Consumer Willingness to pay for Genetically Enhanced Foods in Nigeria: The Role of Nutrition and Process Information

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Abstract

Consumer resistance to novel food technologies, such as genetic modification (GM) and gene editing (GED), is often attributed to a limited understanding of the underlying scientific processes. Literature suggests that providing information about the processes may influence consumer acceptance, but evidence remains inconsistent across regions. This study examines how information on genetic engineering processes influences consumer willingness to pay (WTP) for genetically engineered foods in Sub-Saharan Africa (SSA), where food and nutrition insecurity are pressing issues. Using a discrete choice experiment (DCE) conducted in Nigeria and a randomized experimental design, we subjected respondents to two types of information treatments: one emphasizing the health benefits of a nutritionally enhanced cassava product ("gari") and another that additionally explained the scientific processes behind conventional breeding, GM, GED. The data were analyzed using mixed logit models, comparing full attendance with stated and inferred attribute non-attendance (ANA) specifications. The results show consumers are willing to pay a premium for enhanced micronutrient content. However, information detailing scientific processes increased consumer aversion toward GM and GED methods. Importantly, providing process information significantly reduced instances of ANA behaviour, with stated ANA models offering the best fit to the data. While our findings suggest that efforts to scale up these technologies to address micronutrient deficiency and other nutrition insecurities in Africa are likely to succeed, other concerns about market prospects remain. We discuss these concerns and other market implications of the findings.

Keywords: Novel Food Technologies, Information, Choice Experiment, Willingness to pay, Attribute Non-Attendance, Sub-Saharan Africa.

1. Introduction

Micronutrient deficiency (MND) is a severe dimension of nutrition insecurity prevalent in Africa. Recent estimates show that nearly 282 million people in Africa were undernourished in 2022 of which 88% are from sub-Saharan Africa (SSA) (FAO, 2023). The prevalence of iron deficiencies among women of reproductive age in Africa is found to be the highest (38.9%) with a higher estimate of approximately 52% in Western Africa (FAO, 2023). In Nigeria, the most populous country in SSA and Western Africa, around 68.9% of children and 55% of pregnant women suffer from iron deficiencies (The World Bank, 2023).

A major cause of malnutrition and micronutrient deficiencies in SSA is a diet high in cereal grains and starchy foods that lack essential nutrients (Onuegbu et al., 2017; Okwuonu et al., 2021; Abubakar et al., 2024). To mitigate micronutrient deficiencies in SSA, scientists have attempted to increase the micronutrient content of staple foods lacking in essential micronutrients through biofortification (Bouis et al., 2011; Bouis and Saltzman, 2017). Biofortification can be done using genetic engineering (GE) methods including genetic modification (GM) and gene editing (GED).

However, as novel food products enter markets, consumers increasingly demand information on production methods (Caswell, 1998; Galati et al., 2019; Zhang et al., 2022). The use of GE, a key "production process" attribute, can lead to information asymmetry and potential market failure if not disclosed (Caswell & Mojduszka, 1996; Olynk et al., 2010). This raises concerns about whether consumer resistance to novel food technologies stems from limited understanding and whether "production process" information should be provided to consumers (Nayga et al., 2005; Kahan et al., 2009; Fernbach et al., 2019). While studies have examined information effects on consumer acceptance of novel food technologies elsewhere (Bierbestein et al., 2012; Van Loo et al., 2020; Zhang et al., 2021), little is known about how consumers in SSA would respond to process information on technologies providing some form of benefits e.g. enhancing the micronutrient content of staple foods.

In this study, we examine how information about the scientific process behind transgenic GM and GED technologies will influence consumer's preferences and willingness to pay (WTP) for nutritionally enhanced food in Southern Nigeria in Nigeria. We design and implement a hypothetical discrete choice experiment (DCE) in which we experimentally randomized consumers into a group that received information about the health and nutritional benefits of genetically enhanced food and another group that additionally received information about the scientific process (method) involved in using GM and GED. Our experimental approach which has been applied in other food DCEs (e.g., Caputo, 2020; Yang & Hobbs, 2020; Kilders & Caputo, 2021), allows us to assess the effect of novel food production process information on information treatments influence consumer preferences and WTP. Our study makes two main contributions to the literature.

First, this study provides experimental evidence of the effect of food biotechnology process information on consumers' preferences and WTP among consumers in SSA. Previous studies have shown that consumers are willing to pay a premium for nutritionally enhanced foods when no information or only information about the health benefits is provided (Chowdhury et al., 2011; Oparinde *et al.,* 2016; Herrington et al., 2022). However, evidence of consumers' reactions to information about the scientific process behind GM and GED foods in Africa is largely missing in the literature. It remains unclear whether providing process information improves consumer acceptance of novel foods or if highlighting health benefits alone is sufficient. Global evidence is mixed: in some contexts, process information increases acceptance (e.g., McFadden & Huffman, 2017; Caputo, 2020), while in others, it increases aversion (e.g., Bierbestein et al., 2012; Marette et al., 2021). Given strategic importance of scaling novel food technologies in SSA - a region critical to achieving the Sustainable Development Goal of ending hunger (Atukunda et al., 2021) - this study focuses on consumer responses in this under-researched context.

Second, we make a small but relevant contribution to the literature focusing on how consumers process information about food attributes when making choices (e.g. Scarpa, et al., 2013; Bello & Abdulai, 2016; Caputo, et al., 2018). Evidence has shown that consumers may not attend to certain food attributes when making choices in experiments such as the DCEs (Hensher & Rose, 2009; Kehlbacher, et al., 2013) especially when they are unfamiliar with those attributes (Alemu et al., 2013). Moreover, failure to account for such attribute non-attendance (ANA) behaviour in choice models may lead to inaccurate estimation of preferences and willingness to pay measures and consequently wrong policy conclusions (Scarpa, et al., 2010; Kragt, 2013; Caputo, et al., 2018). Given that this study focuses on a context in which consumers are unfamiliar with GE food technologies (citation needed), one can expect significant non-attendance behaviour to GE attributes in the DCE. For instance, Sandorf, et al. (2017) find that a low level of knowledge is associated with a higher propensity to ignore attributes for which consumers did not have knowledge. While previous studies cited previously have provided mounting evidence of ANA behaviour and possible causes of the ANA behaviour, how information provision influences ANA behaviour in a DCE context has received little attention despite increasing use of information experiments within the DCE context. In this study, we examine how information provision influence ANA behaviour especially in the context where respondents are unfamiliar with food attributes targeted by the information. One can theoretically argue that providing information should increase knowledge and reduce the incidence of ANA. However, such argument remains an hypothesis that need to be tested. Moreover, the type of information that consumers are exposed to in a DCE may condition their attribute-processing strategy (Hensher & Rose, 2009). By examining how not only information, but different information treatments, influence ANA and subsequent WTP estimates, we contribute to a deeper understanding of the interplay between information, ANA, and consumer choices specifically for GE foods.

The paper is organized as follows: We describe the experiment and estimation strategy in section 2, section 3 describes the data and sample characteristics, we present the results in section 4 while the discussion and conclusion was presented in section 5. Then, we highlight the limitations of the study and provide directions for future research in Section 6.

2. Materials and Methods

2.1. Discrete choice experiment: Selection of attributes and attribute levels

To access consumer preferences for GE food, we selected a major staple food, Gari - flakes made from cassava. Cassava is one of the major targets of biofortification efforts in Nigeria for the same reason that it is a major staple food for most consumers. Attributes and levels of Gari used for the experiment were chosen after a review of the literature on the process of biofortification, the use of genetic engineering, and the target micronutrients in Nigeria and SSA (Bouis et al., 2011; Sayre et al., 2011; Birol et al., 2015; Oparinde et al., 2016; Van Der Straeten et al., 2020). In addition, we carried out in-depth interviews with breeders of nutritionally enhanced cassava, processors and consumers of gari to select the important attributes of gari used for the study. We finally selected five relevant attributes which include two micronutrient attributes (Vitamin A (VA) and Iron), plant breeding process attributes (conventional, GM, and GED), starch content, and price. Table 1 presents more details about these attributes and their corresponding levels.

Table 1: Attributes and Levels of Experiment

Attributes	Description	Levels	Reference level
VA	Percentage of estimated average body requirement for VA	60, 100	60
Iron	Percentage of estimated average body requirement for Iron	0, 25, 50	0
Starch Content	Cassava Starch Content	Low, High	High
Plant Breeding Method	Breeding Method used for the Cassava	Conventional, Genetic Modification, Gene Editing	Conventional
Price (Naira)	Price per 1kg of Gari	[1]300, 500, 700	

The VA and Iron are targets of biofortification in Nigeria because most cassava varieties in the country lack these essential micronutrients (Okwuonu et al., 2021). Consequently, increasing the density of VA and iron has been one of the main targets of efforts to address micronutrient deficiency in the study area (Sayre et al., 2011; Oparinde et al., 2016). At the time of our study, the conventional method of plant breeding was applied to the biofortification of cassava with VA in Nigeria (Birol et al., 2015; Oparinde et al., 2016). However, due to the need to ensure the bio-availability of higher levels of VA and also enhance cassava with iron, the Bio-Cassava Plus Program developed GM cassava, which was yet to be approved for commercialization

[1] Price is measured in Naira. ₦416 ≈ US1$ at the time of the survey

(Sayre et al., 2011; Oparinde et al., 2016; Onuegbu et al., 2017). Further, GED is becoming a promising alternative to GM, as studies have shown that consumers seem to favour GED over GM (e.g. Kumar et al., 2022). In line with the objectives of this study, we included these three methods as part of the attribute levels for the plant breeding method in our discrete choice experiment (DCE) design. A major shortcoming of the conventional method is that it can only deliver a maximum of 60% of the estimated average requirement (EAR) of VA for a cassava meal of 200g per day for children and 400g for adults (Bouis et al., 2011; Oparinde et al., 2016). However, it is possible to add multiple vitamins and minerals in a timely and cost-effective manner through biotechnology (De Steur et al., 2012; Van der Straeten et al., 2020). Therefore, we simulate a situation where GE methods can deliver up to 100% of the EAR for VA and 50% of the EAR for Iron. The levels for VA and Iron in gari were presented as percentages, relative to the EAR for these micronutrients. The status quo alternative is 'white gari', which was not fortified with micronutrients. So, a value of 0% was assigned to the VA and iron content for the status quo alternative.

An important sensory attribute of cassava affected by VA enhancement is starch content (Beyene et al., 2017; Oluba et al., 2017). Previous studies indicate that the starch content of cassava can be an important attribute in determining the choice of gari in Nigeria (Dalberg, 2019). Modifying cassava for elevated levels of VA through conventional or GE methods is associated with a lower level of starch content in the final cassava variety (Beyene et al., 2017). Hence, it becomes essential to see how this attribute, along with the enhancement of the micronutrients, can determine the choice of consumers. We only included this attribute in a binary form of "High starch content vs Low starch content," with the former as the base level. The underlying reason is that the "white gari" representing the status quo in our design has high starch content while the nutritionally enhanced gari was likely to have low starch content. Finally, we included the price attribute into the DCE design since we intended to estimate consumers' WTP to gauge their trade-off between other attributes and cost. The price levels chosen for our DCE design range from the average minimum price of “white gari” to the price of the gari enhanced with vitamin A using the conventional method available for sale at the time of the study. The selected attributes and levels were combined to form an unlabeled DCE.

2.1.2. DCE Design and Survey Procedure

We conducted the DCE experiment in two stages: pilot and main studies. The design of the DCE for the pilot study began with a full factorial design, which included all combinations of the selected attributes for this study, yielding 216 profiles. Since this large number of profiles would be cognitively demanding for respondents, the Bayesian efficient fractional design approach was employed to reduce the profiles. Like other fractional designs, the Bayesian design (BD) selects a subset of profiles that produce preference data with minimal standard errors for the estimated parameters given a specific sample size (Scarpa and Rose, 2008).

For the pilot study, priors for the attribute estimates were required for the BD. Following the literature, zeros were specified as priors. The resulting design included 16 choice tasks with two alternatives of nutritionally enhanced gari and a status quo alternative representing the gari sold in the market. We further divided the 16 choice tasks into two blocks to reduce the cognitive burden on respondents making each respondent to face only eight repeated-choice tasks. The pilot DCE study was conducted with 48 respondents. We fitted the data from the pilot DCE to a mixed logit model, and the resulting estimates were specified as priors for designing the main study.

For the main study, the BD similarly resulted in an unlabelled design with 16 choice tasks, including two alternatives of nutritionally enhanced gari and a status quo alternative. As in the pilot study, the tasks were divided into two blocks to minimize respondent cognitive load. All DCE designs were implemented using the idefix package (version 4.2.0) in the R software environment (Traets et al., 2020). Figure 1 provides a sample of the choice task presented to respondents during the survey.

	Gari 1	**Gari 2**	**Gari 3** (Status quo)
			
Vitamin A[1]	Contains 60% of the average Vitamin A required by the body.	Contains 60% of the average Vitamin A required by the body.	Does not contain Vitamin A required by the body.
Iron	Does not contain Iron required by the body	Contains 25% of the average Iron required by the body.	Does not contain Iron required by the body
Starch Content	High Starch Content	High Starch Content	High Starch Content
Plant Breeding Method	Conventional Method	Gene-Editing Method	None
Price per Kg	₦ 300	₦ 500	₦ 300
I will buy	( )	( )	( )

Notes: [1] It is based on the estimated average requirement (EAR) taken from the literature and key informant interviews

Figure 1: Sample of Choice Task from Experiment

In the first part of the main study, respondents answered questions relating to their consumption and purchasing behavior, awareness, and knowledge of biofortification and GE methods, and perception of micronutrient deficiencies. Next, the respondents received information based on the group to which they were randomized. After the information treatment, they responded to the DCE questions. After each choice task in the DCE, respondents were asked to state which of the attributes they ignored. This approach allows us to obtain stated ANA information at each choice task level as demonstrated in Caputo, et al. (2018). Lastly, respondents answered questions about their socio-economic characteristics. In the next section, we provide more details on the information treatments and hypotheses we tested.

2.2. Information Treatment and Hypotheses

To elicit consumer's preferences and to obtain their WTP estimates under different information regimes, we designed the DCE with two information treatments using a between-subject approach. Respondents were randomly assigned to the two experimental groups. The treatments are labelled "Nutrition" and "Method" as presented in Table 2. Both groups were given information before attending to the DCE questions. Participants in both groups received the information through video clips in either English or the local language (Yoruba), depending on the preference of each respondent. The video for the nutrition treatment is 3 minutes 21 seconds, while the video for the method treatment is about 4 minutes 22 seconds. The scripts and link to the video can be found in the appendix. Our choice of video as the communication medium follows findings from previous studies that the use of video is more effective in communicating information on genetic engineering compared to text-only or text with still pictures (Kilders and Caputo, 2021; Yang et al., 2022).

Table 2: Layout of the CE treatments

	Nutrition	Method
Micro-nutrient and health information	✓	✓
Conventional, GM and GED scientific process information		✓

The "Nutrition" treatment video starts by informing participants about the importance of VA and Iron in the body and that many of the staple foods that consumers eat in Nigeria were deficient of VA and Iron. Next, participants were informed about the health risks of VA and Iron deficiencies in adults, children, and pregnant women while they also saw the statistics of children and women suffering from VA and Iron deficiencies in Nigeria. Lastly, participants were informed that some cassava varieties with enhanced VA content but deficient in Iron were already available in the market but because of the insufficient VA in the varieties and lack of Iron, the government was planning to release new varieties that would have sufficient amount of VA and Iron content. In the "Method" treatment, participants watched the same video as the "Nutrition" treatment and were additionally informed about the scientific processes behind three methods that can be used to enhance cassava. First, participants were informed that the enhanced cassava varieties in the market were developed using the conventional breeding method which could only add an insufficient amount of VA to cassava and could not enhance the Iron content. Next, they were informed that the GM (transgenesis) method had also been used to develop new varieties of cassava but with sufficient VA and Iron content. Afterward, participants were informed that varieties developed with the conventional method were already tested and released into the market and that those developed with GM were only tested and approved as not harmful to the environment and consumers' health but not yet commercialized by the government. Next, participants were informed that the GED method was only being proposed but not yet tested and approved by scientists or the government. In contrast to some studies that provide information on both the risks and benefits of GE foods (Kimenju and DeGroote, 2008; Gbegbelegbe et al., 2015), we did not provide information about risks associated with the use of GE methods since there is currently no consensus among scientists concerning the scientific evidence of the adverse effects on health and the environment (Smyth et al., 2021; Stanton et al., 2021; Lynas et al., 2022). Details of the information treatments are provided in the appendix.

We tested four hypotheses in this study. The first hypothesis relates to the role of the information treatments in influencing ANA behaviour. In this regard, we expect consumers in the "Nutrition" group to have a significantly higher propensity to ignore method attributes compared to consumers in the "Method" group. Although consumers in both groups were initially unfamiliar with the method attributes before information provision, we expect that the scientific process information given to the method group should increase the knowledge of consumers in the group thereby reducing their ANA rates. Second, we hypothesize that models that account for ANA will explain the data better than models that assume full attendance. The third hypothesis relates to how consumers in both treatments respond to micro-nutrient and health benefits information. Consistent with previous studies (e.g. Chowdhury et al., 2011; Meenakshi et al., 2012; Oparinde et al., 2016; Lusk et al., 2018), we expect consumers in both treatments to be willing to pay a premium for enhancement in all the micronutrient attributes. To test this hypothesis, we estimated marginal WTPs for the micronutrient attributes for both experimental groups and testes if the estimates are statistically different from zero. The fourth hypothesis relates to the role that process information will play in consumers' preferences for the method attributes. We expect that consumers in the method group will prefer the conventional method to GE methods consistent with most similar studies reported in other regions (Van Loo et al., 2020; Marette et al., 2021). Also, similar to findings from previous studies (Yang & Hobbs, 2019; Marette et al., 2021; Yang et al., 2022), we expect that consumers were likely to have lower disutility for the GED method compared to the GM method. In the next section, we describe the econometric estimation strategies we employed to test the research hypotheses.

2.3. Estimation Strategy

To test our research hypotheses, we estimated models that assumed full attendance and models that accounted for ANA using the DCE data. For the full attendance model, we estimated taste intensities for the gari attributes using data from each treatment group (segmented data). To account for ANA, we employed two popular approaches in the literature. The stated ANA, which is the first approach, entails using questions from respondents about the attributes in the individual utility function. This stated ANA information can either be obtained at the end of each choice task or after responding to all DCE tasks. Models that use task-level information are referred to as choice task ANA while models that use information at the end of the DCE tasks are referred to as serial-level ANA models. The other approach for accounting for ANA – inferred ANA - entails the use of flexible econometric models that allow for ANA to be detected directly from the DCE data (Gonçalves et al., 2022). A recent review of the state of the art in the literature of ANA in food choice studies by Caputo and Scarpa (2022) seems to suggest there is no consensus on which approach is better implying that accounting for ANA may be data-specific in empirical applications. In this study, we compare the choice-task ANA approach as employed by Caputo et al. (2018) and an inferred ANA approach introduced by Hess and Hensher (2010) and applied by Sandorf et al. (2017).

For all the models, the DCE data was fitted to mixed logit models (MXL) (McFadden & Train, 2000). In specifying the MXL, it is common to assume that consumers are rational utility maximizers as described in the Random utility theory (RUT) (McFadden, 1986). According to the RUT, we assume that the indirect utility of respondent n for gari option j in choice situation t can be specified as

$$U_{njt} = V_{njt} + \varepsilon_{njt} \quad (1)$$

Where V_{njt} represents the deterministic part of utility and ε_{njt} represents the stochastic random portion of the utility assumed to follow Type 1 Generalized Extreme Value (GEV) distribution (McFadden, 1986). In many econometric specifications, a common assumption is that V_{njt} is determined only by the attributes of the product alternatives that consumers face. However, it is also common to assume that consumers have full information about the alternatives and attend to all the attributes to make full trade-offs among the attributes. Alternatively, the MIXL can be specified to accommodate ANA behaviour. For this study, we specified full attendance and ANA (non-compensatory) models. For the full attendance specification, we specify

$$V_{njt} = ASC + \beta_{va}VA + \beta_{ir25}IR25 + \beta_{ir50}IR50 + \beta_{ls}LS + \beta_{gm}GM + \beta_{ge}GE + \beta_{price}Price \quad (2)$$

where ASC represents the coefficient for the conventional gari option, VA represents the vitamin A at 100% level, IR_{25} represents iron at 25% level, IR_{50} represents iron at 50%, LS represents the low starch, GM represents GM method, while GE represents GED method with the conventional method being the reference category. ε_{njt} is the stochastic random part of the utility function. VA_{100}, IR_{25}, IR_{50}, LS, GM, $GE,$ are coded as dummy variables with the variable of interest being 1 and otherwise, 0. Price is coded as a continuous variable. The β_{va}, $\beta_{IR_{25}}$, $\beta_{IR_{50}}$, β_{ls}, β_{gm}, β_{ge}, β_{price} represent respective taste parameters for VA_{100}, IR_{25}, IR_{50}, LS, GM, GE and Price variables.

For the ANA model specification, we specify

$$V_{njt} = ASC + (\beta_{va}^{att} + \beta_{va}^{natt})VA + (\beta_{ir25}^{att} + \beta_{ir25}^{natt})IR25 + (\beta_{ir50}^{att} + \beta_{ir50}^{natt})IR50 + (\beta_{ls}^{att} + \beta_{ls}^{natt})LS + (\beta_{gm}^{att} + \beta_{gm}^{natt})GM + (\beta_{ge}^{att} + \beta_{ge}^{natt})GE + (\beta_{price}^{att} + \beta_{price}^{natt})Price$$

(3)

In equation 3, $\beta_{va}^{att}, \beta_{ir25}^{att}, \beta_{ir50}^{att}, \beta_{ls}^{att}, \beta_{gm}^{att}, \beta_{ge}^{att}, \beta_{price}^{att}$ represent utility estimates of respondents who attended to VA, IR25, IR50, GM and GE while $\beta_{va}^{natt}, \beta_{ir25}^{natt}, \beta_{ir50}^{natt}, \beta_{ls}^{natt}, \beta_{gm}^{natt}, \beta_{ge}^{natt}, \beta_{price}^{natt}$ represent the utility estimates for the respondents who ignored the attributes. All parameters in equation (2) and only those for attenders in equation (3) were specified as random parameters meaning they are assumed to vary over individual respondents according to some specified distributions. In this case, an important consideration that can affect estimates of MXL is the distributional assumption made for the random parameters (Train, 2009). In our specification, β_{va}, $\beta_{ir_{25}}$, $\beta_{ir_{50}}$, β_{ls}, β_{gm} and β_{ge} follow normal distribution and β_{price} specified as a fixed parameter as implemented in many food choice studies (e.g. Van Loo et al., 2020). Additionally, all models were specified to allow for correlation among all the parameters except the ASC. The choice probability of MXL can only be estimated using simulated log-likelihood over a series of iterations that require a number of draws (Train, 2009). In all our specifications, we specified 500 sobol draws.

To proceed with the estimation, the first step was to identify attenders from non-attenders. This procedure differs for the stated ANA and inferred ANA approaches. For the inferred ANA, we followed Hess & Hensher (2010) to estimate full attendance MIXL models for each of the treatment groups assuming normally distributed random parameters for all attributes. Using the outputs of the models, we generated individual conditional parameters. We used the mean and standard deviation estimates to compute the coefficient of variation (CoV) for each respondent for each attribute. Then, respondents are categorized to have ignored an attribute if the absolute value of their COV for the attribute is greater than 2 (Hess and Hensher, 2010). For the choice task stated ANA, we used the self-reported response to the questions of whether a respondent ignored an attribute to categorize the respondent into attender or non-attender for the attribute. Finally, we estimated three models for each of the treatment groups – full attendance, choice task stated ANA, and inferred ANA models. Using the model fit statistics, the log-likelihood, and BIC, we selected the model that best fits the data.

The second stage of our empirical strategy involved the determination of whether we should pool the data of the treatments together based on the best-fit model selected in the first stage. Following the practice in the literature (e.g. Matthews, et al., 2017; Van Loo, et al., 2020; Caputo, 2020), we carried out to test the hypothesis of equality of coefficients between the segmented models and the pooled model. The test is based on a log-likelihood values of the segmented and joint models and it is calculated as: $-2[L_{pooled} - (L_{nutrition} + L_{method})]$ where L_{pooled}, $L_{nutrition}$ and L_{method} are respective log-likelihood values for the pooled, nutrition and method models. The test is chi-square-distributed with degree of freedom equal to K(T - 1), where K is the number of restrictions and T the number of treatments.

All models were estimated using the simulated maximum likelihood estimation with the Apollo package in the R Statistical environment (Hess and Palma, 2019). The utilities of our models were all specified in the preference space. Thereafter, estimates of the finally selected models were used to compute WTP estimates that are interpretable in monetary terms as done in other food choice studies (e.g. Van Loo, et al., 2020; Sanou, et al., 2021).

3. Data and Sample Characteristics

3.1. Sampling

We obtained data for this study from a cross-sectional survey of 235 households in Nigeria from April to June 2022. We sampled respondents through household visits in the urban and rural areas of two states (Ondo and Oyo) in the southwestern part of Nigeria. These states were selected based on the availability of nutritionally enhanced gari developed with the conventional method in these areas. This type of gari was available in the market for sale to consumers. The urban areas selected were the capital cities of these states – Akure in Ondo and Ibadan in Oyo. The areas were stratified into three residential zones, which consist of consumers in the low, middle- and high-income strata (Adeoye, 2016; Sanni and Akinyemi, 2017). In each of the zones, we selected two residential areas. In the rural areas, data were collected from two villages in Ayede-Ogbese and Ido Local Government Areas (LGAs) of Ondo and Oyo states, respectively. In contrast to the urban areas, households in the rural areas do not follow any meaningful delineation into residential zones. In both urban and rural areas, we employed a systematic random approach to visit every 4th household. At each household visit, survey administration to the respondents started with securing the consent of the household member to participate voluntarily. The participant in each household is either the household head or an adult who is mainly responsible for food purchases.

3.2. Sample Characteristics and Balance Test

The socioeconomic characteristics presented in Table 3 show that most of the respondents were female, married with an average age of about 41, and lived in rural areas. About 60% of the respondents had only attained the secondary level of education and a majority earned less than 70,000 naira ($168). About half of the female respondents are women of reproductive age while respondents with children aged 5 or below constitute about 46% of the sample. In terms of purchasing preferences, most of the respondents purchase white gari and also purchase from the open market.

About half of the respondents stated that they had heard about nutritionally enhanced gari produced with the conventional method. Concerning awareness of the methods, respondents were asked to state if they had previously heard the terms “GM” and “GED.” Results indicate that although awareness of GM and GED among the respondents was generally low, respondents were still more aware of the GM method compared to the GED method. The consumers were also asked how knowledgeable they think they were about GM and GE on a scale from 1 to 5, where 1 being very unknowledgeable and 5 being very knowledgeable. On average, respondents who were aware of GM and GED felt unknowledgeable.

Table 3: Sample Characteristics

Variable	**Nutrition Mean (SD) / % N = 116**	**Method Mean (SD) / % N = 119**	**Pooled Mean (SD) / % N = 235**	**P-Value**
Female	67.24%	65.55%	66.38%	0.78
Married	86.21%	84.87%	85.53%	0.77
Age	43.63 (13.00)	44.68 (12.06)	41.52 (12.66)	0.33
Live in rural area	63.79%	57.98%	60.85%	0.36
Formal education				
None	5.17%	4.20%	4.68%	0.43
Secondary or lower	63.80%	56.31%	60.01%	
Graduate	21.55%	31.09%	26.38%	
Post-graduate	9.48%	8.40%	8.94%	
Income Group (Naira)				
< 30,000	40%	44%	33%	0.36
30,001 – 70,000	29%	21%	31%	
70,001 – 150,000	12%	24%	18%	
> 150,000	19%	11%	18%	
Women of reproductive age	41.38%	52.10%	46.81%	0.10
With Children aged 5 or below	44.83%	48.74%	46.10%	0.54
Purchasing characteristics				
Favorite purchase location				
Open Market	75.86%	83.19%	79.57%	0.22
From Processor	24.24%	16.81%	20. 43%	
Type of Gari frequently bought				
White	89.66%	90.76%	90.21%	0.59
Yellow	0.86%	0.00%	0.43%	
Both	9.48%	9.24%	9.36%	
Awareness and Knowledge				
Biofortified gari	49.14%	45.38%	47.23%	0.41
GM	21.55%	21.85%	21.70%	0.56
GED	9.48%	12.61%	11.06%	0.70
Subjective knowledge of GM	1.36 (0.98)	1.45 (1.06)	1.40 (1.02)	0.66
Subjective knowledge of GED	1.12 (0.79)	1.13 (0.78)	1.17 (0.82)	0.79
Objective knowledge of GE	6.03%	7.56%	8.09%	0.25

Note: P value from the t-test of the difference between the mean and Chi-square test of difference in distribution

To access the objective knowledge of GE, respondents who claimed to be aware of any of the GE methods were also asked to respond 'Yes,' 'No,' or 'Do not know' to two items: (i) "Genetically modified foods contain genes while non-genetically modified foods do not contain genes" and (ii) "Human genes can change through consuming genetically modified foods." (Gaskell et al., 2006). We categorized respondents who answered 'No' to both questions as having objective knowledge. Results indicate that only about 8% of the sample had objective knowledge of GE. The balanced test results show no significant difference between the treatment groups in terms of their socioeconomic and purchasing characteristics, level of awareness, and knowledge of GE methods.

4. Results

4.1. Rate of Attribute Non-Attendance

Table 4 shows the rate at which the respondents ignored the attributes in each treatment group for both inferred and stated ANA approaches. Results from the two approaches are similar. In both groups, the result indicates a high rate of ANA up to 70% for the method attributes. In contrast, the results show that there are low incidences of ANA for the nutrient-related attributes. Further we observe some differences in ANA rates between the treatment groups. We tested if the differences were significant using an independent sample T-test. The results from the inferred ANA approach show there are significant differences in the rate of attendance to VA, GM, and GED attributes indicating that a higher number of respondents ignored the attributes in the Nutrition group than in the Method group. Results from the stated ANA approach show that there are only significant differences in the number of respondents who ignored GM and GED attributes. Through both approaches, we confirm our first hypothesis that respondents in the nutrition group ignored the method attributes at significantly higher rates than respondents in the method group. Therefore, the results indicate a need to account for ANA in the estimation of the preference estimates.

Table 4: Attributes ignored based on the treatment groups

	Inferred			**Stated**		
	Nutrition	**Method**	**p-value**	**Nutrition**	**Method**	**p-value**
	N=116	**N=119**		**N=116**	**N=119**	
Price	11.21%	14.28%	0.48	24.95%	26.57%	0.42
VA	25.00%	5.04%	<0.001	5.72%	4.62%	0.28
Iron_25	1.72%	4.20%	0.26	16.74%	16.81%	0.97
Iron_50	0.86 %	3.36%	0.18	16.74%	16.81%	0.97
Low starch	21.60%	17.64%	0.45	16.74%	16.81%	0.97
GM	52.58 %	35.29%	0.01	60.48%	55.57%	0.03
GE	68.96 %	50.42%	<0.001	60.48%	55.57%	0.03

4.2. Preference Estimates

Table 5 presents the preference estimates for each treatment group based on full attendance, stated, and inferred ANA models. For each attribute, we present the estimate of the mean and the standard deviation below. The full estimation results of the ANA models include estimates for both attenders and non-attenders. However, as many of the estimates for the non-attenders are not statistically significant, we do not present them here but included in the appendix. Other results are included in the appendix. Based on the log likelihood and BIC of the models, the results show that for both treatment groups, the ANA models fit the data better than the full attendance model with the stated ANA model providing the best fit to the data. This confirms our second hypothesis that models that account for ANA will fit the data better than models that do not account for ANA. There is therefore the need to account for ANA behaviour in estimating preferences for both treatment groups.

Table 6 reports the results of the LR tests of the hypothesis of equality of coefficients. Please, note that we used the stated ANA models for the LR test based on the fact that stated ANA provided best fit. The results show that the LR statistic for Pooled model is statistically insignificant indicating that we cannot reject the hypothesis of equality of coefficients. The results imply that we can pool the data from the two treatments together.

In both treatments as well as the Pooled model, the estimates for the ASC coefficients are negative and statistically significant implying that respondents prefer the nutritionally enhanced options to the gari lacking in essential micro-nutrients. The coefficients of all the micronutrients are positive and statistically significant with consumers having the highest preference for gari that meets 50% of EAR for Iron. Also, coefficients for low starch are positive and statistically significant suggesting that consumers in both treatments prefer gari options with low starch content. For the method attributes, the coefficients for GM and GED attributes in the nutrition group are negative but not statistically significant indicating consumer indifference between the GE and conventional methods. Whereas in the method group, the coefficients for GM and GED are negative but statistically significant for both attributes. In both groups, we observe higher disutility for GM compared to the GED method. Concerning price, coefficients for both treatments are negative and statistically significant. Regarding unobserved heterogeneity, we observe that consumers in the nutrition group vary significantly in their preferences for the status quo option (ASC). For the method group, significant heterogeneity is observed for the status quo option (ASC) and Iron_50 attributes.

Table 5: Preference estimates for full attendance and attribute non-attendance

		Nutrition			Method			
Attribute		**Full Attend**	**Stated ANA**	**Inferred ANA**	**Full Attend**	**Stated ANA**	**Inferred ANA**	**Pooled (Stated ANA)**
ASC	Mean	-9.90 (3.51) ***	-9.23 (2.59) ***	-8.43 (1.62) ***	-6.07 (0.96) ***	-12.94 (4.93) ***	-7.39 (1.5) ***	-9.71 (1.50) ***
	Std. dev	9.11 (3.4) ***	7.57 (2.33) ***	7.28 (1.51) ***	6.84 (1.45) ***	10.83 (4.22) **	9.39 (2.16) ***	8.80 (1.79) ***
Vitamin A	Mean	0.38 (0.17) **	0.52 (0.2) ***	1.24 (0.41) ***	0.94 (0.25) ***	1.58 (0.49) ***	1.16 (0.29) ***	0.70 (0.16) ***
	Std. dev	0.17 (0.56)	0.17 (0.13)	0.49 (0.42)	0.55 (0.25) **	0.86 (0.58)	0.45 (0.31)	0.04 (0.36) **
Iron_25	Mean	1.49 (0.26) ***	2.22 (0.38) ***	2.21 (0.55) ***	2.03 (0.4) ***	3.64 (0.84) ***	2.33 (0.41) ***	2.31 (0.28) ***
	Std. dev	0.22 (0.49)	0.23 (0.49)	0.88 (0.69)	0.96 (0.49) *	0.56 (1.02)	1.03 (0.57) *	0.02 (0.21) *
Iron_50	Mean	2.09 (0.33) ***	3.06 (0.47) ***	3.17 (0.69) ***	2.51 (0.43) ***	4.40 (0.96) ***	2.91 (0.56) ***	2.99 (0.33) ***
	Std. dev	0.16 (0.31)	0.04 (0.16)	0.42 (0.24) *	0.33 (0.31)	1.23 (0.39) ***	0.68 (0.28) **	0.12 (2.29)
Low starch	Mean	1.33 (0.24) ***	1.83 (0.34) ***	3.17 (0.9) ***	1.62 (0.35) ***	2.83 (0.93) ***	2.88 (0.61) ***	1.79(0.28) ***
	Std. dev	0.58 (0.66)	0.27 (0.4)	2.54 (0.72) ***	0.97 (0.32) ***	2.01 (1.69)	0.57 (0.21) ***	1.49 (1.23) **
GM	Mean	-0.25 (0.37)	-0.83 (0.49)	-1.00 (0.69)	-0.65 (0.51)	-2.32 (1) **	1.06 (0.77)	-1.25 (0.37) ***
	Std. dev	0.46 (0.28)	0.28 (0.31)	0.38 (0.72)	0.18 (0.25)	0.23 (3.71)	3.11 (0.82) ***	0.72 (0.50)
GED	Mean	-0.08 (0.22)	-0.48 (0.45)	-0.49 (0.86)	-0.68 (0.3) **	-1.46 (0.6) **	-1.56 (0.47) ***	-0.74(0.30) ***
	Std. dev	0.04 (0.17)	0.33 (1.24)	0.86 (0.37) **	0.36 (0.34)	0.27 (0.64)	0.23 (0.16)	0.83 (0.63) ***
Price	Mean	- 0.002 (0) ***	-0.01 (0) ***	-0.003 (0) ***	- 0.002 (0) ***	-0.01 (0) ***	-0.003 (0) ***	-0.005 (0) ***
Model Statistics								
N Parameters		30	43	43	30	43	43	43
N Respondents		116	116	116	119	119	119	235
N Observations		928	928	928	952	952	952	1878
Log Likelihood		-563.03	-451.96	-510.43	-581.30	-455.90	-516.09	-922.75
BIC		1331.04	1197.65	1314.68	1368.35	1206.73	1327.1	2169.64

*Note: ***, ** Significant at 1%, 5% standard errors are in parenthesis*

Table 6: Log-likelihood ratio test based on Stated ANA models

Models	N	Log-Likelihood	LR test statistic	Degrees of Freedom	P-Value
Nutrition	928	-451.96			
Method	952	-455.9			
Pooled	1878	-921.08	26.44	43	0.98

4.3. Mean WTP Estimates

Table 7 reports the mean marginal willingness to pay (WTP) estimates for the segmented models and pooled ANA model. WTP estimates from full attendance models for both treatment groups are also added for comparison purpose. First, we observe differences in the WTP estimates of the full attendance models and the stated ANA models. In each treatment, we see a downward correction of the WTP estimates in the stated ANA estimates. Now, the results for the segmented ANA models show that consumers in both treatments are willing to pay a significant premium for all the micronutrients. However, we find that consumers in the method treatment are willing to pay higher premiums compared to consumers in the nutrition group. Altogether, the premiums for micronutrients confirm the third hypothesis that consumers in both groups are willing to pay a significant premium for the micronutrient attributes based on the nutrition information given to both groups. Concerning the WTP estimates for the method, the results show that consumers in both groups discount both GM and GED methods with higher discounts for the GM method. Also, we observe higher discounts on the GM and GED methods for consumers in the method group. This result confirms our fourth hypothesis that consumers in the method group are likely to discount both GE methods.

Table 7: Mean WTP Estimates Based on Full Attendance and ANA Models

	Nutrition		Method		Pooled
	Full	**Stated ANA**	**Full**	**Stated ANA**	**Stated ANA**
Vitamin A	207.93 (104.01) **	102.27 (36.61) ***	517.98 (218.16) **	271.19 (74.99) ***	155.24 (32.19) ***
Iron_25	804.55 (281.75) ***	437.46 (87.15) ***	1117.73 (455.43) **	625.1 (147.21) ***	497.78 (75.45) ***
Iron_50	1132.65 (363.92) ***	601.94 (100.83) ***	1381.66 (519.21) ***	755.74 (158.99) ***	642.01 (82.9) ***
Low starch	717.71 (250.06) ***	360.55 (82.29) ***	890.82 (348.15) **	486.91 (152.71) ***	387.19 (68.59) ***
GM	-134.54 (194.43)	-162.87 (87.12)	-357.62 (296.05)	-398.36 (161.57) **	-270.24 (76.04) ***
GE	-45 (116.73)	-94.11 (85.69)	-376.75 (171.47) **	-250.36 (89.11) ***	-172.45 (58.32) ***

*Note: ***, ** Significant at 1%, 5% standard errors are in parenthesis*

5. Discussion and Conclusion

5.1. Discussion

The finding that before receiving information, most respondents were not aware of GM and GED methods confirm earlier findings about consumers' knowledge of these methods (Kimenju and DeGroote, 2008; Ewa et al., 2022). Without informing consumers about these methods, they were likely to ignore attributes relating to these methods in their choices (Alemu, et al., 2013). Indeed, the results confirm that the majority of the respondents did not incorporate these attributes into their decision-making, even for those who were informed about the methods, although we observe a slight improvement in attendance to the method attributes among those who were informed about method compared to those who were not informed. These results point to the importance of consumer understanding of novel food attributes especially those relating to the production methods in choices of novel food technologies with unfamiliar attributes. Further, the fact that information about the methods only had minimal effect on the tendency to ignore the attributes point to the need to go beyond a one-time provision of information for consumers in this context to understand GE food attributes and use them in their decision making.

Having accounted for ANA, the results show that consumers are willing to pay significant premiums for higher levels of micro-nutrients, regardless of whether they are informed only about the health benefits of GM and GED technologies or are additionally informed about the process behind these technologies. This result is consistent with previous studies (e.g., Oparinde et al., 2016; Kolapo et al., 2023). Regarding the WTP for the methods, the finding that consumers who were not informed about them showed no preference for any of the methods compared to the conventional method further confirms their unfamiliarity with these attributes. However, for those who were informed about the methods and attended to the method attributes, we find a similar pattern of aversion for GE attributes observed in previous studies (Muringai et al., 2019; Kilders & Caputo, 2021; Marette et al., 2021). Furthermore, the relatively lower discount consumers have for GED compared to GM, regardless of the type of information provided, suggests that GED has a greater market prospect in the region. The reduced consumer aversion to GED as a novel food technology has also been reported in other studies (e.g., Yang & Hobbs, 2019; Ding et al., 2023).

Concerning our estimation approach in this study, our results point to the importance of accounting for ANA when evaluating consumer choices of novel food with unfamiliar food attributes. Specifically, the results show a large downward correction of the WTP estimates when we compare the ANA models to models that assumed full attendance. Previous studies have shown that models accounting for ANA fit data better and provide more realistic WTP estimates (Hess and Hensher, 2010; Largade, 2013) Our finding here suggests that researchers evaluating consumers' WTP for novel food technologies should pay attention to how novel attributes which consumers may not be familiar with may induce ANA and influence the validity of WTP estimates.

5.2. Practical Implications

Our study shows that effective consumer education is important for consumer WTP for GE foods in Sub-Saharan Africa (SSA), as most consumers remain unfamiliar with GM and GED methods, and a single exposure to information has a limited effect on their understanding. However, a key challenge that may undermine consumer education efforts is the lack of food labeling in many African markets, limiting consumers' ability to make informed choices. Consumer education only matters to the extent that consumers can access information on food labeling. Otherwise, consumers only choose based on subjective cues, which may not reflect their preferences. Nonetheless, this study shows that consumers exhibit a significant WTP for enhanced micronutrients, indicating that marketing strategies should prioritize communicating health benefits rather than focusing solely on production methods. Notably, consumers are less averse to GED than to GM, suggesting that GED-based biofortification efforts may have better market prospects in SSA. Furthermore, studies on WTP for novel foods must account for attribute non-attendance (ANA), as failing to do so can lead to biased consumer WTP estimates.

5.3. Conclusion

Novel food technologies to address global food security challenges are emerging. High levels of nutrition insecurity in SSA offers a unique opportunity for scientists to apply GE methods to develop nutritionally enhanced foods. However, experiences from previous studies focusing on other regions of the world suggest that consumers are likely to discount the use of these technologies. Evidence on how consumers in SSA might trade off the benefits of GE methods to enhance their food with a possible aversion to these methods is lacking despite the region's critical role in addressing global food and nutrition insecurity. This study used a hypothetical DCE with Gari consumers in Nigeria to investigate the effect of information about the health benefits of nutritionally enhanced food and the scientific process behind conventional, GM, and GED plant breeding methods on consumer WTP. We also examine how the two types of information influence consumers ANA behaviour.

Overall, this study shows that when consumers lack knowledge about the underlying production methods of novel foods, consumers will rather focus on attributes they are familiar with and perceived to be beneficial to them and may not care about how the food is produced. Conversely, consumers will care about how their food is produced when they learn about the different methods of producing the food. Although GE foods are being commercialized in SSA, most consumers are still unfamiliar with the foods as they are not yet available in the market. Consumer acceptance for these foods may take time and preferences for GE foods may change when consumers get familiar with these foods as studies have shown that familiarity with novel foods predicts acceptance (Bryant et al., 2019).

More significantly, as GE foods are being commercialized, the concern is that the current state of food markets in many African countries, where staple foods often lack labelling, may hinder consumers' ability to make informed choices. Although biofortification efforts often target rural households that primarily depend on their food production, many urban and even rural consumers who might be nutritionally insecure are likely to still depend on the market for their common foods.

In light of consumers' positive valuation for elevated nutrients but aversion for GE methods, scaling up GE food technologies to combat nutrition insecurity in SSA requires a holistic approach that combines biotechnological innovation with consumer education and credible food labelling mechanisms to facilitate informed decision-making and long-term acceptance.

6. Limitations and future research directions

The use of hypothetical DCE to elicit consumer preferences and WTP may have influence on the outcome of this study. However, the fact that the use of GE methods for the food product investigated in this study have not been commercialized does not permit us to use real food products. With the hope of commercializing these products, further studies can use real food products to provide a robust WTP measures of consumers for GE foods in the region.

We find that majority of the consumers in our study area have low level of awareness and knowledge of GE concepts resulting in high rates of ANA for the GE attributes even after being provided with both nutrition and scientific process information. Therefore, we suggest future research on novel food technologies using DCE should take account of ANA behaviour in their preference and WTP estimation even after information provision especially when respondents are unfamiliar with the technologies. Moreover, future studies should also investigate the role of GE labelling on consumers' WTP as it has been done in studies focusing on other regions. We also suggest that future studies can carry out multi-country studies that can compare findings for different countries across SSA to test the robustness of our findings in this study.

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Appendix A

Information Treatment 1 – Information on the health risks of micronutrient deficiency and benefits of biofortified food (Nutrition information treatment)

Vitamin A and Iron are among the micronutrients that our body needs to be healthy. Anyone who does not eat a lot of vegetables and fruits but mainly eats our common foods like gari, rice, maize, yam, etc. is likely to have very low Vitamin A and Iron in his or her body. People who have very low Vitamin A in their bodies may not see well at night and if they do not take care of themselves in time, can lead to permanent blindness. Also, their brain may not function very well and they may be falling sick regularly. Children who have low iron in their bodies may not grow and learn well. Adults who have low iron in their bodies get tired at all times. It may also cause pregnant women to give birth before they are due. The weight of their babies can be low and the babies may not grow well.

Scientists have found out that in Nigeria, 2 out of 100 children and 8 out of 100 pregnant women cannot see well at night because of low Vitamin A in their bodies. They also found out that some children between 1 and 4 years are dying because of low Vitamin A in their bodies. About 60 out of 100 women of reproductive age are not having sufficient iron in their bodies. For pregnant women, it is about 50 out of 100, and for children, it is about 70 out of 100 who lack sufficient iron in their bodies

To address these problems, scientists have successfully added Vitamin A to cassava because a lot of us eat foods like gari regularly. These cassava varieties have been in the market and used to make gari but still contain a low amount of Vitamin A. Now, there are new types of cassava they have developed which will have sufficient Vitamin A and Iron that our body needs. Gari made from the new cassava varieties may soon be available in the market if approved by the Government of Nigeria.

Information Treatment 2 – Information on the different production methods used for biofortification of Cassava. (Production method treatment)

Up till now, scientists have used two different methods to add micronutrients to Cassava in Nigeria. These methods are referred to as conventional and genetic modification approaches. Now, they are considering an additional method referred to as gene editing. In this video, we will give you brief information about these three methods while we highlight the main differences between them.

Conventional Method for Adding Vitamin A to Cassava

Scientists used this method to develop vitamin A Cassava in Nigeria. To start with, they identified two types of cassava. The first cassava type, which most farmers like to grow, contains little amount of vitamin A. The second cassava type is rich in vitamin A but not usually grown by farmers. Scientists then combined these two types of cassava in a way that is very similar to how humans and animals meet sexually to produce their children. Thereafter, they selected the cassava varieties with the highest amount of vitamin A among different varieties produced during this process. The cassava type produced from this method is has been approved by the Government and now available in the market. One limitation with this method is that only Vitamin A can be added to cassava using this method. Also, the amount of vitamin A that can be added is not sufficient for what our bodies need.

Genetic Modification (Transgenesis)

This is a genetic engineering method used to introduce a new desired trait into the DNA of an organism by transferring the desired trait from another organism. Scientists have used this method to develop new Vitamin A and Iron cassava in Nigeria. They took genes that were rich in substances that can produce a lot of vitamin A and iron from bacteria and inserted them into the DNA of cassava which was not having sufficient vitamin A and iron. The cassava type produced has been tested and grown on the field to see if it adapts to the environment and is not harmful to the body. However, scientists in Nigeria are still waiting for the approval of the government to allow farmers to be growing genetically modified cassava. Therefore, it may be released into the market if approved by the government. With this method, scientists can add more than one type of micronutrient which is not possible with the conventional method.

Gene Editing

This will allow scientists to make certain changes to genes of the same organism without the need to transfer genes from another organism. In the case of Cassava, scientists will change the sequence of the DNA of the cassava in a way that will make that cassava have more vitamin A. Cassava made from this method has not been developed but is only being considered by scientists. Scientists may also develop them if the government gives them approval. Like the genetic modification method, scientists can add more than one type of micronutrient to crops which is not possible with the conventional method.

To summarize, the conventional method involves combing traits between one cassava and another cassava type through a natural process. The genetic modification involved transferring genes from bacteria to cassava artificially. Gene editing will involve changing the gene of cassava that is not having sufficient Vitamin A and iron into a form that can make it produce sufficient vitamin A and Iron.

Link to Information Treatment in English Language

https://www.youtube.com/watch?v=yfNwGCEjmrs&t=38s

Link to Information Treatment in Yoruba Language

https://www.youtube.com/watch?v=nVTDWvE3z8w&t=86s

Appendix B

Table B.1 Preference estimates for non-attenders

*Note: ***, **, * Significant at 1%, 5% standard errors are in parenthesis*

	Nutrition		Method	
Attribute	**Stated ANA**	**Inferred ANA**	**Stated ANA**	**Inferred ANA**
Vitamin A	-1.40 (1.22)	-1.05 (0.29)***	-0.80 (0.96)	-0.90 (0.28)***
Iron_25	-0.70 (0.57)	0.23 (0.34)	-2.44 (1.80)	-2.34 (0.56)***
Iron_50	-1.00 (0.98)	1.29 (0.32)***	-1.96 (1.36)	-1.19 (0.45)**
Low starch	0.36 (0.37)	-0.34 (0.17)**	1.31 (0.80)	-0.61 (0.16)***
GM	-0.20 (0.50)	0.65 (0.53)	-1.21 (0.79)	-0.85 (0.50)
GED	0.09 (0.32)	0.23 (0.32)	-0.85 (0.53)	0.61 (0.30)**
Price	0.006 (0.001)***	0.001 (0.000)	0. 008 (0.002)***	0.001 (0.000)

References

Abubakar, H.A., Shahril, M.R. & Mat, S. (2024). Nutritional status and dietary intake among Nigerian adolescent: a systematic review. *BMC Public Health,* 24, 1764.

Adeoye, D. O. (2016). Challenges of urban housing quality: insights and experiences of Akure, Nigeria. *Procedia-Social and Behavioural Sciences,* 260-268.

Agossadou, M. A. J. & Nayga Jr., R. M. (2023). Information effects in discrete choice experiments: Does type of delivery matter for valuation estimates and attribute nonattendance?. *Journal of the Agricultural and Applied Economics Association,* 2(1), 51-66.

Alemu, M. H., Mørkbak, M. R., Olsen, S. B. & Jensen, C. L. (2013). Attending to the Reasons for Attribute Non-attendance in Choice Experiments. *Environ Resource Econ,* 54, 333 - 359.

Atukunda, P., Eide, W. B., Kardel, K. R, Iversen, P. O. & Westerberg, A. C. (2021). Unlocking the potential for achievement of the UN Sustainable Development Goal 2 - 'Zero Hunger' - in Africa: targets, strategies, synergies and challenges. *Food & Nutrition Research*, 65, 7686.

Ben-Akiva, M., Bradley, M., Morikawa, T., Benjamin, J., Novak, T., Oppewal, H. & Rao, V. (1994). Combining Revealed and Stated Preferences Data. *Marketing Letters,* 5(4), 335-350.

Beyene, G., Solomon, F. R, Chauhan, R. D., Gaitán-Solis, E., Narayanan, N., Gehan, J., Siritunga, D., Stevens, R. L., Jifon J., Van Eck, J., Linsler, E., Gehan, M., Ilyas, M., Fregene, M., Sayre, R.T., Anderson, P., Taylor, N. J. & Cahoon, E. B. (2017). Provitamin A biofortification of cassava enhances shelf life but reduces dry matter content of storage roots due to altered carbon partitioning into starch. *Plant Biotechnol J.*, 16(6), 1186-1200.

Bieberstein, A., Roosen, J., Marette, S., Blanchemanche, S., Vandermoere, F. (2012). Consumer choices for nano-food and nano-packaging in France and Germany. *Eur. Rev. Agric. Econ*. 40(1),73–94

Birol, E., Meenakshi, J., Oparinde, A., Perz, S., & Tomlins, K. (2015). Developing country consumers' acceptance of biofortified foods: a synthesis. *Food Security*, 7, 555-568.

Bouis, H. E., Hotz, C., McClafferty, B., Meenakshi, J. V. & Pfeiffer, W. H. (2011). Biofortification: A new tool to reduce micronutrient malnutrition. *Food and Nutrition Bulletin*, 32 (Suppl. 1), S31–S40.

Bouis, H. E. & Saltzman, A., (2017). Improving nutrition through biofortification: A review of evidence from HarvestPlus, 2003 through 2016. *Global Food Security,* 12(2017), 49-58.

Bryant, C. & Dillard, C. (2019). The impact of framing on acceptance of cultured meat.

Front. Nutrit. 6. https://doi.org/10.3389/fnut.2019.00103.

Caputo, V. (2018). Comparing Serial, and Choice Task Stated and Inferred Attribute Non-Attendance Methods in Food Choice Experiments. *Journal of Agricultural Economics,* 69(1), 35-57.

Caputo, (2020). Does information on food safety affect consumers' acceptance of new food technologies? The case of irradiated beef in South Korea under a new labelling system and across different information regimes. *Australian Journal of Agricultural and Resource Economics*, 64, 1003–1033.

Caputo, V. & Scarpa, R., (2022). Methodological Advances in Food Choice Experiments and Modeling: Current Practices, Challenges, and Future Research Directions. *Annual Review of Resource Economics,*14, 63–90.

Caswell, J. A. (1998). How Labeling of Safety and Process Attributes Affects Markets for Food. *Agricultural and Resource Economics Review*, 27 (2), 151–58.

Caswell, J., & Mojduszka, E. (1996). Using Informational Labeling to Influence the Market for Quality in Food Products. *American Journal of Agricultural Economics*, 78 (5), 1248-1253.

Chowdhury, S., Meenakshi, J. V., Tomlins, K. I. & Owori, C. (2011). Are consumers in developing countries willing to pay more for micronutrient-dense biofortified foods? Evidence from a field experiment in Uganda. *Amer. J. Agr. Econ.* 93(1), 83–97.

Colson, G. & Huffman, W. E. (2011). Consumers' willingness to pay for genetically modified foods with product-enhancing nutritional attributes. *American Journal of Agricultural Economics*, 93(2): 358–63.

Dalberg. 2019. *Commercialization assessment: Vitamin A cassava in Nigeria*. Final report for GAIN and HarvestPlus.

Das, C., Anderson, C. M. & Swallow, S. K. (2009). Estimating distributions of willingness to pay for heterogeneous populations. *Southern Economic Journal,* 75(3), 593-610.

De Steur, H., Gellynck, X., Feng, S., Rutsaert, P. & Verbeke, W. (2012). Determinants of willingness-to-pay for GM rice with health benefits in a high-risk region: Evidence from experimental auctions for folate biofortified rice in China. *Food Quality and Preference,* 25, 87–94.

De Steur, H., Jeroen Buysse, J., Shuyi Feng, S. & Gellynck, X. (2013). Role of information on consumers' willingness-to-pay for genetically modified rice with health benefits: An application to China. *Asian Economic Journal,* 27(4), 391–408.

Ding, Y., Jiangyu, Y., Sun, Y., Nayga, R. M. & Liu, Y. (2023). Gene-edited or genetically modified food? The impacts of risk and ambiguity on Chinese consumers' willingness to pay. *Agricultural Economics,* 54, 414–428.

FAO, IFAD, UNICEF, WFP and WHO. 2023. *The state of food security and nutrition in the world 2023*. *Urbanization, agrifood systems transformation, and healthy diets across the rural-urban continuum.* Rome.

Fernbach, P. M. Light, N. Scott, S. E. Inbar, Y & Rozin, P. (2019). Extreme opponents of genetically modified foods know the least but think they know the most. *Letters,* https://doi.org/10.1038/s41562-018-0520-3.

Galati, A; Tulone, A; Moavero, P. & Crescimanno, M. (2019). Consumer interest in information regarding novel food technologies in Italy: The case of irradiated foods. *Food Research International*, 119 (2019), 291-296.

Gaskell, G., Stares, S., Allandottir, A., Allum, N., Corchero, C., Fischler, C., Hampel, J., Jackson, J., Kronberger, K., Mejlgaard, N., Revuelta, G., Schreiner, C., Torgersen, H & Wagner, W. (2006). Europeans and biotechnology in 2005: patterns and trends. Final report on eurobarometer 64.3.

Gbadegesin, L. A., Ayeni, E. A., Tettey, C. K., Uyanga, V. A., Aluko, O. O., Ahiakpa, J. K., Okoye, C. O., Mbadianya, J. I., Adekoya, M. K., Aminu, R. O., Oyawole, F. P., Odufuwa, P. (2022). GMOs in Africa: status, adoption and public acceptance. *Food Control,* 141 (2022) 109193.

Gbashi, S., Adebo, O., Adebiyi, J. A., Targuma, S., Tebele, S., Areo, O. M., Olopade, B., Odukoya, J. O. & Njobeh P. (2021). Food safety, food security and genetically modified organisms in Africa: a current perspective. *Biotechnology and Genetic Engineering Reviews*, 37(1), 30-63.

Gbegbelegbe, S. D., Lowenberg-DeBoer, J., Adeoti, R., Lusk, J. & Coulibaly, O. (2015). The estimated ex-ante economic impact of Bt cowpea in Niger, Benin, and Northern Nigeria. *Agricultural Economics*, 46 (2015), 563–577.

Gonçalves, T., Lourenço-Gomes, L & Lígia M. Costa Pinto, L. M. (2022). The role of attribute non-attendance on consumer decision-making: Theoretical insights and empirical evidence. *Economic Analysis and Policy,* 76 (2022), 788–805.

Gonza´ lez, C., Johnson, N. & Qaim, M. (2009). Consumer acceptance of second generation GM foods: The case of biofortified cassava in the North-east of Brazil. Journal of Agricultural Economics, 60 (3), 604–624.

Haaland, I., Roth, C. & Wohlfart, J., 2023. Designing Information Provision Experiments. *Journal of Economic Literature,* 61(1), 3-40.

Hensher, D. A., 2010. Hypothetical bias, choice experiments and willingness to pay. *Transportation Research Part B: Methodological,* 44(6), 735-752.

Hensher, D., Louviere, J. & Swait, J., 1998. Combining sources of preference data. *Journal of Econometrics ,* Volume 89, 197-221.

Herrington, C. L., Maredia, M .K., Ortega, D . L., Taleon, V., Birol, E., Sarkar, M. & Rahaman, M. (2022). Rural Bangladeshi consumers' (un)willingness to pay for low-milled rice: Implications for zinc biofortification. *Agricultural Economics*, 2023 (54), 5–22.

Hess, S, Daly, A., Dekker, T., Cabral, M.O. & Batley. R. (2017). A framework for capturing heterogeneity, heteroskedasticity, non-linearity, reference dependence and design artefacts in value of time research. *Transportation Research Part B,* 96(2017), 126–149.

Hess, S. & Hensher, D. A., 2010. Using conditioning on observed choices to retrieve individual-specific attribute processing strategies. *Transportation Research Part B,* 44(2010), 781–790.

Hess, S. & Palma, D. (2019). *Apollo*: A flexible, powerful and customisable freeware package for choice model estimation and application. *Journal of Choice Modelling,* 32, 100170.

Kahan, D., Braman, D., Slovic, P., Gastil, J. & Cohen, G. (2009). Cultural cognition of the risks and benefits of nanotechnology. Nature Nanotechnology 4, 87–90.

Kehlbacher, A., Balcombe, K. & Bennett. R. (2013). Stated attribute non-attendance in successive choice experiments. *Journal of Agricultural Economics,* 64(3), 693-706.

Kilders V.& Caputo V. (2021). Is animal welfare promoting hornless cattle? Assessing consumer's valuation for milk from gene-edited cows under different information regimes. *J. Agric. Econ.* 72, 3375–59.

Kimenju, S. C. & De Groote, H. (2008). Consumer willingness to pay for genetically modified food in Kenya. *Agricultural Economics*, 38, 35–46

Kolapo, A. (2023). Heterogeneous preferences and market potentials for biofortified foods in sub-Saharan Africa: Evidence from Nigeria. *Future Foods,* 8, 100278.

Kragt, M. E., 2013. AES Prize Essay, 2013 Stated and Inferred Attribute Attendance Models: A Comparison with Environmental Choice Experiments. *Journal of Agricultural Economics,* 64(3), pp. 719-736.

Kumar, R., Kamuda, T., Budhathoki, R., Tang, D., Yer, H., Zhao, Y. & Li, Y. (2022). CRISPR-Based Genome Editing for Nutrient Enrichment in Crops: A Promising Approach Toward Global Food Security. *Frontiers Genome Editing*, 6 (4) doi: 10.3389/fgeed.2022.960414.

Lagarde M. (2013). Investigating attribute non-attendance and its consequences in choice experiments with latent class models. *Health Econ*., 22(5), 554-67.

Lusk, J. L., Mcfadden, B. R. & Wilson, N. (2018). Do consumers care how a genetically engineered food was created or who created it? *Food Policy,* 78, 81-90.

Lynas, M., Adams, J. & Conrow, J. (2022). Misinformation in the media: global coverage of GMOs 2019-2021. GM Crpos & Food, 1-10.

Marette, S., Disdier, A.-C. & Beghin, J. C., 2021. A comparison of EU and US consumers' willingness to pay for gene-edited food: Evidence from apples. *Appetite,* 159(2021), p. 105064.

Matthews, Y., Scarpa, R. & Marsh, D., 2017. Using virtual environments to improve the realism of choice experiments: A case study about coastal erosion management. *Journal of Environmental Economics and Management,* 81(2017), p. 193–208.

McFadden, D., 1986. The choice theory approach to market research. *Marketing Science,* Volume 5, pp. 275-297.

McFadden, D. & Train, K., 2000. Mixed MNL models for discrete response. *Journal of Applied Econometrics,* 15(5), pp. 447 - 470.

McFadden, J. R. & Huffman, W. E. (2017). Consumer valuation of information about food safety achieved using biotechnology: Evidence from new potato products. *Food Policy*, 69 (2017) 82–96.

Meenakshi, J. V., Banerji, A., Manyong, V., Tomlins, K., Mittal, N. & Hamukwala, P. (2012). Using a discrete choice experiment to elicit the demand for a nutritious food: Willingness to pay for orange maize in rural Zambia. *Journal of Health Economics,* 31 (2012) 62–71.

Muringai, V., Xiaoli, F. & Goddard, E. (2020). Canadian consumer acceptance of gene-edited versus genetically modified potatoes: A choice experiment approach. *Cand J. Agr Econ.* 68, 47–63.

Nayga, R.M., Wipow, A. and Nichols, J.P. (2005). Information effects on consumers' willingness to purchase irradiated food products. *Oxford Journals,* 27, 37–48.

Okwuonu, I. C., Narayanan, N. N., Egesi, N. C.& Taylor, J. N. (2021). Opportunities and challenges for biofortification of cassava to address iron and zinc deficiency in Nigeria. *Global Food Security,* 28(2021),100478.

Oluba, O.M., Oredokun-Lache, A. B., & Odutuga, A. A. (2017). Effect of vitamin a biofortification on the nutritional composition of cassava flour (gari) and evaluation of its glycemic index in healthy adults, *Journal of Biochemistry,* 42 (4).

Olynk, N. J., Tonsor , G. T. & Wolf, C. A. (2010). Consumer willingness to pay for livestock credence attribute claim verification. *Journal of Agricultural and Resource Economics,* 35 (2), 261- 280

Onuegbu, N., Ihediohanma, N., Eze, C., Okafor, D. & Ojukwu, M. (2017). Biofortification of local staples in Nigeria: prospects and problems. *Journal of Food Biotechnology Research,* 1(5), 1-10.

Oparinde, A., Banerji, A., Birol, E. & Ilona, P. (2016). Information and consumer willingness to pay for biofortified yellow cassava: evidence from experimental auctions in Nigeria. *Agricultural Economics,* 47, 215–233.

Richartz, C. & Abdulai, A. (2022). The role of information in consumer preferences for sustainable certified palm oil products in Germany. *PLoS ONE*, 17(7), e0271198.

Sandorf, E. D., Campbell, D. & Hanley, N., 2017. Disentangling the influence of knowledge on attribute non-attendance. *Journal of Choice Modelling,* 24(2017), pp. 36-50Sanni, L & Akinyemi, F. O. (2009). Determinants of households' residential districts' preferences within metropolitan city of Ibadan, Nigeria, *Journal of Human Ecology,* 25(2), 137-141.

Sanou, A., Liverpool-Tasie, L. S. O., Caputo, V. & Kerr, J. (2021). Introducing an aflatoxin-safe labeling program in complex food supply chains: Evidence from a choice experiment in Nigeria. *Food Policy,* 102, 102070.

Sayre, R., Beechung, J. R, Cahoon, E. B., Egesi, C., Fauquet, C., Fellman, J., Fregene, M., Gruissem, W., Mallowa, S., Manary, M., Maziya-Dixon, B., Mbanaso, A., Schachtman, D.P., Siritunga, D., Taylor, N., Vanderschuren, H. & Zhang, P. (2011). The BioCassava Plus Program: biofortification of cassava for Sub-Saharan Africa. *Annu. Rev. Plant Biol*. 62, 251–72.

Scarpa, R. & Rose, J. M. (2008). Design efficiency for non-market valuation with choice modelling: how to measure it, what to report and why. *Australian Journal of Agricultural and Resource Economics*, 52, 253–282.

Scarpa, R., Thiene, M. & Hensher, D. A., (2010). Monitoring Choice Task Attribute Attendance in Nonmarket Valuation of Multiple Park Management Services: Does It Matter?. *Land Economics,* 86(4), 817-839.

Smyth, S. J., McHughen, A., Entine, J., Kershen, D., Ramage, C. & Parrott, W. (2021). Removing politics from innovations that improve food security. *Transgenic Research, 30*, 601–612. https://doi.org/10.1007/s11248-021-00261-y.

Stanton, J., Rezai,G. & Baglione, S. (2021). The effect of persuasive/possessing information regarding GMOs on consumer attitudes. *Future Foods*, 4, 100076.

Traets, F., Sanchez, D. G. & Vandebroek, M. (2020). Generating optimal designs for discrete choice experiments in R: The idefix Package. *Journal of Statistical Software,* 10 (2).

The World Bank, (2023). *World Development Indicators.* [Online] Available at: https://datacatalog.worldbank.org/search/dataset/0037712/World-Development-Indicators [Accessed 14 October 2023].

Train, K. E., (2009). *Discrete Choice Methods with Simulation.* 2nd ed. Cambridge: University of Cambridge.

Train, K. & Weeks, M. (2005). Discrete Choice Models in Preference Space and Willingness-to-Pay Space. In: R. Scarpa & A. Alberini, eds. *Applications of Simulation Methods in Environmental and Resource Economics.* Berlin: Springer-Verlag, 1-16.

Van Der Straeten, D., Bhullar, K. N., De Steur, H., Gruissem, W., MacKenzie, D., Pfeiffer, W., Qaim, M., Slamet-Loedin, I., Strobbe, S., Tohme, J., Trijatmiko, K. R., Vanderschuren, H., Montagu, M., Zhang, C. & Bouis, H. (2020). Multiplying the efficiency and impact of biofortification through metabolic engineering. *Nature Communications,* 1-10.

Van Loo, E. J. V., Caputo, V. & Lusk, J. L. (2020). Consumer preferences for farm-raised meat, lab-grown meat, and plant-based meat alternatives: Does information or brand matter?. *Food Policy,* 95, 101931.

Webb, E. J. D., Stamp, E. & Collinson, M. (2020). Measuring commissioners' willingness-to-pay for community based childhood obesity prevention programmes using a discrete choice experiment. *BMC Public Health*, 20, 1535.

Wuepper, D., Wree, P. & Ardali, G. (2019). Does information change German consumers' attitudes about genetically modified food?. *European Review of Agricultural Economics,* 46(1), 53–78.

Yang, Y. & Hobbs, J. E. (2019). The power of stories: narratives and information framing effects in science communication. *American Journal of Agricultural Economics*, 102(4), 1271–1296.

Yang, H., House, L. A., & Zhifeng, G. (2022). How do consumers respond to labels for crispr (gene-editing). *Food Policy,* 112, 102366.

Zhang, J., Shi, H. & Sheng, J. (2022). The effects of message framing on novel food introduction: Evidence from the artificial meat products in China, *Food Policy,* 112 (2022) 102361.

Appendix A

Information Treatment 1 – Information on the health risks of micronutrient deficiency and benefits of biofortified food (Nutrition information treatment)

Vitamin A and Iron are among the micronutrients that our body needs to be healthy. Anyone who does not eat a lot of vegetables and fruits but mainly eats our common foods like gari, rice, maize, yam, etc. is likely to have very low Vitamin A and Iron in his or her body. People who have very low Vitamin A in their bodies may not see well at night and if they do not take care of themselves in time, can lead to permanent blindness. Also, their brain may not function very well and they may be falling sick regularly. Children who have low iron in their bodies may not grow and learn well. Adults who have low iron in their bodies get tired at all times. It may also cause pregnant women to give birth before they are due. The weight of their babies can be low and the babies may not grow well.

Scientists have found out that in Nigeria, 2 out of 100 children and 8 out of 100 pregnant women cannot see well at night because of low Vitamin A in their bodies. They also found out that some children between 1 and 4 years are dying because of low Vitamin A in their bodies. About 60 out of 100 women of reproductive age are not having sufficient iron in their bodies. For pregnant women, it is about 50 out of 100, and for children, it is about 70 out of 100 who lack sufficient iron in their bodies

To address these problems, scientists have successfully added Vitamin A to cassava because a lot of us eat foods like gari regularly. These cassava varieties have been in the market and used to make gari but still contain a low amount of Vitamin A. Now, there are new types of cassava they have developed which will have sufficient Vitamin A and Iron that our body needs. Gari made from the new cassava varieties may soon be available in the market if approved by the Government of Nigeria.

Information Treatment 2 – Information on the different production methods used for biofortification of Cassava. (Production method treatment)

Up till now, scientists have used two different methods to add micronutrients to Cassava in Nigeria. These methods are referred to as conventional and genetic modification approaches. Now, they are considering an additional method referred to as gene editing. In this video, we will give you brief information about these three methods while we highlight the main differences between them.

Conventional Method for Adding Vitamin A to Cassava

Scientists used this method to develop vitamin A Cassava in Nigeria. To start with, they identified two types of cassava. The first cassava type, which most farmers like to grow, contains little amount of vitamin A. The second cassava type is rich in vitamin A but not usually grown by farmers. Scientists then combined these two types of cassava in a way that is very similar to how humans and animals meet sexually to produce their children. Thereafter, they selected the cassava varieties with the highest amount of vitamin A among different varieties produced during this process. The cassava type produced from this method is has been approved by the Government and now available in the market. One limitation with this method is that only Vitamin A can be added to cassava using this method. Also, the amount of vitamin A that can be added is not sufficient for what our bodies need.

Genetic Modification (Transgenesis)

This is a genetic engineering method used to introduce a new desired trait into the DNA of an organism by transferring the desired trait from another organism. Scientists have used this method to develop new Vitamin A and Iron cassava in Nigeria. They took genes that were rich in substances that can produce a lot of vitamin A and iron from bacteria and inserted them into the DNA of cassava which was not having sufficient vitamin A and iron. The cassava type produced has been tested and grown on the field to see if it adapts to the environment and is not harmful to the body. However, scientists in Nigeria are still waiting for the approval of the government to allow farmers to be growing genetically modified cassava. Therefore, it may be released into the market if approved by the government. With this method, scientists can add more than one type of micronutrient which is not possible with the conventional method.

Gene Editing

This will allow scientists to make certain changes to genes of the same organism without the need to transfer genes from another organism. In the case of Cassava, scientists will change the sequence of the DNA of the cassava in a way that will make that cassava have more vitamin A. Cassava made from this method has not been developed but is only being considered by scientists. Scientists may also develop them if the government gives them approval. Like the genetic modification method, scientists can add more than one type of micronutrient to crops which is not possible with the conventional method.

To summarize, the conventional method involves combing traits between one cassava and another cassava type through a natural process. The genetic modification involved transferring genes from bacteria to cassava artificially. Gene editing will involve changing the gene of cassava that is not having sufficient Vitamin A and iron into a form that can make it produce sufficient vitamin A and Iron.

Link to Information Treatment in English Language

https://www.youtube.com/watch?v=yfNwGCEjmrs&t=38s

Link to Information Treatment in Yoruba Language

https://www.youtube.com/watch?v=nVTDWvE3z8w&t=86s

Appendix B

Table B.1 Preference estimates for non-attenders

*Note: ***, **, * Significant at 1%, 5% standard errors are in parenthesis*

	Nutrition		Method	
Attribute	**Stated ANA**	**Inferred ANA**	**Stated ANA**	**Inferred ANA**
Vitamin A	-1.40 (1.22)	-1.05 (0.29)***	-0.80 (0.96)	-0.90 (0.28)***
Iron_25	-0.70 (0.57)	0.23 (0.34)	-2.44 (1.80)	-2.34 (0.56)***
Iron_50	-1.00 (0.98)	1.29 (0.32)***	-1.96 (1.36)	-1.19 (0.45)**
Low starch	0.36 (0.37)	-0.34 (0.17)**	1.31 (0.80)	-0.61 (0.16)***
GM	-0.20 (0.50)	0.65 (0.53)	-1.21 (0.79)	-0.85 (0.50)
GED	0.09 (0.32)	0.23 (0.32)	-0.85 (0.53)	0.61 (0.30)**
Price	0.006 (0.001)***	0.001 (0.000)	0. 008 (0.002)***	0.001 (0.000)