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Boosting Demand for Biofortified Foods: The Case of Orange Fleshed Sweet Potato Bread in Tamale, Ghana

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Abstract: In the context of introducing biofortification of staple crops as a food-based approach to combat micronutrient malnutrition in Sub Saharan Africa (SSA), we carried out a survey in Tamale, Ghana to elicit consumers' preference of and willingness to pay for one of the highly nutritious biofortified staple crop processed product: the Orange Fleshed Sweet Potato (OFSP) bread. Our results indicate that scores of respondents in the sample show preference for OFSP bread. The most important determinants of OFSP bread preference are its sweet taste and soft texture and consumers are willing to pay 0.634 pesewas more for the attribute sweet, 0.204 pesewas more for the attribute soft and 0.265 pesewas more for the attribute yellow on top of the going price of same roll size of normal wheat bread, 50 pesewas. We also investigated the effect of prior knowledge on nutrition and health-enhancing properties of OFSP on consumer choice. We find that consumers with prior knowledge of OFSP were more likely to choose OFSP bread. These findings have multiple implications for OFSP growers, for bakers who are trying to create value-added products to maximize revenue, and for the International Potato Center to restructure scaling up efforts.

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1. Introduction

Low-cost nutritionally improved composite bread was developed using a locally produced staple crop, the biofortified orange flesh sweet potato, to be made available to the target population in northern Ghana. This paper attempts to answer the following questions: Will the target population accept the new bread? How much would they be willing to pay for the new bread? How does the knowledge of health and nutrition benefits of OFSP affect the target population's bread choice decision? Does gender play a role?

Severe malnutrition is a major concern in many parts of developing countries due to a lack of nutritious food. According to Food and Agriculture Organization (FAO, 2017), the number of people undernourished across the globe has increased from 777 million in 2015 to 815 million in 2016 with Sub Saharan Africa and South Eastern and Western Asia accounting for the biggest lion share.

Malnutrition of micronutrients such as vitamin A is a public health concern in SSA (WHO, 2009). Clinical observations indicate that vitamin A is important for numerous bodily functions. For instance, an infant deficient in vitamin A grows poorly, suffers more persistent or severe infections, develops night blindness, and can even die (WHO, 1995). The population segments most affected by this issue are young children, pregnant women and lactating mothers. Even adults deficient in vitamin A may witness diminishing cognitive ability (Black et al., 2013). Given the importance of nutrition in economic development of a country, efforts must be multiplied in the region to ensure that food supplied provides not just calories but also essential vitamins and minerals.

The past few years have seen substantial and growing efforts by national and international organizations to introduce biofortification of staple crops as a food-based approach to combat micronutrient malnutrition in Sub Saharan Africa. Biofortification is a technique of significantly enhancing micronutrient concentration in staple food crops using conventional breeding techniques (Nestel et al., 2006).

In West Africa, particularly in Ghana, the International Potato Center (CIP) in collaboration with the Food Research Institute (FRI) of the Council for Scientific and Industrial Research (CSIR) of Ghana have successfully bred and released the Orange Fleshed Sweet Potato (OFSP), in communities in the northern regions with high

prevalence of vitamin A deficiency (VAD). Results from studies conducted in Kassena-Nankana district from 1989-1991 indicate that VAD is a problem in the Northern and Upper East regions. Over 14% of preschool children who had their serum samples taken had serum retinal levels $< 0.35 \mu\text{mol/l}$ (the normal serum retinal level being $0.35 \mu\text{mol/l}$) and the nightblindness rate was 1.5% (WHO, 1995). OFSP is one of the highly nutritious biofortified pro-vitamin A staple crops (CIP Website). Owing to its high content in β -carotene - a precursor of vitamin A in the body, the OFSP can be seen as a health-enhancing crop with potential to improve vitamin A status in pregnant women, new mothers, young children and adults. Increasing the consumption of OFSP and/or its derived products is therefore an excellent approach to remediate Vitamin A deficiency (Low et al., 2017).

Efforts to create awareness of the new crop have involved the use of mass communication mediums (regional radios affiliated with Farm Radio International), for the propagation of nutrition and health benefits of the OFSP. While this radio approach has produced high public awareness on the nutritional and health benefits of the OFSP, for a variety of reasons, primarily preference, superstitions, or unavailability, the OFSP crop is not being consumed in adequate amounts by the target population. How then should we bring OFSP into the target population's diet?

One possible solution is if OFSP can be processed into food product that is largely accepted in daily diet of both urban and rural populations: bread, then we should see a rise in its consumption. By focusing on bread - a staple food that the target population already eat/consume, this study intends to introduce an inexpensive and effective mean of delivering vitamin A to large numbers of vulnerable population.

Previous studies on the consumer acceptance of the OFSP have relied on hypothetical scenarios in rural settings, for the OFSP crop had not yet been released (Chowdhury et al., 2011; Naico & Lusk, 2010). This study is different from the previous research because it uses real OFSP as a major ingredient for backing real OFSP bread that was used in the sensory evaluation exercise on urban consumers. There are few past studies that examine OFSP processed products and we hope to contribute to the growing literature on the acceptance of biofortified staple crops using real products.

The rest of the paper follows this order: Section 2 reviews the literatures including alternative approaches that have been or are still been implemented to achieve

same objectives as the biofortification techniques, in terms of micronutrients deficiency alleviation to improve diet and health. Section 3 covers the methodology of the study. In Section 4, we present the results of the study and section 5 concludes the paper.

2. Literature Review

Different studies have been conducted using various econometric specification approaches to evaluate consumers' acceptance of and the WTP for new food products, particularly those with health enhancing properties, in various places and settings. In this paper, we tried to summarize a few of these works that focused on biofortification (nutrients enhancing) staple food products that are closely related to the type of investigation we embark on. The claim that OFSP and its related processed products improve vitamin A status automatically qualifies OFSP bread as a "functional food". Thus, we have dedicated a portion of our literatures review to functional foods in developed countries.

2.1 Acceptance of Functional Foods in Developed Countries

Functional foods are food made to specifically deliver some form of health functions to consumer in addition to their nutritional effects thereby reducing the risk of disease (Diplock et al., 1999). There is a wealth of studies on consumer preference and willingness to pay for food products with health enhancing attributes conducted in developed countries. These studies investigated the determinants of consumers' acceptance of functional foods controlling for product and consumer level characteristics that may influence consumer' choice decisions beside budget constraints.

The commonly reported factors influencing consumers' choice apart from preferences and budget constraints are consumer's own characteristics such as gender, age, education, and product characteristics, etc. One line of studies looked at the extent to which gender affects the acceptance and willingness to pay for functional foods. Johansen et al. (2011), report from their cross-cultural study that female consumers in Norway, Denmark, and California have positive attitudes towards functional dairy products compared to male consumers. Likewise, female in Sweden purchase more functional food products than their counterpart, males (Landstrom et al. 2007). Another finding on gender dimension is that, female consumers attach higher values of

willingness to pay to functional food products than male consumers (Ares et al. 2009).

Another line of authors explore age dimension on consumers' acceptance and willingness to pay for functional food products. A study in Finland shows that older consumers are more likely and willing to accept functional food products compared to younger consumers. This maybe due to the fact that functional foods claim to reduce the risk of certain diseases, and older consumers are more concerned with health issues related to aging (Urala and Lahteenmaki 2004, 2007). The older one gets, the higher your demand for functional food products (Bonanno 2012, Chase et al. 2009). Attributes or product's intrinsic and extrinsic characteristics – color, taste, texture, appearance, packaging, labeling etc. - are also believed to influence consumers acceptance of and willingness to pay for health-enhancing food products. A study to estimate consumers' preference of and willingness to pay for different value-added attributes of whole grain bread in Germany reveals that consumer's taste expectations play decisive roles in their bread choice. Bread with particular properties will be preferred only if consumers are satisfied with the taste experience (Teuber et al., 2016).

As we can see from the aforementioned literature, products and consumers' characteristics play a key role in acceptance of and willingness to pay for health-enhancing food products. However, one cannot extrapolate these findings to developing countries, for cultures and food habits vary across continents and countries. Therefore, there is need to survey what has been found on consumer behavior towards health-enhancing food products in developing countries.

2.2 Acceptance of Biofortified (Functional) Foods in Developing Countries

A score number of economists have pondered over whether biofortified staple crops will be accepted in developing countries. We provided here an overview of a handful of this growing literature particularly those related to our analysis. One line of research assessed consumers' acceptance of and WTP for pro-Vitamin A staple crops. Empirical evidence from Kenya, Uganda, Mozambique, and Zambia show that consumers prefer the pro-vitamin A staple crop varieties relative to their local varieties and are willing to pay a premium price on them with and without the knowledge of nutrition and health benefits of pro-Vitamin A crop being revealed to them. However, researchers agreed that nutrition education plays important role in the acceptance of

pro - Vitamin A crops among the rural consumers (De Groote & Kimenju, 2008; Muzhingi et al., 2008; Chowdhury et al., 2011; Naico & Lusk, 2010; De Groote et al., 2011; Stevens & Winter-Nelson, 2008).

In a separate study in India, Banerji, Birol, Karandikar, and Rampal (2016) employ the BDM mechanism and hedonic testing methods to examine the impact of nutrition information, branding, and certification on consumer willingness to pay for high-iron pearl millet (HIPM) in Maharashtra. Their results showed that consumers in the control group were willing to pay a modest premium for the high-iron pearl millet even in the absence of nutrition information. In treatment groups, the provision of information on health benefits of HIPM was found to increase the premium substantially. Based on the findings, the authors suggest that awareness of the nutritional benefits and trust in certification and branding will increase the valuation of the high-iron pearl millet.

2.3 Various approaches to vitamin A deficiency alleviation

Vitamin A, also known as retinol, is a fat-soluble substance found in the liver – particularly fish liver - and in egg yolk, and dairy products. Other food sources that could potentially provide the body with vitamin A are green leafy vegetables, red palm oil and yellow fruits, to name a few, because they contain carotenoids which are pro-vitamin A precursors that can be converted to retinol in the wall of the gut (WHO, 1995). Thus, a natural way to remedy VAD is to ensure a daily diet that contains a variety of the aforementioned animal and plant products. However, not everyone can afford to have such a diet.

For years, vitamin A capsule supplement has been and still is in many parts of the developing world, the only way to go about combatting chronic VAD among children under five years old. In Sub-Saharan Africa for instance, governments and non-governmental organizations (NGOs) rely on international funds to deliver the life saving capsules to millions of children. However, funding for vitamin A capsules is often in limited supply, and as a result, many national vitamin A supplementation programs throughout Sub-Saharan Africa do not cover the entirety of their respective territory resulting in regional disparities in terms of prevalence in VAD. UNICEF observes that due to the high cost of administering vitamin A supplements in the form of capsules,

which are not sustainable by some governments, nutrition programs are now considering the use of food-based strategies (UNICEF, 2007).

Direct Food Fortification, such as iodide in salt, and Biofortification can be considered two recent, novel techniques in the developing world's efforts to fight micronutrient malnutrition. Though different in their approaches, they are both food-based strategies with same objective: to alleviate micronutrient deficiencies (WHO & UNICEF, 2003). However, direct food fortification is an approach that was studied and found to be not cost-effective and therefore lacks investors in the developing world. Even if it were to be made available it would not serve rural communities and poor populations cannot afford it.

Biofortification is a set of procedures that use conventional breeding techniques to significantly enhance micronutrient concentration in staple food crops. The overall aim of biofortification is to help eliminate micronutrient deficiencies in vulnerable populations in developing countries (Banerji et al., 2013). Studies have been conducted to show evidence on nutritional efficacy of OFSP in South Africa and an effectiveness study in Mozambique to show that there was an increase in serum retinol levels among children at school who were fed on a regular basis OFSP and from families who grow and consume OFSP (van Jaarsvel et al., 2005; Low et al., 2007).

3. Methodology

3.1 Design protocol

I used a survey-based stated preference data collection method to gather data in order to elicit the extent to which respondents in Tamale prefer the OFSP bread relative to the regular wheat bread. Stated preference method is a set of techniques that involve asking respondents to make hypothetical trade-offs between alternatives (Kroes and Sheldon, 1988). Given the difficulties that might arise by asking respondents to place monetary value on a food product that they have not seen or tasted yet and due to the fact that hypothetical data would not describe actual true bread preference behavior, I instead draw from food science and modify the stated preference method by employing real products to allow sensory evaluation exercise whereby respondents could taste real bread.

The presence of bread vendors along roadsides, in the market places, checkpoints and at each transit station in the capital city, Accra, is palpable evidence of

the acceptance of the bread in Ghanaian diet. In Kumasi and particularly in the Tamale area, where this study was conducted, I have observed people consume bread almost every day in both urban and rural households. But, what attributes of the bread do they like?

As Thaler and Sunstein, (2009, p. 7) point out, what most people care about in food is the taste of the food, not simply about health. In order for us to decide which attributes of the bread to include in the questionnaires, we decided to pay a visit to local bakers and street vendors in both cities, Kumasi and Tamale. As a result of those visits and due to the low literacy level in the region, we settled on four attributes: color, taste, texture and price to facilitate the task for respondents and enumerators. The regular wheat bread's attributes are as follows: tastes salty, dense texture and white color inside. The OFSP bread has sweet taste, soft texture and yellow color (Figure 1). The regular wheat bread roll was sold at the going price of 50 Ghana pesewas, and was left fixed as base price. However, because the OFSP bread is a new product that we are trying to determine the optimum price for, we varied its price 60 Ghana pesewas up to 1 Ghana Cedes. The baker we hired to oversee the provision of bread for the study is an entrepreneur and food science student at the University of Development Studies (UDS) of Tamale. Two days before the survey began we purchased fresh OFSP roots from a local farmer who grew the crop in the dry season using an irrigation system. We provided the baker with fresh OFSP roots as well as the OFSP bread recipe developed by the CIP and its partner organizations.

3.2 Survey Site and data

The current study took place in the Republic of Ghana, specifically in the northern city of Tamale. The Republic of Ghana is located in the western part of Sub Saharan Africa. It's bordered in east by Togo, in the west by Cote D'Ivoire, in the north by Burkina Faso, and in in south by the Atlantic Ocean. Ghana has a democratic government and the country is considered as a model in terms of democracy because the governship alternates between political parties.

Located at 370 miles North of the capital city Accra, Tamale is the fourth largest and one of the fastest growing cities in Ghana. The city of Tamale can be described as a conglomerate of small towns with mixed architecture of traditional round mud houses

and sophisticated modern buildings. With its 922 sq. km, Tamale was estimated in 2010 census to house about 360,569 residents (GSS, 2010). Economic activities in Tamale revolve around formal and informal trading, agriculture and animal husbandry as well as artisanship. The Ghana Living Standard Survey (GLSS, 2014) had classified the northern regions, of which Tamale is the capital, as the poorest regions in Ghana. This explains the proliferation of Non Governmental Organizations (NGOs) in the area, including the International Potato Center (CIP).

We used face-to-face interview method in homes and on streets across the city over the course of four days. Fresh bread (regular and OFSP) and bags of water were delivered early each morning at the CIP office before the teams departed for the survey. Seven well-trained interviewers/enumerators were employed to conduct the survey. Interviewers were instructed to do their best to achieve a certain level of randomness by alternating between genders and to avoid self-selected individuals who come to them asking to be part of the bread tasting by simply giving them a roll of bread and let them go.

After the interviewer obtains the respondent's consent to participate in the study, s/he proceeds with administering the demographic questionnaires. During this phase, if a respondent answers "NO" to the question "Would you consume sweet potato or sweet potato processed products?" s/he is automatically disqualified and the interview is discontinued. Otherwise, the interviewer pursues with the explanation of the sensory exercise and the respondent is then presented with two alternative breads with dissimilar attributes color, texture, taste, and price. Figure 1 in the Appendix shows what this looks like in terms of the choice set that was presented to each respondent. After the respondent finished sampling one type of bread, the interviewer makes sure that s/he rinses the mouth with the bag of water that is been provided him/her before trying the second type. Finally, the respondent is invited to state their preference of the breads. If s/he chooses the OFSP bread, s/he is required to states the attributes of the chosen bread that s/he likes the most as well as to place monetary amount s/he is willing to pay for it. It is worth noting that in this study, the respondent's preference of the OFSP bread attributes will be measured in terms of their choice and individual statement made right after the tasting exercise (sensory evaluation). We expect preference of the bread attributes to vary across respondents

because, a group many like one thing but still, each individual member has their particular reason for liking the thing.

Overall, we collected data on individual level demographics, awareness of nutrition and health benefits of OFSP, the consumption of local sweet potato varieties as well as frequencies of bread consumption from a representative sample of 387 respondents.

Our explanatory variables of interest are the OFSP bread attributes sweet, soft, yellow as well as the respondent level socio demographic characteristics such as age, sex, education and income. The variable price is also important, because its coefficient will be used in the computation of willingness to pay. Our outcome variable “chose_ofsp” denotes the choice of the OFSP bread. The variable “chose_ofsp” is a binary variable that takes on the value of 1 when respondent chooses the OFSP bread and 0 otherwise.

We are also interested in investigating the effect of the knowledge on the nutritional and health benefits of OFSP on the respondents’ preference of the bread. Unlike in previous studies where nutritional and health benefits information was used as treatment during the survey, our study ask respondents directly whether they have heard of such information (We did not assess the source of information). We construct the variable “Informed” which takes on values of 1 if the respondent has heard of OFSP and 0 otherwise.

3.3 Theoretical Framework

In this inquiry, we employed the simplest and widely used model for dichotomous choice data: the logit model. The theoretical approach of the logit model stems from Thurstone’s Model of Comparative Judgment (Thurstone, 1927), according to which humans do not perceive a stimulus in the same fashion on different occasions, despite keeping the stimulus object intact, therefore Random Utility Theorem (RUT). RUT states that in general, consumers choose the goods that they prefer and a deviation from this behavior can be explained by some random factors (McFadden, 1974). We also draw from Lancaster’s Characteristics Theory according to which the choice of a good does not depend on the good per se, but rather on the characteristics or attributes of the good (Lancaster, 1966). In this contest, respondent chooses the

attributes s/he values the most. If we let y_{in} represent our dichotomous dependent variable (chose_ofsp) that takes the value 1 if the respondent chooses the OFSP bread and 0 otherwise, then, the probability that the respondent chooses the OFSP bread can then be expressed as:

$$P(i | C_n) = \Pr(U_{in} \geq U_{jn}, \forall j \in C_n). \quad (1)$$

Because there are only two alternatives i and j (two types of breads), the two possible choices in terms of probability are:

$$P_n(i) = \Pr(U_{in} \geq U_{jn}) \text{ and } P_n(j) = 1 - P_n(i). \quad (2)$$

3.4 *Econometric Model*

Respondent in our bread sampling exercise faces a discrete choice set of two alternative breads. Following the Characteristics and Random Utility Theorems, it is assumed that the respondent maximizes utility U_{in} by choosing an alternative with the highest attributes. However, this utility function cannot be fully observed by a researcher. For instance, during the survey, only the respondent's choice between the regular wheat bread and the composite OFSP bread were observed. Thus, the addition of the stochastic component to the utility function

$$U_{in} = V_{in} + \varepsilon_{in}, \quad (3)$$

where, V_{in} is a nonstochastic function and ε_{in} is stochastic, reflecting idiosyncratic tastes. (V_{in} is a function of observable individual characteristics and product attributes).

The final model specification of the utility function for respondent n choosing option OFSP bread is as follows:

$$\Pr(\text{chose_ofsp} = 1) = F(\beta_0 + \beta_1 \text{sweet} + \beta_2 \text{soft} + \beta_3 \text{yellow} + \beta_4 \text{informed} + \dots + \beta_k X_k)$$

$$U_{in} = \alpha + \beta_1 X_{in} + \beta_2 Z_{in} + \beta_3 \text{informed} + \varepsilon_{nj}, \quad (4)$$

where U_{in} is the utility of the respondent i from choosing alternative n , X_{in} is a vector of OFSP bread attribute, Z_{in} is a vector of socio-economic characteristics of the respondent, α constant term, and β_s are the parameters. It is worth noting that the characteristics of alternative i only affect the utility of the choice i , but not the choice of the alternative j . We assume that the parameters β_s are the same for all respondents and we assume no heterogeneity. The identifying assumption here is that the error term ε_{nj}

conditional on covariates is mean zero. The main thing that would undermine that assumption is the omitted variable bias.

We employed a binary logit model for the estimation of the coefficients. Logit model suits well dichotomous choice problems. It fits maximum likelihood models with dichotomous dependent variables coded as 0 and 1. It models the probability of a positive outcome (1) given a set of regressors. Thus we can write the logit probability as follows:

$$P_{\text{rob}}(Y_{\text{in}}=1 | x_i) = \frac{\exp(U_{\text{in}})}{1 + \exp(U_{\text{in}})} \quad (5)$$

After we run the logit model followed by the marginal effects, we will use the stata command “wtp”, written by Arne Risa Hole to compute the willingness to pay values for OFSP bread. This command uses the delta method to compute willingness to pay confidence intervals where coefficients on OFSP bread attributes are divided by the coefficient on price variable.

$$\text{WTP} = - b_k / b_c,$$

where b_c is the price coefficient and b_k is the coefficient for attributes x_k .

$$\text{WTP} = - \beta_{\text{ofsp_bread attributes}} / \beta_{\text{price}} \quad (6)$$

4. Results

4.1 *Sample and Descriptive Statistics*

The summary statistics of the sample is reported in Table 1. Of a total of 387 respondents, 190 were females. The mean age of the respondents was 28, whereas the maximum age is 80 years old. When we disaggregate the sample by gender, we see that the mean age among females and males are respectively 29 years old and 27 years old. The respondents have a diverse educational background. About 30.5% of respondents have no basic formal schooling. Almost 16% have completed university and the rest are repartitioned as follows: 5.7% primary education, 14.7% junior secondary and, 33.6% senior secondary. One hundred thirty three respondents reported having a child under 5 years old.

The mean income is 368 GHC and the maximum income is 4,700 GHC (1USD = 4.43328 GHC). Of the 387 respondents, 258 reported that they have learned about the nutritional and health benefits of the Orange-fleshed Sweet potato. However, because our objective was not to assess the effectiveness of the communication medium, we did

not ask to know through what means they have learned about the benefits of OFSP even though we collected data on television and radio ownership.

We assessed respondents' bread and local sweet potatoes consumption frequencies. Regarding the bread consumption frequencies, of the 387 respondents, 62.27% reported that they consume bread on a daily bases, 27.39% of the respondents said that they have bread at least once in a week, respectively 6.20% and 4.13% reported that they consume bread when they can afford it with the former recalling that at least once every month they eat bread and the later said they seldom have bread.

Of the local sweet potatoes varieties, the white fleshed and the red/purple skinned that the local population confound with the OFSP are the most preferred by the respondents in our sample.

A binary logit regression model was run to elicit consumers' preference of and willingness to pay for OFSP bread. We report the results from the regression of the outcome variable "chose_ofsp" on the predictors (OFSP bread attributes, informed, and price) using the aggregated sample in Table 2 of Appendix A. Column (1) shows that all the bread attributes are statistically significantly different from zero. Attribute "sweet" is statistically significantly different from zero at 0.01 level whereas attributes "soft" and "yellow" are statistically significantly different from zero at 0.05 level. The variable "informed" which denotes prior knowledge on the nutritional and health benefits of OFSP is also statistically significantly different from zero at 0.01 level. This imply that respondents who heard of the nutritional and heath benefits of OFSP were more likely to choose OFSP bread relative to those who were not.

As expected, the coefficient on the price variable is negative and statistically significantly different from zero at 0.05 level. This entails that there is a downward sloping demand curve (see Figure 1 in the Appendix A). The set of explanatory variables used in the first regression explain 83% (Pseudo $R^2 = 0.8341$) of the variation in the outcome variable "chose_ofsp." Column (2) through column (4) display the coefficients from the same regression, but this time we control for consumer level characteristics. The coefficients on the bread attributes remained statistically significant as well as the ones on the variables "informed" and "price." However, none of the consumer level variables is significant. The coefficients on variables "age", "education", and "income" are negatives and statistically insignificant. This tells us that older

respondents in the sample with more education and higher income are less likely to choose the OFSP bread. The coefficient on price is negative throughout and statistically significant from zero at 0.05 level. This means that as the price increases, respondents become less likely to choose OFSP bread.

We used the coefficients from this first set of regressions to compute the willingness to pay for the OFSP bread. The values are reported in Table 5 in the Appendix A. Respondents in our sample are willing to pay 0.634 pesewas more for the attribute “sweet”, 0.204 pesewas more for the attribute “soft”, and 0.265 pesewas more for the attribute “yellow”.

To further investigate whether gender matter in the bread choice, we disaggregated the sample by gender and run separate gender specific regressions. The results reported in Table 2 through Table 3 reveal that bread attributes preference differ by gender. Adding all the explanatory variables in the model, we observe that not all variables are statistically significant. Attributes “sweet” and “yellow” are the most significant determinants of OFSP bread choice for females whereas “sweet” and “soft” significantly determined OFSP bread choice for males. The coefficients on the variable “informed” are statistically significantly different from zero at 0.1 level for females. The same coefficients are positives for males, but statistically insignificant. These results revealed that females with the knowledge of the nutritional and health benefit of OFSP were more likely to choose OFSP bread compared to their counterpart males who had information. Thus, information played a key role in females’ bread choice.

We also ran a binary probit model as a robustness check and the results from these regressions are displayed in Table 4 in the Appendix A. The coefficients in column (1) are consistent with those in the binary logit model. In column (2) through column (4), as we controlled for more respondent level characteristics, the coefficients on bread attributes, price and informed remained statistically significantly different from zero as it was the case with the logit model. One could also note that coefficients on the respondent level characteristics are all statistically insignificant.

From these analyses, it results that the most important determinants of OFSP bread choice are its attributes which preference differ by gender. Having prior information on the nutritional and health benefits of OFSP also increases the likelihood of respondents choosing the OFSP bread. These findings are consistent with previous

studies on biofortified crops in the developing countries (Banerji, et al. 2016; DeGroot, et al. 2010; Chowdhury et al. 2011; and Naico and Lusk 2010). It is worth making the distinction between previous studies and ours, for they have provided information as a treatment. In our case, we assessed respondents' knowledge on the nutritional and health benefits of OFSP during the interview, referring to the utilization of farm radio international as a means to diffuse this information.

5. Conclusion and Discussions

This paper sought to investigate whether the target population in Northern Ghana will accept the OFSP bread relative to regular wheat bread and if so, how much are they willing to pay more for it? The paper also sought to assess the effect of having prior knowledge on the nutritional and health benefits of OFSP on the respondents' preference of OFSP bread.

The overall goal of the paper is to demonstrate that, bread- a staple food that the target population in Northern Ghana already consume in large amount could be an inexpensive and effective mean of delivering pro-vitamin A food to large numbers of vulnerable population in the developing countries. Using stated preference survey method; we employed real OFSP and regular wheat breads to elicit consumer's preference between the two breads. Preferences are measured in terms of respondent's choice. The binary logit model allows us to estimate the coefficients of interest. Coefficients on price variable and bread attributes variables are then used to compute the willingness to pay for different OFSP bread attributes.

The results indicate that of a total convenience sample size of 387 respondents, nearly 57% (219 out of 387) have chosen OFSP bread as their most liked bread after the sensory evaluation. As we have mentioned above, this translates in the preference of the OFSP bread relative to the regular wheat bread. The logit model allows us to closely identify the determinant factors in the OFSP bread choice. Results indicate that the most important factors in OFSP bread choice are the bread attributes (sweet taste and soft texture, and yellow color) as well as the knowledge of prior information on the nutritional and health benefits of the OFSP. These results are consistent with previous research on the adoption of biofortified staple crops foods in the developing countries (Chowdhury et al. 2011; and Naico and Lusk 2010). Our results also show that there are

gender differences in the preference of the bread attributes. This finding is consistent with Johansen et al. (2011).

As policy recommendation, focusing on increasing information dissemination particularly among females and encouraging local entrepreneurs to transform OFSP in various value added products will increase the take-up of OFSP. For further studies, we will recommend allowing more alternatives, rather than limiting to two products.

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Appendix A

Table 1. Summary Statistics of Respondents Demographics

Variable	Description	Mean (Std.dv) Female	Mean (Std.dv) Male	Mean (Std.dv) Sample
Gender	1-Female	1	0	0.490
	0-Male	(0)	(0)	(0.500)
Age	In Years	29.326 (12.401)	27.050 (11.510)	28.167 (11.994)
Educ	0-No Schl	1.649	2.321	1.979
	4-Universi	(1.461)	(1.457)	(1.495)
Income	Per month	346.236 (319.913)	404.208 (569.162)	375.746 (464.159)
Yellow	Prefer yellow	0.563 (0.497)	0.284 (0.452)	0.421 (0.494)
Sweet	Prefer sweet	0.757 (0.429)	0.365 (0.482)	0.558 (0.497)
Soft	Prefer soft	0.594 (0.492)	0.284 (0.452)	0.436 (0.496)
Informed	Knowledge of OFSP	0.763 (0.426)	0.573 (0.495)	0.666 (0.472)
N		190	197	387

Note: Standard deviation in parentheses

**Table 1: Parameter Estimates from the Binary Logit Model
(Aggregated). DepVar chose_ofsp**

	(1) Chose_ofsp	(2) Chose_ofsp	(3) Chose_ofsp	(4) Chose_ofsp
Soft	1.747** (0.655)	1.640* (0.677)	1.602* (0.685)	1.634* (0.677)
Sweet	5.007*** (0.726)	5.058*** (0.770)	5.228*** (0.807)	5.062*** (0.769)
Yellow	2.000** (0.642)	2.119** (0.673)	2.240** (0.702)	2.119** (0.674)
Price	-6.786* (3.223)	-8.102* (3.590)	-8.111* (3.655)	-7.977* (3.625)
Informed	2.483*** (0.741)	2.551*** (0.756)	2.506*** (0.753)	2.538*** (0.756)
Age		-0.0325 (0.0300)	-0.0315 (0.0311)	-0.0318 (0.0302)
Gender		0.269 (0.713)	0.184 (0.727)	0.279 (0.713)
Educ		-0.0166 (0.222)	0.051 (0.233)	-0.008 (0.225)
Income		-	-0.001 (0.000)	-
Loginc		-	-	-0.078 (0.340)
Constant	0.357 (2.766)	2.218 (3.333)	2.457 (3.428)	2.500 (3.559)
Log likelihood	-43.938	-43.304	-42.395	-43.277
Pseudo R ²	0.8341	0.8365	0.8399	0.8366
N	387	387	387	387

Standard errors in parentheses * p<0.05, ** p<0.1, *** p<0.01

**Table 2: Parameter Estimates from Binary Logit Model
(Disaggregated by gender). DepVar chose_ofsp**

	Females	Males	Females	Males
	(1)	(2)	(3)	(4)
	chose_ofsp	chose_ofsp	chose_ofsp	chose_ofsp
Soft	0.831 (0.91)	4.134** (2.59)	0.632 (0.65)	4.945** (2.60)
Sweet	5.699*** (4.62)	5.844*** (3.63)	6.727*** (4.19)	7.268** (2.99)
Yellow	2.285** (2.70)	0.191 (0.12)	2.682** (2.73)	-0.902 (-0.44)
Price	-3.703 (-0.89)	-10.52 (-1.23)	-5.722 (-1.17)	-13.35 (-1.16)
Informed	3.340** (2.91)	1.141 (1.12)	3.595** (2.96)	1.181 (1.11)
Age	-	-	-0.039 (-1.11)	-0.073 (-1.02)
Educ	-	-	0.445 (1.22)	-0.853 (-1.66)
Constant	-2.788 (-0.75)	4.201 (0.58)	-1.616 (-0.34)	9.392 (0.93)
Log likelihood	-22.968	-17.265	-20.980	-15.521
Pseudo R ²	0.7839	0.8686	0.8026	0.8818
N	190	197	190	197

Standard errors in parentheses * p<0.05, ** p<0.1, *** p<0.01

**Table 3: Parameter Estimates from Binary Logit Model
(Disaggregated by gender). DepVar chose_ofsp**

	Females	Males	Females	Males
	(1)	(2)	(3)	(4)
	chose_ofsp	chose_ofsp	chose_ofsp	chose_ofsp
Soft	0.680 (0.70)	4.336* (2.29)	0.701 (0.69)	4.153* (2.22)
Sweet	6.802*** (4.19)	7.467** (2.93)	6.739*** (4.21)	7.290** (2.98)
Yellow	2.717** (2.73)	-0.743 (-0.36)	2.699** (2.69)	-0.543 (-0.26)
Price	-5.516 (-1.16)	-16.28 (-1.23)	-6.930 (-1.28)	-15.20 (-1.25)
Informed	3.605** (2.96)	1.00 (0.92)	3.689** (2.96)	1.159 (1.25)
Age	-0.035 (-0.97)	-0.070 (-0.94)	-0.045 (-1.23)	-0.069 (-0.92)
Educ	0.500 (1.33)	-0.785 (-1.49)	0.375 (1.01)	-0.792 (-1.52)
Income	-0.001 (-0.62)	-0.001 (-0.83)	-	-
Loginc	-	-	0.534 (1.02)	-0.534 (-0.93)
Constant	-1.740 (-0.37)	12.19 (1.04)	-3.283 (-0.62)	13.55 (1.17)
Log likelihood	-20.776	-15.142	-20.432	-15.06
Pseudo R ²	0.804	0.884	0.807	0.885
N	190	197	190	197

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

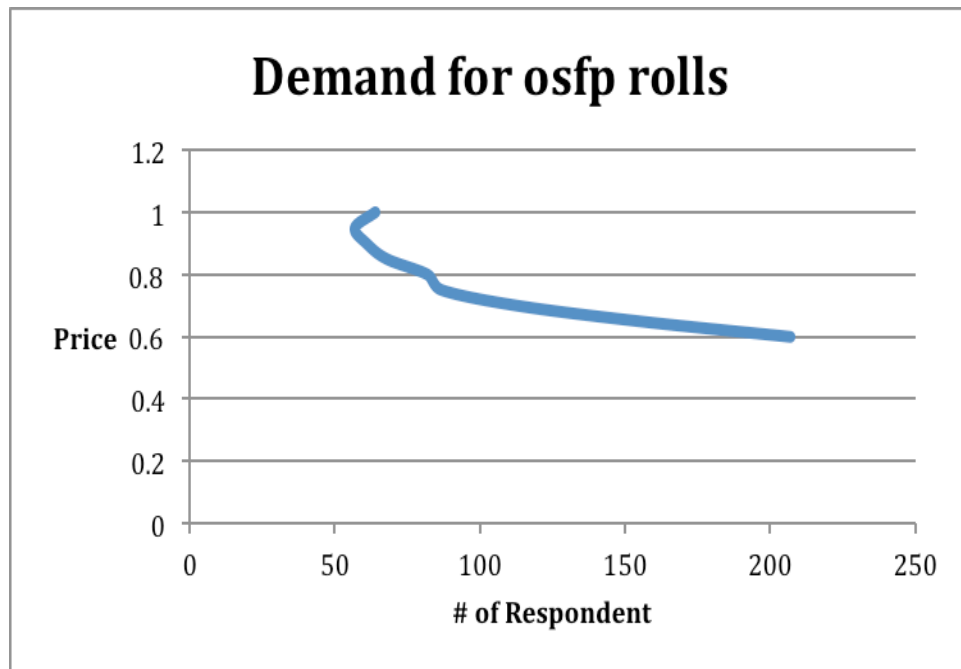
Table 4: Parameter Estimates from the Binary Probit Model (Aggregated). DepVar chose_ofsp

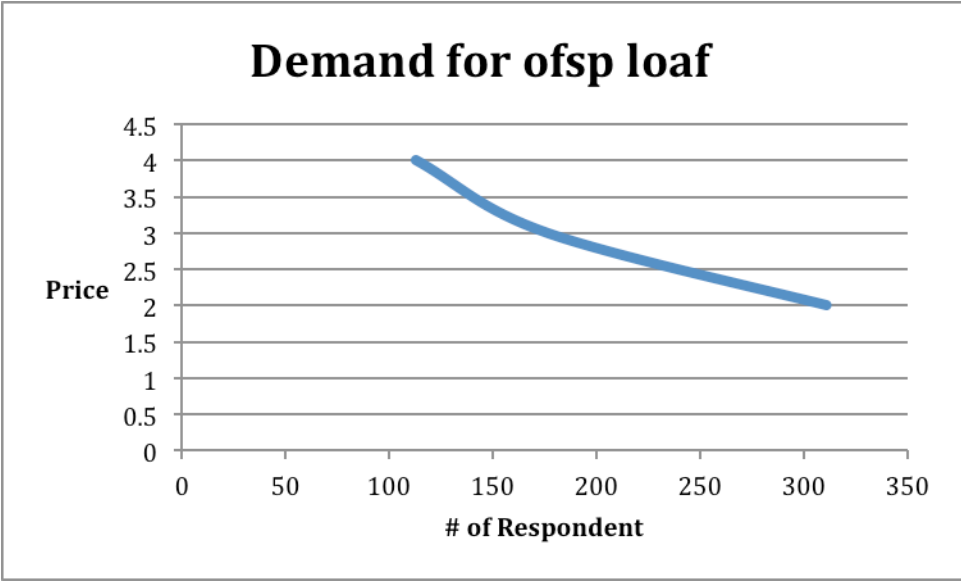
	(1)	(2)	(3)	(4)
	chose_ofsp	chose_ofsp	chose_ofsp	chose_ofsp
Soft	0.847** (0.313)	0.824** (0.323)	0.789* (0.323)	0.832* (0.324)
Sweet	2.658*** (0.330)	2.665*** (0.348)	2.708*** (0.355)	2.664*** (0.349)
Yellow	0.869** (0.309)	0.911** (0.318)	0.933** (0.321)	0.912** (0.318)
Price	-3.596* (1.615)	-4.026* (1.723)	-4.017* (1.722)	-4.056* (1.742)
Informed	1.093*** (0.316)	1.101*** (0.320)	1.064*** (0.321)	1.106*** (0.323)
Age		-0.014 (0.013)	-0.013 (0.014)	-0.015 (0.013)
Gender		0.126 (0.331)	0.105 (0.332)	0.124 (0.332)
Educ		-0.012 (0.101)	0.014 (0.106)	-0.015 (0.104)
Income			-0.000 (0.000)	
Loginc				0.020 (0.150)
Constant	0.359 (1.375)	1.095 (1.570)	1.154 (1.577)	1.022 (1.665)
Log likelihood	-45.906	-45.269	-44.773	-45.260
Pseudo R ²	0.8267	0.8291	0.8310	0.8291
N	387	387	387	387

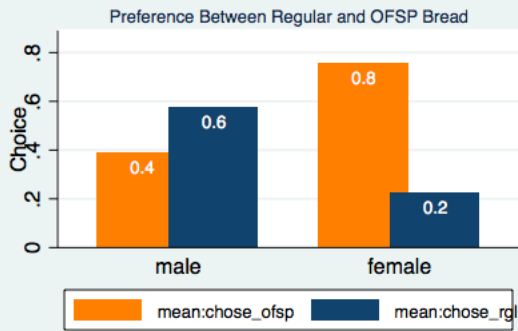
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5: Willingness to Pay Estimates for the OFSP bread

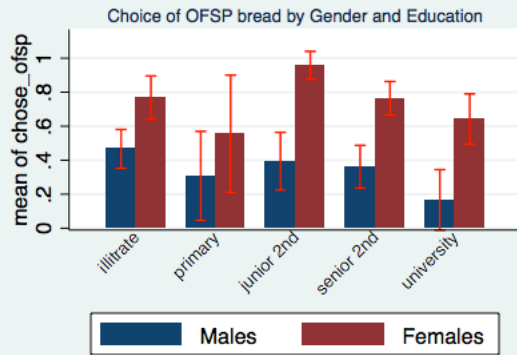
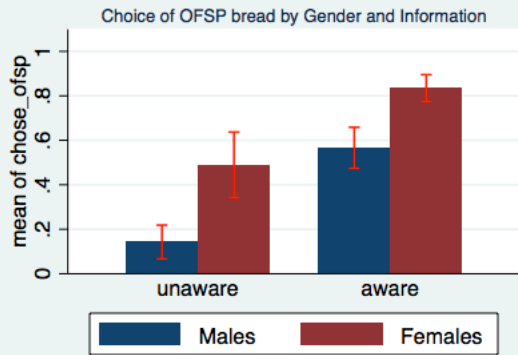
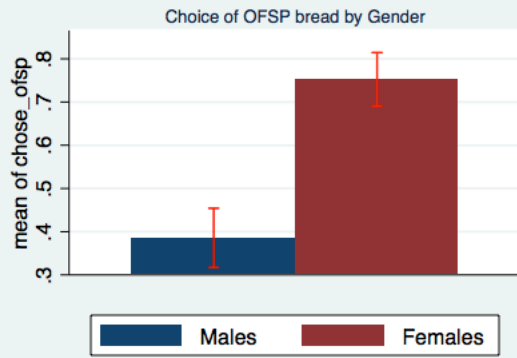
	sweet	soft	yellow
wtp	0.634	0.204	0.265
ll	0.063	-0.037	-0.009
ul	1.205	0.447	0.541







Tamale-Ghana June-July 2017



Appendix B

Survey Questionnaires

Consent

Hello! May I have a minute of your time, please? My name is XYZ. I am a student researcher trying to assess the market of new bread. I would be very grateful if you would answer a few questions. The interview takes about fifteen minutes and you will have the opportunity to try two types of bread, one of which is made out of the Orange Fleshed Sweet Potato. There are no right or wrong answers, so please be honest and tell us what is true for you. The information being collected is for research purposes only and there are no personal risks to your participation. I do not need to know your name and address. Everything that you say will be confidential, and the only identifier on the questionnaire will be a number, not your name. Do you have any questions?

Would you like to participate? YES No

Administrative Information

Name of the City: Tamale

Name of the Neighborhood:

Date of Interview:

Time of interview:

Name of the interviewer:

Demographic Information

Respondent's ID: (e.g. 003)

Age (in years):

Gender: Male Female

-Single

-Married

Schooling

Are you literate? -Yes -No

If yes, up to which class have you completed?

I completed primary education -Yes -No
I completed junior secondary -Yes -No
I completed senior secondary -Yes -No
I completed University -Yes -No

Employment

Are you employed? -Yes -No
Formal sector -Yes -No
Informal sector -Yes -No
Self-employed -Yes -No
Farming -Yes -No
Unemployed -Yes -No

Income

Approximately how much money do you make or receive per month? in GH¢

Do you own any of the following items?

House -Yes -No
Land -Yes -No
Motorcycle -Yes -No
Vehicle -Yes -No
Motor taxi aka 'Yellow Yellow' -Yes -No
Radio/Cable TV -Yes -No
Smart Phone -Yes -No
Face Book -Yes -No
WhatsApp -Yes -No

Consumption of sweet potato in general (local and OFSP varieties)

Do you eat sweet potato? Yes No

Note: If **NO**, terminate the interview.

What type of local sweet potato varieties do you eat?

- Yes No -Yellow
- Yes No -White
- Yes No - Orange

Assessing the knowledge of OFSP

Have you heard of Orange Fleshed Sweet Potato? Yes No

If **YES**, what do you know about it?

Healthy & nutritious -Yes -No

Contains Vitamin A -Yes -No

Good for Children -Yes -No

Good for pregnant women -Yes -No

Good for lactating women -Yes -No

Correct your vision -Yes -No

Assessing the consumption of OFSP and its processed products

Would you eat OFSP or products made of it? -Yes -No

Note: If No terminate the interview

Frequency of bread consumption

How often do you eat bread?

Once a day or more

Once a week or more

Once a month or more

Rarely

What type of bread do you prefer to eat?

- Regular wheat sugar bread

- Regular wheat salt/butter bread



- Cake bread

Bread tasting exercise

Now, we are going to assess your preference between two breads, one of which is made out of OFSP. As I mentioned to you at the beginning, there are no right or wrong answers, so please be honest and tell us what is true for you.

Types of bread

(Interviewer) describe the composition of the breads as we did in the training and invite the respondent to taste one at the time and make sure the respondents rinse their mouth in between with the water you provide.

Figure 1: Breads & their attributes					
Bread 1		Color	Texture	Taste	Price
Yes <input type="checkbox"/> No <input type="checkbox"/>		White (Main ingredients: wheat, salt & butter) <input type="checkbox"/>	Dense <input type="checkbox"/>	Salty <input type="checkbox"/>	50 pesewas (Going market price)
Bread 2 Yes <input type="checkbox"/> No <input type="checkbox"/>		Yellow (Main ingredients: wheat, ofsp, margarine) <input type="checkbox"/>	Soft <input type="checkbox"/>	Sweet <input type="checkbox"/>	60-65 pesewas
					70-75 pesewas
					80-85 pesewas
					90-95 pesewas

Based on what you now know from tasting each bread tell me which one you like most and what attributes do you prefer from that bread?

If the respondent chooses bread 2, ask:

Would you buy Bread 2 at 60 pesewas if you have GH¢1 to spend on bread?

-Yes

-No

Would you buy Bread 2 at 65 pesewas if you have GH¢1 to spend on bread?

Would you buy Bread 2 at 70 pesewas if you have GH¢1 to spend on bread?

-Yes

-No

Would you buy Bread 2 at 75 pesewas if you have GH¢1 to spend on bread?

-Yes

-No

Would you buy Bread 2 at 80 pesewas if you have GH¢1 to spend on bread?

-Yes

-No

Would you buy Bread 2 at 85 pesewas if you have GH¢1 to spend on bread?

-Yes

-No

Would you buy Bread 2 at 90 pesewas if you have GH¢1 to spend on bread?

-Yes

-No

Would you buy Bread 2 at 95 pesewas if you have GH¢1 to spend on bread?

-Yes

-No

Would you buy Bread 2 at GH¢1?

-Yes

-No

Let say you went to the store or to the roadside retailer to buy bread and you see the OFSP bread



Would you buy this bread if it were offered at:

- GH¢4 ?

- GH¢3 ?

- GH¢2 ?

- GH¢1 ?

Thank you for your time and have a good day!



Map No. 4386 Rev. 3 UNITED NATIONS
February 2005