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Consumers' acceptability of iodine-biofortified tomato in Abeokuta, Southwestern Nigeria

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Abstract

Higher exposure rate to certain chemicals found in processed foods that reduce iodine absorption and a depletion in the amount of iodine found in soil have been reported to be detrimental to health. This study seeks to examine the consumers' acceptability and willingness to pay a price premium for iodine-enriched tomatoes in Abeokuta, southwest, Nigeria. Primary data were used to collect a sample of 300 respondents. The data were analyzed by descriptive statistics and Contingent Valuation Method (CVM) under double bounded dichotomous choice approach. The use of dichotomous choice (DC) method in explaining the willingness to pay (WTP) in contingent valuation studies is a common method in Economics. Research has shown that double-bounded Dichotomous Choice methods provide statistically superior outcomes than single bounded methods, given appropriate sampling design. Results from the socioeconomic characteristics of the respondents revealed a mean age of 42 years and are mainly (83%) in their economic active age (<50 years), 69% male respondents, 63% were married and 53% of the respondents had prior knowledge of iodine-biofortified tomato. It was also revealed that 58% of the respondent are willing to accept and pay a premium for iodine-biofortified tomato. Although, the proportion of the respondents who were willing to pay generally decreases with increases in price. It is concluded that age, level of education, income, prior knowledge and bid price were the significant factors influencing respondents' willingness to pay a price premium for iodine-biofortified tomato in the study area.

Keyword: acceptability, contingent valuation method, iodine-biofortified tomato, price premium

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Introduction

The health and well-being of a population are significantly influenced by their nutritional status. A healthy and well-balanced diet, with a variety of high-quality foods ensuring the right proportions of different types of nutrients, is important in both prevention and treatment of several diseases. Not only do daily calorie requirements need to be carefully met, but also the consumption of a number of specific elements, the lack of which may promote or lead to serious ailments, needs to be guaranteed in order to prevent nutritional deficiencies.

Iodine is an essential element for human physiology (Andersson et al., 2005), being involved in the synthesis of thyroid hormones. The recommended dietary allowance (RDA) for adult amounts to 150 ug iodine per day (Pearce et al., 2004). Chronic iodine deficiency, called hypothyroidism, can trigger goiter, growth impairment, reproductive failure, hearing loss, cretinism, and several kinds of brain damage (Andersson et al., 2005; Delange, 2000; Dillon and Milliez, 2000; Haddow et al., 1999).

According to World Health Organization (2014), iodine deficiency disorders are a major public health concern, resulting in cognitive impairment, congenital abnormalities, cretinism, hypothyroidism or endemic goiter Although iodine deficiency can be treated, it is still a public health problem for almost 35% of the world's population (Pearce et al., 2004; Winger et al., 2008), and the population at risk is more than one billion (Winger et al., 2008; World Health Organization, 2004).

Iodized salt is the most common approach for dietary iodine supplementation (Andersson et al., 2005; Delange and Lecomte, 2000). However, since iodine supplementation may cause problems during food processing, it is difficult to control its loss during transport, storage, and food cooking (Winger et al., 2008). Therefore, enhancing iodine content in vegetables represents a cost-effective way to control its deficiency, since iodine in food is readily bioavailable (up to 99%) and assimilated (Dai et al., 2004; Weng et al., 2009; White and Broadley, 2009).

The main strategy for controlling and preventing iodine deficiency is the universal fortification of salt with iodine (Andersson et al., 2010). "Universal" is the key word in this strategy because it highlights that all the salt consumed by the population should be iodized, including salt used in food processing and for animal feed. This strategy has been implemented by many countries over the past few decades and has dramatically reduced the prevalence of iodine deficiency worldwide (Zimmermann, 2009; Andersson et al., 2010). However, a boost to the consumption of iodized salt is becoming increasingly untenable, as it conflicts with other important public health objectives, such as the prevention of cardiovascular diseases. Other strategies have been adopted, including the addition of iodine to oils, bakery products, or even to drinking water, but none of these alternatives has proved effective by itself as a means of prevention.

The World Health Organization (WHO) recommends reduction in dietary salt as a cost-effective strategy to reduce risk of chronic disease (World Health Organization, 2007), and numerous studies have demonstrated the efficacy of reducing salt for lowering blood pressure (Sacks et al., 2001) and other risk factors for chronic diseases such as cardiovascular disease (CVD) (Cook et al., 2007). Iodine Biofortified Tomato (IBT) is a type of tomatoes which has been biofortified with an adequate level of iodine to reduce various health issues arising from the deficiency of iodine. Tomatoes have a high tolerance to a high level of iodine stored in both the vegetative tissues and fruits at concentrations that are more than sufficient for the human diet (Landini et al., 2011). Landini et al. (2011) have proposed tomato as a possible candidate for iodine biofortification programs. Both its widespread distribution and possible consumption as a fresh fruit make it a good target crop for a fortification study. Indeed, positive results in terms of effective iodine accumulation within the fruits, representing the edible part of the plant, have been achieved (Landini et al., 2011). Consumption of iodine-rich foods is the only natural way of avoiding iodine deficiency, however, due to the iodine depleted soils and limited access to fish foods have increased the number of vulnerable people (Gomez Galera et al., 2010). In view of this new development, there is need to look at the acceptability of tomato fruits fortified with iodine among consumers, as a new product, in the market. This informed this study on the Willingness to Pay (WTP) for this Iodine-Biofortified Tomato (IBT).

Among the stated preference techniques, Choice Modelling (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, and the product attributes and factors influencing it WTP (Lusk and Hudson, 2004). Contingent Valuation Method 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. Willingness to pay is the amount of money that an individual is willing to sacrifice to acquire a good or service. The WTP function establishes the price that an individual is willing to pay for a given level of quality, given prices, income and preferences of consumers (Lusk and Hudson, 2004). Alternatively, it can also be stated that WTP is the maximum amount of money an individual is willing to pay for a commodity; as such, WTP is an indicator of the value of the commodity to that individual. It is an essential determinant of the incentives for product improvement (Unnevehr et al., 1999) and an important concept for benefit cost analysis.

Estimating WTP from contingent valuation studies using Dichotomous choice (DC) questions is an increasingly technique (Bateman and Turner, 1992). However, Hanemann et al. (1991) demonstrated that, using maximum likelihood solutions with double-bounded DC strategy is statistically more efficient technique than a single question. In other words, eliciting whether a respondent is willing to pay a higher bid if he/she respond "yes" to the initial bid, or willing to pay a lower amount if they respond "no", provides a more accurate information which, if the bid selection strategy is correct (Kanninen, 1993) reduces the variance of estimated WTP.

Specific techniques in CVM include payment cards, bidding games, open–ended and dichotomous choice. This study uses double bounded dichotomous choice contingent valuation method (DBDC-CVM) because it has more efficiency as well as more information than single bounded approach (Hanemann et al., 1991). Some of the recent studies that employed double bounded choice included Ara (2002), Rodríguez et al. (2007), Abdullah and Jeanty (2011) and Claudy et al. (2011).

Willingness to pay for IBT as a product for the respondents need some empirically validation of the possible factors that could affects it acceptance among the consumers. The introduction of IBT will be a welcome idea to solve this problem. Therefore, this study broadly examines consumers' acceptability of IBT in Abeokuta, Southwestern Nigeria using double bounded dichotomous choice Contingent Valuation Method (DBDC-CVM). Specifically, (i) to describe socio-economic characteristics and awareness of the respondents, their attitudes and perceptions towards IBT, (ii) to assess consumers' willingness to pay (WTP) for IBT and (iii) to identify factors influencing consumers' willingness to pay for IBT.

Materials and Methods

The study was conducted in Federal University of Agriculture, Abeokuta (FUNAAB), Federal College of Education, Osiele and Moshood Abiola Polytechnic, Ogun State, Nigeria. Primary data were collected by means of a structured questionnaire. A total of 300 respondents were randomly selected, 100 from each of the aforementioned institutions. The study used structured questionnaire to elicit information on respondents' socioeconomic characteristics, level of awareness and willingness to pay for IBT. To elicit consumers' willingness to pay for IBT, contingent valuation method was applied, which helped to find out how much an individual respondent would be willing to pay by using hypothetical survey questions as used by Mitchell and Carson (1989) and kamal et al. (2009). Double bounded dichotomous choice contingent valuation method (DBDC-CVM) was used for this study. Using double bounded approach, respondents were asked two questions. Question format was "Are you willing to pay 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 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

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

$$= Pr[B \le WTP / Bu \le WTP] Pr[B^u \le WTP] \quad (2)$$

$$= PrB^u \le WTP = 1 - F(B^u) \quad (3)$$

Where
Pr_{yy} = the probability of answering "Yes" "Yes"
B^u = the price in the first question
= the 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:

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

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

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

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

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 300 respondents, where , are bids used for the ith respondent, the log–likelihood function was specified as:

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

where yy, yn, ny and nn are 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:

$$WTP_i = \alpha + \sigma Bid_i + \lambda X_i + \varepsilon_{it} \quad (8)$$

Where:
α = intercept of the model
= proposed price (hypothetical price) given to respondents
= the coefficient of Bid
= the vector of socioeconomic variables of consumer ith
= the coefficients of
i = individual consumer (ith)

A-priori Expectation of Variables used in the Model

All the variables and the aprori expectation are defined in Table 1.

Table 1: Variables of the Double Bounded Logit Model

Variables Expected	Description of variables	Sign (+/–)
Dependent variable	Response to bid: receives 1 if answer "yes" with proposed bid amount, 0 if saying "no"	
Independent variables		
Gender	Respondents' gender (1=female, 0=male)	+
Age	Age of respondents (years)	+
Marital status	Marital status of respondents (1=Married, 0=otherwise)	+
Level of Education	level of education attained (years)	+
Income	Monthly income (₦)	+
Household size	Household size (number of family's member)	+
Prior Knowledge	Consumer awareness of IBT (1=Yes, 0=No)	+
Bid	Hypothetical price	-

Payment Vehicle Designing (Designing Bid Amount)

In this study, designing hypothetical prices (bids) to apply double bound dichotomous was based on the questionnaire pretest and the prices of the conventional tomato in the markets (₦ 500/kg). Bidding system was used in Table 2. Each respondent was asked for answering one of four random bids set below to minimize the bias of starting bids. Table 2 presents the distribution of the double-bounded WTP responses. In terms of the different structure of bid prices of 20% and 30% increment. The bid designs captured the WTP ranges quite well. The proportion of the respondents who were willing to pay the bid generally decreased with increases in price. This is confirmed by the fact that the higher starting bid price was less likely to generate a "Yes/Yes" response and more likely to produce a "No/No" response.

Table 2: Bid System for Iodine Biofortified Tomato

Questionnaire versions	Conventional price (₦/Kg)	First bid (₦/Kg)	Second bid (₦/Bundle)	
			Higher amount	Lower amount
	500	600	650	550

Results and Discussion

Socioeconomic characteristics of the Respondents

As a background to this study, Table 3 presents the socioeconomic variables of the respondents. Socioeconomic characteristics of the respondents are important factors directly and indirectly determining willingness to pay. These include age, gender, marital status, level of education, household size among others and the results were summarized in Tables 3. The results showed that the age structure of the respondents and the modal age group ranged from 31 – 50 years with a frequency of 51.33% and mean age of 42 years while the mean household size was 5. These suggested that a typical urban household head is in his economic active years and has a moderate family size. Results also showed that 58.67% were male while 63.33% were married revealing that majority of the respondents were married and have families to cater for. The level of education of respondents is assumed to influence the level of awareness and perception of iodine biofortified tomato. 50.00% had HND/BSC with the average years of working experience was 12 years. It was revealed that 81.33% received a monthly income of less than ₦100,000 with the mean income of ₦78,635 per month. With this amount, it is assumed that respondents should respond positively in paying a price premium for IBT. However, 15.67% of the respondents have a prior knowledge of IET while 32.67% of them are hypertensive.

Table 3: Socioeconomic characteristics of respondents

Variable	Frequency	Percent (%)
Age (years)		
Below 30	114	38.00
31-50	154	51.33
51 and above	32	10.67
Gender		
Male	176	58.67
Female	124	41.33
Marital status		
Single	96	32.33
Married	190	63.33
Divorced	12	4.00
Widowed	2	0.34
Household size		
1-3	166	55.33
4-6	118	39.33
7 and above	16	5.34
Prior Knowledge of IBT		
Yes	47	15.67
No	253	84.33
Health Status of Respondent		
Non-Hypertensive	202	67.33
Hypertensive	98	32.67
Level of Education		
NCE/OND	64	21.33
HND/BSC	150	50.00
MSC/PHD	86	28.64
Monthly Income		
₦50,000- ₦100,00	244	81.33
₦100,001- ₦200,000	42	14.00
Above ₦200,001	14	4.67

WTP for Iodine-Biofortified Tomato

Table 4 indicates that 58% of the respondents are willing to pay a premium for IBT. They were later asked to respond to the double-bounded dichotomous choice questions with two bid prices: a starting bid and a follow-up bid.

Table 4: Percentage of consumers who are willing to pay a price premium

	Frequency	Percent
Yes	174	58.00
No	126	42.00
Total	**300**	**100**

Source: Field Survey, 2019

Distribution of the Double-Bounded Willingness to Pay Responses

Table 5 presents the distribution of the double-bounded WTP responses for IBT. The bid designs in Table 2 captured the WTP ranges quite well. The proportion of the respondents who were willing to pay the bid generally decreased with increases in price. This is confirmed by the fact that the higher starting bid price was less likely to generate a "Yes/Yes" response and more likely to produce a "No/No" response.

Table 5: Distribution of Double-Bounded Dichotomous Choice Willingness to Pay Responses

Percentage of Respondents (N=300)				
Yes– Yes	**Yes–No**	**No–Yes**	**No–No**	**Total**
58 (19.33%)	83 (27.67%)	118 (39.33%)	41 (13.67%)	300 (100%)

Source: Field Survey, 2019

Note: *"Yes/Yes" indicates Yes and Yes response in the first and second bid, respectively.*
"Yes/No" indicates Yes and No response in the first and second bid, respectively.
"No/No" indicates No and No response in the first and second bid, respectively.
"No/Yes" indicates No and Yes response in the first and second bid, respectively.
Figures in parentheses are the percentage of the possible outcomes.

However, the price acceptance chart shows that the willingness to pay of respondents reduced with an increase in price. This is shown in the model expression within the chart. The model expression specifies a linear, negative relationship between the acceptance level and price level. From the model, it can be inferred that for every 1% increase in price of iodine-enriched tomatoes, there is a corresponding 0.14% decrease in acceptability by respondents. This is very significant because respondents been queried had just been educated about the effects of iodine deficiency and iodine's utility.

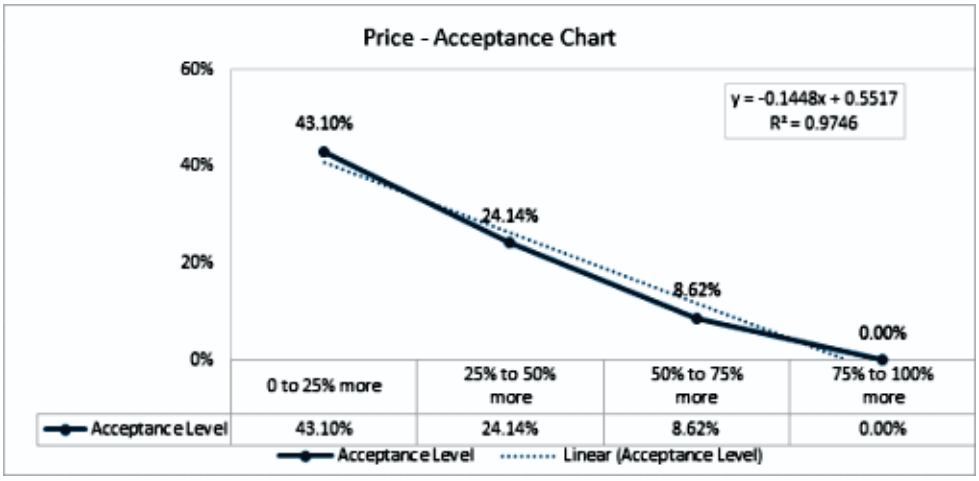

Figure 1. Price - Acceptance Chart

The mean and median WTP were calculated by using the estimated parameters from the constant-only bid function, which restricts all the exploratory variables except the bid variable (Table 6). Thus, the parameter estimates are contained in the constant (intercept) and bid variable in the model (Hanemann, et al., 1991). The results of the mean/median WTP in Table 6 shows that consumers were willing to pay a mean amount of ₦575.26 per kg. This means that consumers would pay around 15% higher for IET than conventional ones sold in the markets.

	WTP	Lower bound	Upper bound
Mean	₦ 575.26	₦ 543.75	₦640.21
Median	₦ 530.43	₦ 540.93	₦ 678.47
95% CI of mean WTP	₦575.56 - ₦572.89		
(₦/bundle)			

Source: Field Survey, 2019

Determinants of Willingness to Pay

Table 7 revealed the results of the logit regression model. The results show that the age, level of education, income, bid price, prior knowledge were significant in the model. The bid price was negative and this is in conformity with the apriori expectation. The implication of this is that as the bid price increases, the respondents willing to pay decreases. However, age, level of education, income and prior knowledge were significant at $p<0.1$, $p<0.01$, $p<0.01$, $p<0.01$ and were positive implying that the higher the age, level of education, income and prior knowledge of the respondents, the increase in the likelihood WTP for a price premium for IBT. In order to evaluate the performance and goodness of fit of the models, Wald test by Kanninen and Khawaja (1995) was used. The wald tests was significance at $p<0.01$ show that explanatory variables were generally suitable.

Table 7: Factors Influencing Willingness to Pay for Iodine Biofortided Tomato

Variable	Coefficient	Standard error	Marginal Effects
Gender	-0.376	0.388	-0.079
Age	0.044*	0.023	0.009
Marital status	-0.240	0.531	-0.050
Level of education	0.048***	0.018	0.010
Monthly income	0.000***	0.000	0.002
Household size	-0.142	0.151	-0.030
Prior Knowledge	0.795***	0.262	0.167
Bid amount	-0.006**	0.003	-0.001
Constant	-2.798***	0.931	
Diagnostic statistics			
Wald chi2(9)	22.400***		
Prob > chi2	0.008***		
Pseudo R^2	0.110		
Log likelihood	-90.805		

Conclusion and Recommendation

This study assessed consumers' willingness to pay for IBT. The results showed that attitude towards IBT were positively. It was revealed that 58% of the respondent are willing to pay a price premium for IBT. However, the proportion of the respondents who were willing to pay the bid price generally decreased with increases in price. This was confirmed by the fact that the higher starting bid price was less likely to generate a "Yes/Yes" response and more likely to produce a "No/No" response. Also, consumers were willing to pay a mean amount of ₦575 per kg of IBT. This means that consumers would pay around 25% higher for IBT than conventional tomatoes sold in the markets. It is concluded that age, level of education, income, prior knowledge and bid price were significant factors influencing respondents' willingness to pay a price premium. Therefore, policy issues aimed at encouraging willingness to pay for IBT should focus on increasing widespread awareness programmes.

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