developing the domestic iodine biofortified tomato fruits market. The marketing strategies for introducing iodine biofortified tomato fruits to the domestic market are more likely to be successful if marketers target elderly consumers and families without young children, but with high household incomes. This has clear implications for distribution strategies and mechanisms. The empirical results showed that greater knowledge about iodine biofortified tomato fruits will not only induce new purchasers to try iodine biofortified tomato fruits but will raise the level of price that consumers would be willing to pay for them. Therefore, the study recommends that policy issue aimed at increasing consumer's acceptance and willingness to pay for iodine biofortified tomato fruits should focus on reducing the price as to be able to compete favourably with the conventional, non-GM tomato fruits.

References

Abel, A. and Bernanke, B. (2001), Macroeconomics Textbook, Pearson Custom Publishers, Boston, MA.

Ahmed, T., Hossain, M. and Sanin, K. I. (2012). Global burden of maternal and child undernutrition and micronutrient deficiencies. *Annals of Nutrition and Metabolism* 61(Suppl 1):8-17.

Andersson, M. and Zimmermann, M. (2012). Global iodine nutrition: a remarkable leap forward in the past decade. *IDD Newsletter*. 40(1):1–5

Basu and Imrhan 2006. Tomatoes versus lycopene in oxidative stress and carcinogenesis: conclusions from clinical trials. *European Journal of Clinical Nutrition* 61:295–303

Batte, M. T., Hooker, N. H., Neal H. and Haab, T. C. and Beaverson, J. (2007). "Putting their money where their mouths are: Consumer willingness to pay for multi-ingredient, processed organic food products." *Food Policy* 32(2): 145-159

Bhutta, Z. A., Ahmed, T., Black, R. E., Cousens, S., Dewey, K., Giugliani, E., Haider, B. A., Kirkwood, B., Morris, S. S., Sachdev, H. P. and Shekar, M. (2008). Maternal and Child Undernutrition Study Group. What works? Interventions for maternal and child undernutrition and survival. *Lancet* 371:417-40.

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., Mathers, C. and Rivera, J. (2008). Maternal and Child Undernutrition Study Group. Maternal and child under nutrition: global and regional exposures and health consequences. *Lancet* 371:243-60.

Blasco B., Rios J. J., Cervilla L. M., Sánchez-Rodrigez E., Ruiz J. M. and Romero L. (2008). Iodine biofortification and antioxidant capacity of lettuce: potential benefits for cultivation and human health. *Annals of Appliied Biology*. 152, 289–299.

Bouis, H., Hotz, C., McClafferty,B., Meenakshi, J.V. and Pfeiffer, W.H. (2011). Biofortification: a new tool to reduce micronutrient malnutrition. *Food and Nutrition Bulletin* 32:S31-S40.

Carson, R. T. and Hanemann, W. M. (2005). Contingent valuation. In K.-G. Maler & J. R. Vincent (Eds.), *Handbook of Environmental Economics* 2:642). North-Holland, New York: Elsevier.

Dai, J.-L., Zhang, M., and Zhu, Y.-G. (2004a). Adsorption and desorption of iodine by various Chinese soils: I. *Iodate. Environment. International* 30:525–530.

De Steur H, Blancquaert D, Strobbe S, Lambert W, Gellynck X, Van Der Straeten D. (2015). Status and market potential of transgenic biofortified crops. *Nature Biotechnology* 33:25-9.

De Steur, H., Gellynck, X., Blancquaert, D., Lambert, W., Van Der Straeten, D. and Qaim, M. (2012). "Potential Impact and Cost-effectiveness of Multi-biofortified Rice in China." *New Biotechnology* 29: 432–442.

De Steur, H., Gellynck, X., Storozhenko, S., Liqun, G., Lambert, W., Van Der Straeten, D. and Viaene, J. (2010). Health impact in China of folate biofortified rice. *Nat Biotechnology* 28:554-556.

FAOSTAT (2011), "Production – Crops – Area harvested/ Production quantity – Tomatoes – 2014", FAO Statistics online database, Food and Agriculture Organization, Rome, www.fao.org/faostat/en (accessed 22 Sept. 2017).

Farre, G., Twyman, R.M. and Zhu, C.F. (2011). Nutritionally enhanced crops and food security: scientific achievements versus political expediency. *Current Opinion in Biotechnology* 22: 245-251

Gil, J., A. Gracia, A. and Sánchez, M. (2000). "Market segmentation and willingness to pay for organic products in Spain." *International Food and Agribusiness Management Review*, **3**: 207-226.

Grimsrud, K. M., McCluskey, J. J., Loureiro, M. L. and Wahl. T. I. (2004). Consumer attitudes to genetically modified food in Norway. *Journal of Agricultural Economics,***55**(1): 75-90.

Gujarati, N. (2004), Basic Econometrics, 4th ed., Tata McGraw-Hill Publishers, New York, NY.

Hanemann, M., Loomis, J. and Kanninen, B. (1991). Statistical Efficiency of Double–Bounded Dichotomous Choice Contingent Valuation. *American Journal of Agriculture Economics*, 73(4): 1255–1263

Khush, G., Lee, S. and Cho JI. (2012) Biofortification of crops for reducing malnutrition. *Plant Biotechnology Reports* 6: 195-202.

Landini M., Gonzali S. and Perata P. (2011). Iodine biofortification in tomato. *Journal of Plant Nutrition and Soil Science* 174: 480-486.

Lee, K. and Hatcher, C. (2001). Willingness to pay for information: An analyst's guide. *Journal of Consumer Affairs*, 15(1).

Lusk, J. L. (2003). Effects of cheap talk on consumer willingness-to-pay for golden rice. *American Journal of Agricultural Economics*,**85**(4): 840-856.

Lyons GH, Stangoulis JCR and Graham RD. (2004) Exploiting micronutrient interaction to optimize biofortification programs: The case for inclusion of selenium and iodine in the HarvestPlus program. *Nutrition Reviews* 62: 247-252.

McGuire, S. (2013). WHO, World Food Programme, and International Fund for Agricultural Development. 2012. The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome, FAO. *Advances in Nutrition* 4: 126-127.

Mitchell, R. C. and Carson, R. T. (1989). *Using surveys to value public goods: The contingent valuation method.* Washington, D.C., *Resources for the Future*. 1-90

NPC (2007). National Population Commission of Nigeria

Perez-Massot, E., Banakar, R. and Gomez-Galera, S. (2013). The contribution of transgenic plants to better health through improved nutrition: opportunities and constraints. *Genesand Nutrition* 8: 29-41.

Rodríguez, E., Lacaze, V. and Lupín, B. (2007). *Willingness to Pay for organic food in Argentina: Evidence from a consumer survey*. Contributed Paper prepared for presentation at the 105th EAAE seminar, International Marketing and International Trade of Quality Food Product, Bologna, Italy, March 8–10, 2007. Pp.31.

Sanjuán, A. I., Sánchez, M., Gill, J. M. and Soler, F. (2003). "Brakes to organic market enlargement in Spain: consumers' and retailers' attitudes and willingness to pay." *International Journal of Consumer Studies*,**27**(2): 134-144.

Van-Elzakker, B., Parrott, N., Chola, M. C. and Adimdao, S. (2007). *Organic Farming in Africa.***In:** H. Willer and M. Yusseffi (Eds.) The World of Organic Agriculture: Statistics and Emerging Trends. Bonn, IFOAM, Pp. 96-106.

Weng, H. X., Hong, C. L., Yan, A. L., Pan, L. H., Qin, Y. C. and Bao, L.-T. (2008a). Mechanism of iodine uptake by cabbage: effects of iodine species and where it is stored. *Biology Trace Element Research*. 125: 59–71.

Yuan, D., Bassie, L., Sabalza, M., Miralpeix, B., Dashevskaya, S., Farre, G., Rivera, S. M., Banakar, R., Bai, C., Sanahuja, G., Arjo, G., Avilla, E., Zorrilla-Lo´pez, U., Ugidos-Damboriena, N., Lo´pez, A., Almacellas, D., Zhu, C., Capell, T., Hahne, G., Twyman, R. M., Christou, P. (2011). Potential impact of plant biotechnology on the Millennium Development Goals. *Plant Cell Report 3*0:249–265

Zhu C, Naqvi S, Gomez-Galera S, Pelacho AM, Capell T, Christou P (2007). Transgenic strategies for the nutritional enhancement of plant. *Trends Plant Science* 12:548–555

Zimmermann, M. B., Jooste, P. L. and Pandav, C. S. (2008) Iodine-deficiency disorders. *Lancet* 372:1251-1262.