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Invited paper presented at the 5th International Conference of the African Association of Agricultural Economists, September 23-26, 2016, Addis Ababa, Ethiopia

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Consumer's preferences and willingness to pay for biofortified juice in Rwanda: Does the nutritional information matter?

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Abstract

Understanding Consumer Preferences and Estimating Willingness-to-Pay for Orange-Fleshed Sweet Potato Juice: Does Nutrition information Matter?

Identifying consumer preferences and willingness to pay for Orange Fleshed Sweet potato (OFSP) juice were the objectives of the study. This study is based on a structured survey and taste tests administered to 980 randomly approached and verbally agreed participants (384 female and 562 male) selected from seven different markets representing different income groups in Rwanda. Four juices types were tested: two popular brands of 100% pineapple juice, one 100%-OFSP juice, and one 80% OFSP-20% pineapple juice blend. During the taste testing, there was no information provided as to what the type or brand of the juice was. The consumers ranked different juice attributes such as aroma, taste, color, "right" amount of sugar, and aftertaste by rating using a Likert scale (1 to 5, with five being the most preferred).

Heckman two-stage probit model is used to analyze willingness-to-pay and a multinomial logit model to analyze the determinants of juice choice. It is indicated that both consumer characteristics and juice attributes influence willingness-to-pay and preference: sex of the consumer, juice buying frequency, aroma, right amount of sugar, taste of the juice, and vitamin A knowledge were positively associated with willingness-to-pay and juice choice.

Without nutritional information on OFSP juice, the willingness-to-pay for the standard juices compared to OFSP-based juices were statistically higher; but with nutritional information the willingness-to-pay and juice choice for OFSP juice was significantly improved. It is concluded that nutritional information, particularly about the role that vitamin A plays in health is important in determining the juice preferences and willingness to pay.

Introduction

Micronutrient malnutrition, vitamin A, in particular, is one of the major public health problems in Africa. Malnutrition causes blindness and death of children under five years of age and lactating mothers (Tomlins et al. 2007). Malnutrition affects the productivity and cognitive capacity at older ages, hence, affects the economic growth of countries (De Groote and Kimenju 2008; Low et al. 2007a; Magadi 2011; Meenakshi et al. 2012; Sindi, Kirimi, and Low 2013). Globally, estimated 250 million preschool children are vitamin A deficient and of which about 0.25 million children become blind every year, consequently, half of them die within 12 months of losing their sight. The joint United Nations Children's Fund (UNICEF), World Health Organization (WHO) and World Bank Group report indicated that, in 2012 alone, 36%, 29% and 28%, respectively, of the world stunted, underweight and wasted children lived in Africa (WHO; and UNCF; 2013). Similarly, in 2014, while the stunting rates are dropping globally, more than one third of all stunted children under 5 lived in Africa and the number of stunted children under 5 in Africa is rising (UNCIF, WHO, and WB 2015)). The major cause of micronutrient malnutrition in Africa is the poor quality of diets (Chowdhury et al. 2011).

Sweetpotato *(Ipomoea batatas (L.) Lam)* is one of the staple crops in East African, it plays a major role in household food security, nutrition, income, and cash for subsistent smallholder farmers in the (Amajor et al. 2014; Bashaasha et al. 1995; Ebregt et al. 2004, 2007; Scott, Rosegrant, and Ringler 2000; Smit 1997; Tomlins et al. 2007). Orange Fleshed Sweetpotato (OFSP), which is naturally Biofortified; high in beta-carotene, a precursor of Vitamin A; is proofed to be an alternative means to address vitamin A deficiency in children below two years of age and pregnant women (De Groote and Kimenju 2008; Low et al. 2007a). OFSP can easily be absorbed by the body than any others leaves or vegetables, and easy to grow and affordable to resource-poor households in developing countries (Chowdhury et al. 2011; Low et al. 2007b). As such biofortification or improving the micronutrient contents of crops emerged as an alternative approach to combat micronutrient deficiencies (De Groote and Kimenju 2008). However, addressing malnutrition through food-based approach received less attention.

Background: Sweetpotato Production in Rwanda

Rwanda with a total area of 26,334 km2 is one of the smallest landlocked countries in Africa, it has the highest population density of 407 per km2 in the continent (Muhinda 2013). Agriculture is an important sector in the economy; it contributes, 34% of GDP, 80% employment, and 70% foreign earning (Muhinda 2013). Sweetpotato is one of the main staple food crops in the country, with 88kg per capita annual consumption[1]. For instant in major growing seasond, season A;

[1] http://www.newtimes.co.rw/section/article/2015-10-03/193134/)

sweetpotatoes accounts for (7.1%) of the land under crop cultivation (NISR 2013). The share of crop production for individual crops was highest for Sweet potatoes (18.3%) followed by Banana for beer (17.2%). Despite the promising economic growth in the past few years, 7.2%, annually and improved malnutrition prevalence since, 2010, both poverty rate and malnutrition prevalence is still at high. The percentage of the population living below the poverty line was 44.9% in 2011. About 43% (CI: 42.7-45.2%), children under five years of age suffer from chronic malnutrition; and 11% are underweight.

Production and consumption of sweetpotato improve both nutritional and economic well-being of the poor; however, the perception of about the crop is considered as inferior good and left for dubbed as "poor men's" crop in most part the world. The crop is mainly consumed as fresh, boiled, or roasted, reserved as dried flour. Perishability of sweetpotato roots makes its post-harvest management difficult and discourages farmers from production. Value adding process, creating sweetpotato-based products is assumed as the way out to deal the possibility and spoilage after harvesting. Industrial processing enhances the commercialization of the crops, increase availability of the nutritious food for urban consumers; create employment opportunities for farmers and rural households, through the value addition. However, lack of appropriate technologies to increase shelf life have limited the potentials of the crop in addressing the malnutrition, and improve the livelihood of smallholder farmers through commercialization. Therefore, integrated research activities and development activities to improve production, storage, post-harvest, processing has critical importance to improve the economic and nutritional status of the community. Developing OFSP juice is one among the ways to improve the shelf life; incorporating the crop in the household's diets, and consequently increases vitamin A intake. Production of any crop in excess requires incentive to produce, market availability and linkage to the consumers. Therefore, studying the willingness to pay and consumer preferences for such a product, received a paramount attention by the research community. The sweetpotato market can only be created if the non-sweetpotato producing rural communities and the urban population is willingness to buy the product. Therefore, consumer preference, and willingness to pay will enables the policy designers, processors and the government in identifying the appropriate strategies to expand the markets and change the consumption behavior of the households. Identifying the market demand, enables expansion of the market for the sweetpoato produce, by non-sweet potato producers, which increase the market access for the producers, and access to the sweetpoatato products for non-sweetpotato producers; hence, increase income for producers in turn creates demand for industrial products. This further strengthen market linkage between rural and urban areas, the income from sweetpotato can help farm households to purchase more of modern agricultural inputs such as fertilizer, seed, and improved agricultural tools. The decision to choose among many juice type is determined by the level of utility that can be derived from particular choice is greater than the other choices, multinomial logit model is used to identify the factors that determine consumer preferences towards a given juice type.

Previous studies

Previous studies have applied different methodologies to measure the willingness to pay consumer preference for different products and services. The model used in our study relied on similar studies conducted in related topics. The core assumption is based on the rational decision theory, the relative preference and willingness to pay depend on both individual and product attributes. This paper uses the Heckman two stage models to explore the link between individual characteristics, product attributes in one hand, and the willingness to pay on the other hand; similarly, the choice of particular juice is modeled by using the multinomial logit model.

A studies by Owusu-Sekyere et al (2014), on the consumer preferences and willingness to pay for beef safety assurance in Ghana, employed Random Parameters Logit (RPL) model. Halkos and Matsiori (2012) analyzed WTP for coastal area quality improvements in Greece using contingent valuation method (CV) and OLS methods. Bett et al (2013), used contingent valuation method to identify factors influencing the preferences and two-stage Heckman selection model to determine decision of choice and amount willing to pay for underutilized indigenous chicken products in Kenya. The study concluded that both individual characteristics and product attributes such as educational status, age and income level of the consumer; and price of the products and its substitute, taste, flavor, leanness, packaging, and, geographic location play a decisive role (Bett et al. 2013; Halkos and Matsiori 2012; Owusu-Sekyere, Owusu, and Jordaan 2014). Study by Meenakshi et al (2012), used a discrete random parameter logit model to elicit WTP for Biofortified orange maize against yellow and white maize varieties in Zambia and De Groote and Kimenju (2008) estimated willingness to pay for Biofortified yellow maize in urban Kenya used semi-double-bound logistic model.

This paper addresses the following research questions. First, identifying how much are consumers willing to pay for OFSP based juices. If consumers are willing to pay, what are the factors that affect WTP; how different is the willingness to pay for 100%-OFSP juices vs. other juice types. Second, does the provision of information on the nutritional value of OFSP based juices affects the consumer's willingness to pay and preference. Third, the study answers questions on the determinants of the juice choices.

Methodology

Theoretical model

In literature consumer preference modeled mainly using discrete choice utility framework of (Hanemann 1984). This utility framework assumes, consumer utility function given by,$U(X, Q, A, I)$ is influenced by the characteristics of an individual consumer (age, sex, purchase frequency, income, knowledge about vitamin A, and perception about the health effect), X, which affect both willingness to buy and product choice; quantity of juice purchased Q; product attributes such as, price, taste, color, aroma and sugariness, A. The theoretical foundation of multinomial logit model is based on the random utility theory (Loureiro, McCluskey, and Mittelhammer 2001). An agent (consumer) derives different utilities by choosing different juice varieties. Suppose that the ith consumer's utility derived from the consumption juice J (OFSP juices vs. pineapple juices), as stated in (Loureiro, McCluskey, and Mittelhammer 2001); can be represented as follows:

$$U_{ij} = X_i\beta_j + \varepsilon_{ij} \quad i = 1, \dots, n; j = 1, \dots, J \qquad (1)$$

Where U_{ij} represents the utility obtained by the ith consumer from choosing the jth juice type; X_i represents a set of variables that affects the decision to choose j^{th} juice; β_j is the set of coefficents associated with each of the variable, X_i's; and ε_{ij} is the error terms which captures the errors in perception and the choice decision. In this study, respondents were asked to choose their best juice among the four juice varieties. Perhaps the utility that can be derived by choosing j^{th} juice variety is not observable; however, the consumer choice is. Assuming rational behavior for the agent, one can expect the agent chooses the juice variety with highest utility possible. If the consumer i choose juice type j, then utility,U_{ij}, is the highest utility that can be obtained among the four juice types. Thus, the probability that juice type j is choosen by individual consumer i is given by:

$$Prob(y_i = j) = Prob\big(U_{ij} > U_{ia}; o = 1,2, \dots, J, a \neq j\big)$$
$$= Prob\big(\varepsilon_{ij} - \varepsilon_{ia} > \widehat{U}_{ia} - \widehat{U}_{ij}; a = 1,2, \dots, J, o \neq j\big) \qquad (2)$$

Where $\widehat{U}_{ij} = X_i\beta_j$

As stated shown by Maddala, as the residuals, ε_{ij} and ε_{ia}, are independently and identically distributed error terms, the difference in error terms in equation, (2), has a logistic distribution (Maddala 1999). Then, the multinomial logistic model representing the probability of ith consumer of selecting j^{th} juice type can be presented as:

$$Prob(y_i = j) = \frac{e^{X_i\beta_j}}{\sum_{k=1}^{4} e^{X_i\beta_k}}, \qquad j = 1,2,3,4 \qquad (3)$$

Where β_j is a parameter to estimated that weight exogenous variables in determining the the utility of jth juice choice; X_i, is a row vector of exogenous variable values representing the individual consumer characteristics and juice attributes that determine the choice decision.

After identifying the determinants of juice preferences, the second step is identifying factors affecting the willingness to pay and the value to pay. Since, payment is observed only for those

participants willing to pay for a particular juice; inducing the selection bias. Therefore, this study adopted the two-stage Heckman probit model to address the selection bias. The first step involves probit estimation on the probability of whether the participant is willing to pay or not; followed by the OLS estimation to examine how much the participant is willing to pay if they want to pay. Suppose p_i denotes i^{th}'S probability of willing to pay for the juice. The probit estimates presented as follows:

$$p_i^* = z_i\gamma + \mu_i \qquad p_i = \begin{cases} 1\ if\ \ p_i^* > 0; \\ 0\ otherwise \end{cases} \qquad (4)$$

p_i^* Is dummy equal 1 if the respondent is willing to pay and 0 otherwise. z_i is the vector of explanatory variables that affects the probability of willingness to pay. γ is the vector of coefficients to be estimated; which indicates the change in probability of willingness to pay for unit changes in ethe explanatory variables z_i; μ_i is normally distributed error terms captures factors affecting the decision to pay but were not included in the model. Willingness to pay is a function of decision to pay or not.

$$\Pr(\ p_i^* > 0|z) = \Pr(p_i = 1|z) = \Phi(z\gamma) \qquad (5)$$

Where $\Pr(.)$ is the probability of deciding to pay; $\Phi(.)$ is the cumulative normal distribution function. The outcome equation is analyzing factors affecting the value ($) of willingness to pay for the juice of choice. The willingness to pay for juice by individual i can be expressed as:

$$lnWTP_i = \beta x_i + \varepsilon_i\ iff\ p_i^* > 0 \qquad (6)$$

Where $lnWTP$ is willingness to pay; x is the set of explanatory variables presumed to affect the willingness to pay; β is the parameter to be estimated; and ε is normally distributed error term.

Multinomial logit model

Respondents were asked to taste and choose the best juice among the four juice types (100%-OFSP, 80/20 Blended, P-Inyange and P-SINA). Therefore, the empirical specification of the utility level underlying multinomial logit model can be formulated as follows:

$$U_{ij} = \beta_{0j} + \beta_{1j}Sex_i + \beta_{2j}Age_i + \beta_{3j}HeardVitA_i + \sum_{k=1}^{7}\beta_{kj}A_j + \sum_{r=1}^{3}\beta_r M_r + \varepsilon_{ij} \qquad (7)$$

Where, $HeardVitA$, dummy if the respondent heard about vitamin A; A_j is the dummy for the jth juice k^{th} attiribute (sugarness, aroma, taste, consistence, affordability, healthiness, quantity bought); and M_r is the dummy for the rth market location (low, middle, and high end) markets. The utility,U_{ij}, obtained by i^{th} consumer by choosing the jth juice type is the latent unobservable, it is an indication of the latent unobservable utility. The multinomial logit model specified in (4) was estimated by using maximum likelihood estimation techniques. The estimated marginal effects and asymptotic standard deviations are reported in table 8.

In the multinomial logit specification, the parameter associated with one of the choices must be must be normalized to zero. In this study, the parameters associated with the Blended juice type were set to zero, to make comparison between the juice types. The marginal effects associated with each juice type present the effects of the explanatory variables on the probability of choosing a particular juice type. The marginal effects associated with each explanatory variable are computed by calculating the probabilities associated with the choice of each juice type; holding the reset the variables at their mean level.

Data collection and survey design

This study is based on the survey of 957 individuals selected from seven different representative markets in Rwanda, five markets from Kigali city; one from Muhanaga town and one from Muzanze (the second largest city). The objective of the study is to assess prospective consumer preferences and perception of the newly developed orange-fleshed sweetpotato juice and its blend with pineapple juice. Two popular brands pineapple juices produced by two different companies were selected from the local market for the comparison. The selection of market places is based on the team judgement to include different income groups of individuals in the study. Respondents were asked to show their preference juice brands, their buying frequencies, the attributes that influences the decision to buy, for four different juice types without any labels, the tasters are asked to taste each of the juice and rank them attributes one after the other. The tasters are blind on the contents of the juice; it is only the shape of the bottle differs. The choice of the survey locations was to capture different urban social-economic classes within Rwanda.

Table 1 Distribution of respondents by the type of location and market type

Market location	Market type	# of respondents	Total by type	% total
UTC	High end	37	37	4%
SINA Nyirangarama	Middle end	34		
SINA Kigali	Middle end	108	142	15%
Musanze	Low end	101		
Kimironko	Low end	479		
Muhanga	Low end	119		
Gakenke	Low end	68	767	81%

Survey set up

Each of the enumerators was given a distinctive T-shirt that identified them as a member of the study. The setup was at the entrance of the identified shops or market. The enumerators were given comfortable one table and two chairs, one for themselves and the other for the respondents. We placed four juices to be tested in identical clear plastic bottles on the table. However, each of the bottles was marked with a symbol; bottle containing 100%-OFSP juice marked with big

Circle; bottles containing 100% Pineapple-Inyangand 100% SINA-pineapple juice, were marked with Square and Diamond, respectively; the bottle containing a blend of 20% SINA pineapple and 80% OFSP juice was marked with Star. Since there has never been another type of sweetpotato-pineapple blend or 100%-OFSP juice in the market the selected juices where the best products for comparison tests. On the table, we had also a bottle of water well labeled and small cups to cleans/rinse after each tasting. This reduces biasedness in the response regarding the juice preferences and willingness to pay. We used a modified quadruple 'blind testing' methodology. Respondents were asked to rank each attributes (color, taste, aftertaste, aroma, and sugariness) of the juice on 5-point Likert scale (1= Dislike very much, 2= Dislike slightly, 3= Neither dislike nor like, 4= Like slightly, and 5= Like very much). In this case, the respondents were given the four juices that were clearly labeled as Circle, Square, Diamond, and Star as explained above. The respondent's selection was random from the location, individuals visiting near the market location. The respondents at the beginning of the testing were unaware of the identity of the brands of the juices tested. This eliminates any bias that might otherwise occur in the results due to respondent's pre-conceived attitude about a particular brand or manufacturer. Each set of question were asked only after a product had been tasted. When comparisons were being made between the juices, we asked questions only after all the products have been tasted. After giving all the scores on each product, each respondent was asked to give the prices they were willing to pay for each of the products. Then each respondent was given additional information that the two of the juices (Circle and Star) tested had high amounts of vitamin A. They were then asked to evaluate the two products again and now if they preferred them to the ones that had no vitamin A. The purpose of this additional information was to find out if additional information that a product had superior nutritional content could affect preferences.

After giving their evaluation additional information was given that the two juices with vitamin A were made using orange flesh sweetpotato (OFSP) that is rich in Beta Carotene a precursor of vitamin A. After getting this additional information, they were asked to evaluate only the two juices. This approach was used to gauge if knowledge about sweetpotato being an ingredient in the juices would bias the respondent in any way towards the products. Additional information was collected using a structured questionnaire at the beginning of the interview that included social economics data, their juice buying habits, and the cost of the juices they usually buy.

Analysis

Willingness to pay for 0.5L of different juice types and preference

The descriptive analysis in the table presents results of willingness to pay for different juice type and respondents' best juice. About one third of respondents, 34%, were in favor of Pineapple-SINA juice and willing to pay on average 465 RWF($0.66), the maximum willingness to pay goes as high as 8000RWF ($11.48) for a half liter SINA juice. Only 13% of the respondents preferred 100%-OFSP juice with other juices. Similarly, 30%, of the consumers indicated blend juice as their best juice among other juices, demonstrating the blend juice is at least as good as the standard juices.

Table 2 Willingness to pay for 0.5L of different juice types and preference (n=947)

Juice type	Best juice N (%)	WTP (RWF($))	Standard Deviation	Maximum
P-Inyange	230(24.29)	453($0.65)	146($0.21)	1500($2.14)
P-SINA	321(33.90)	465($0.66)	281($0.40)	8000($11.43)
OFSP juice (100%)	120(12.67)	396($0.57)	182($0.26)	3000($4.29)
Blend (80% OFSP:20% pineapple)[2]	275(29.04)	451($0.64)	360($0.51)	7000($10.00)
All		441($0.63)	156($0.22)	2350($3.36)

1USD~ 700RWF; RWF Rwandese frank; P-Inyange: Pineapple-Inyange; P-SINA: Pineapple-SINA

Table 3 Descriptive analysis of variables used WTP measures (n=947)

Variable	Mean/proportion	Std. Dev.	Min	Max
Sex(=1, if sex is male)	0.59	0.49	0.00	1.00
Age (year)	28.95	9.40	6.00	89.00
Hear of vitamin A (=1, if yes)	0.76	0.43	0.00	1.00
Quantity bought (liters/week)	2.99	0.98	0.25	32.00
Natural log of price (RWF)	6.76	1.04	4.61	11.00
Buy juice weekly (=1, if yes)	0.79	0.41	0.00	1.00
Bought because it is affordable (=1, if yes)	0.32	0.47	0.00	1.00
Bought because it is tasty (=1, if yes)	0.25	0.43	0.00	1.00
Bought because it is healthy (=1, if yes)	0.29	0.45	0.00	1.00
Lower market dummy (=1, if yes)	0.81		0.00	1.00
Middle market dummy (=1, if yes)	0.15		0.00	1.00
Upper market dummy (=1, if yes)	0.04		0.00	1.00

[2] Blend juice is made of 80% OFSP juice and 20% Pineapple juice.

About 60% of respondents were males and the remaining 40% were females, Table 3. The average age of participants is about 29 years with minimum and maximum age being six and 89 years, respectively. Respondents were asked to indicate their buying frequencies and the reason why they have bought any juices. On average, they have bought three liters of juice in a week. About 80% of the respondents mentioned that they bought juice at least once in a week. Affordability of juice, 30%, tastefulness, 25%, and perceived health benefits, 30%, were attributes that influence respondents to buy juice. About 80%, 15%, and 5% of the total respondents reside in lower, middle, and higher market areas (Table 1).

Table 4 Preference, attributes and precipitation towards juice

Opinion	100%-OFSP	Blend	P-Inyange	P-SINA
Dislike very much	19.26	17.78	6.67	2.54
Dislike slightly	25.93	20.74	8.68	6.67
Neither dislike or like	16.61	17.46	12.28	13.44
Like slightly	23.92	22.12	36.30	44.02
Like very much	14.29	21.90	36.08	33.33

Table 5 Preference, attributes and precipitation towards juice

Attributes	100%-OFSP	Blend	P-Inyange	P-SINA
Right amount of sugar (=1, if yes)	0.10	**0.23**	0.25	0.41
Like aroma (=1, if yes)	0.38	0.44	0.72	0.77
Like taste (=1, if yes)	0.42	0.58	0.66	0.76
Like color (=1, if yes)	0.33	**0.71**	0.47	0.40
Aftertaste (=1, if yes)	0.50	**0.64**	0.49	0.59
Willing to pay (=1, if yes)	0.96	0.96	0.99	0.99

Majority of the respondent preferred Pineapple-SINA juice, and about 40% of the have shown that it has the right amount of sugar (see Table 4). However, 90% of the consumers were against the sugar content of 100%-OFSP juice. Similarly, more than three-quarter of the respondents indicated that they like the aroma of the P-SINA juice followed by P-Inyange juice (72%). Like other attributes, the taste of P-SINA juice is preferred by about 75% of the respondent followed by P-Inyange juice (66%). Unlike other attribute, the color of the P-SINA juice is chosen by only 40% of the respondents, while Blend juice appreciated by about 70% of the respondents for color. Similarly, the consistence of the aftertaste, taking a mouthful of Pineapple-SINA juice confirmed by about 60% the respondents.

Table 6 Participants' opinion towards different juice attributes (# of respondents)

	Sex of participant			Heard of vitamin A		
Juice type	Female (384)	Male (562)	Difference	No (228)	Yes (718)	Difference
100%-OFSP	376 (8.38)	461 (8.11)	-35**(12.01)	373 (10.06)	404 (7.09)	-31**(13.81)
Blend	433 (19.25)	464 (14.68)	-31 (23.84)	408 (12.68)	465 (14.86)	-58**(27.33)

Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

There is sizeable difference in willingness to pay for 100%-OFSP juice, between male and female respondents, Table 6. Male consumers were willing to pay 35RWF, and 31RWF more for 100%-OFSP, and blended juices, respectively, compared with their female counterpart, but only the former is significant. Knowledge about vitamin A has played decisive role in the decision to choose and pay for OFSP juice. There is statistically significant difference on WTP based on the knowledge of vitamin A. Respondents with prior knowledge on vitamin A were willing to pay about 8% and 15% more for 100%-OFSP, and blended juice, respectively, compared with those without prior Vitamin A knowledge.

The impact of nutritional information

Table 7 presents summary statistics on the Likert scale (1-5) for different juice attributes and willingness to pay (WTP) before providing the nutritional information on the OFSP-based juices. Respondents were asked to rank, color, aroma, taste, aftertaste, mouthfeel and willingness to pay for OFSP-based and ordinary pineapple juices. The descriptive analysis shown that significantly larger number of consumers ranked higher OFSP-based juices for color. The average score for 100%-OFSP and blend juice was about four indicating most of the consumers like the color of the OFSP-juices. On the other hand, the pineapple juice received the average rank of three (neither like nor dislike). However, OFSP-based juice received a lower rank for attributes such as aroma, taste, aftertaste and mouthfeel compared with pineapple juice. Similarly, WTP is highest for pineapple-SINA, 466RWF ($0.67), followed by pineapple-inyange, 453RWF ($0.65). The difference in WTP between OFSP-based (100%-OFSP and blend) juice is significantly lower in the later one. In the absence of nutritional information, there was statistically significant difference between OFSP juice and ordinary pineapple juices in the mean score regarding aroma, taste and aftertaste taste, in all cases the ordinary pineapple juice has received higher ranking, Table 7. Similarly, compared with blend juice, ordinary pineapple juices taste liked better. The willingness to pay for half litter of OFSP juice is below that of pineapple juice.

To see whether provision of nutritional information on OFSP-based juice alters the preferences and WTP or not we repeat the experiment, with the nutritional information on OFSP juices, results presented in Table 8. Nutrition information has substantial impact on determining the preferences and WTP. When consumers provided with the nutritional information (OFSP juices

have highest beta-carotene contents) consumers were preferring and WTP higher for OFSP-based juices. After provision of nutritional information: color, aroma, taste, aftertaste, and mouthfeel of 100%-OFSP juice were more preferred than any other juices. However, aroma, taste and mouthfeel of the blend juice received the lowest score even after the introduction of the nutrition information. Comparing the respondent's willingness to pay, between OFSP and pineapple juices, we find that after the provision of nutritional information, the WTP for 100%-OFSP juice was about, 30RWF, 40RWF, and 50RWF higher, respectively, compared to P-Inyange, P-SINA, and blend juices, which is significant at least at the 5% level of significance. The finding were consistent with other studies, such as Kinnucan et al.1997, who find significant positive impact of health information on meat demand in US, and Chowdhury et al. 2011, who find nutritional information was translated into increased WTP for orange sweetpotato varieties in Uganda. This indicates the importance of inclusion of nutritional information to boost the dissemination and acceptance of Biofortified sweetpotato products among the consumers. Increased willingness to pay signals the growing demand for OFSP products, create market, and incentives to switch to production of OFSP.

Table 7 Average Consumer Likert Scores (range 1-5) for Attributes of Four Juices and Consumer Willingness-to-Pay for those Juices, without nutrition information (n=944)

Juice type	Color	Aroma	Taste	Aftertaste	Mouthfeel	WTP
P-Inyange	3.18	3.86	3.65	3.48	3.21	453
P-SINA	3.08	3.99	4	3.8	3.62	466
OFSP-Juice	3.96	2.88	2.98	2.97	3.22	397
Blend	3.82	3.1	3.48	3.36	3.59	451
T-statistics difference in means without nutritional information of the juice						
OFSP vs. P-Inyange	0.78***(0.07)	-0.98***(0.06)	-0.67***(0.06)	-0.51***(0.07)	0.01(0.07)	-56***(6.20)
OFSP vs. P-SINA	0.88***(0.06)	-1.11***(0.06)	-1.02***(0.06)	-0.83***0.06()	-0.4***(0.06)	-69***(10.55)
OFSP vs. P-Blend	0.13***(0.04)	-0.22***(0.05)	-0.05***(0.06)	-0.39***(0.05)	-0.37***(0.05)	-54**(11.83)
Blend vs. P-Inyange	0.65***(0.07)	-0.76***(0.07)	-0.17**(0.07)	-0.12(0.07)	0.38***(0.07)	-2(11.82)
Blend vs. P-SINA	0.75***(0.06)	-0.89***(0.06)	-0.52***(0.06)	-0.44***(0.07)	-0.03(0.07)	-14(13.76)

Table 8 Average Consumer Likert Scores (range 1-5) for Attributes of Four Juices and Consumer Willingness-to-Pay for those Juices, with nutrition information (n=129)

Juice type	Color	Aroma	Taste	Aftertaste	Mouthfeel	WTP
P-Inyange	2.78	3.55	3.40	3.24	2.93	417
P-SINA	3.05	3.80	3.68	3.60	3.44	406
OFSP-Juice	4.16	3.87	4.02	3.89	4.00	449
Blend	3.88	3.43	3.24	3.47	3.75	399
T-statistics difference in means after nutritional information of the juice is provided						
OFSP vs. P-Inyange	1.37***(0.19)	0.32*(0.18)	0.62***(0.17)	0.65***(0.19)	1.07***(0.18)	33**(16)
OFSP vs. P-SINA	1.11***(0.11)	0.07(0.17)	0.33**(0.17)	0.29(0.18)	0.55***(0.17)	43**(17)
OFSP vs. P-Blend	0.27**(0.12)	0.44***(0.16)	0.78***(0.18)	0.43**(0.17)	0.24(0.17)	50***(18)
Blend vs. P-Inyange	1.10***(0.20)	-0.12(0.21)	-0.16**(0.19)	0.22(0.21)	0.82***(0.20)	-18(18)
Blend vs. P-SINA	0.83***(0.17)	-0.37**(0.17)	-0.44***(0.18)	-0.13(0.19)	0.31*(0.18)	-8(16)

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. *100% Pineapple juices: P-Inyange and P-SINA. OFSP-Juice is 100%-OFSP; Blend is 80% OFSP, 20% Pineapple juice.

Determinants of willingness to pay

Consumer preferences and WTP studies often interested in identifying the market potential for new product; the OFSP juice is new for the Rwandese consumers. This study aims at understanding the preference to and WTP for the OFSP juice. It has been hypothesized that consumer's WTP, and preference is influenced by demographic characteristics of the consumer like age, sex, education, income, and family size, prior perception, and knowledge about the product (Ariyawardana, Govindasamy, and Puduri 2009; Haghjou et al. 2013; Xia and Zeng 2008). The relationship between consumer characteristics (sex, age, juice buying frequency, perception, and income class); juice attributes (taste, color, aroma, prices, mouthful taste) on the decision to pay and the willingness to pay is presented in Table 9. The table presents the estimated coefficients for the probit model for the first stage and the OLS results for the second stage. The sex factor coefficients are statistically significant for 100%-OFSP and blended juice choices. There is a significant difference between male and female respondents regarding willingness to pay for OFSP based juice varieties. Compared with female, male respondents were willing to pay 10% ($0.35) and 7% ($0.30), more for 100%-OFSP and blended juices, respectively, which is consistent with the descriptive analysis presented in Table 6. Older respondent were less likely (significant for 100%-OFSP and pineapple SINA juices) to pay for any of the juices compared with the younger respondents. Similarly, the age of the respondent is significant (p<10% for OFSP based juices) negatively related to the probability of the decision to pay (selection equation). The perceived right amount of sugar, positively affects the WTP, those who perceive the juice has right amount sugar were willing to pay more. The price of the juice negatively affects willingness to pay (except for pineapple). The taste of juice significantly influences willingness to pay. Consumers who like the taste of the juice willing to pay, 20%, 26%, and 7%, more for 100%-OFSP, blend and P-Inyange juices, respectively. The coefficient on market dummy indicates that compared with the lower market segment, middle-income consumers were willing to pay significantly higher premium for 100% OFSP (7%) and blended juice (9%), respectively. The same factors affecting willingness to pay also affects the decision to pay for OFSP based juices.

Table 9 Natural logarithm of willingness to pay Heckman two stage probit model

Variables (Dept. LnWTP)	100%-OFSP	Blend (20/80)	P-Inyange	Pineapple-SINA
Sex (1= male 0 otherwise)	0.10***	0.07**	0.01	0.04
	(0.02)	(0.03)	(0.02)	(0.07)
Age (in years)	-0.00*	-0.00	-0.00***	-0.01
	(0.00)	(0.00)	(0.00)	(0.00)
Quantity bought(liter/month)	0.05	0.03	-0.01	0.03
	(0.03)	(0.03)	(0.03)	(0.08)
Dummy heard of vitamin A (1 Yes, 0 No)	-0.01	-0.00	-0.00	0.00
	(0.00)	(0.01)	(0.00)	(0.01)
Natural log price ($)	-0.02	-0.03**	-0.04**	-0.02
	(0.01)	(0.01)	(0.01)	(0.04)
Dummy right sugar (1 Yes, 0 No)	0.08*	0.09**	0.09***	0.09
	(0.04)	(0.03)	(0.02)	(0.08)
Dummy like aroma (1 if like)	0.08*	0.04	0.04	0.03
	(0.03)	(0.03)	(0.03)	(0.09)
Dummy like taste (1 if like)	0.20***	0.26***	0.07*	0.08
	(0.03)	(0.05)	(0.03)	(0.09)
Taste consistent (1 if consistent)	0.04	0.07*	0.03	-0.00
	(0.02)	(0.03)	(0.02)	(0.08)
Dummy like color (1 if like)	0.03	0.03	0.05*	-0.01
	(0.03)	(0.03)	(0.02)	(0.07)
Dummy buy weekly (1 if buy weekly)	0.15***	0.14***	0.08*	0.08
	(0.03)	(0.04)	(0.03)	(0.11)
Dummy affordable (1 if Yes)	-0.00	-0.00	0.09*	0.09
	(0.04)	(0.05)	(0.04)	(0.13)
Dummy tasty (1 if Yes)	0.04	0.00	0.06	0.07
	(0.04)	(0.05)	(0.04)	(0.12)

Dummy Healthy (1 if Yes)	0.03	0.01	0.08*	0.08
	(0.04)	(0.05)	(0.04)	(0.12)
2.Middle market dummy	0.07*	0.09*	0.04	0.05
	(0.03)	(0.04)	(0.03)	(0.10)
3.High market dummy	0.07	0.10	0.12*	0.12
	(0.06)	(0.07)	(0.06)	(0.18)
Probit selection equation willing to pay (1 if Yes)				
Age (in years)	-0.02**	-0.02*	0.03	0.00
	(0.01)	(0.01)	(0.06)	(0.02)
Quantity bought (liter/month)	0.30	0.52*	-4.29	0.12
	(0.19)	(0.21)	(6415.78)	(0.35)
Natural log price (RWF)	0.04	0.08	0.50	0.00
	(0.06)	(0.08)	(0.61)	(0.06)
Dummy like aroma (1 if like)	0.06	0.02	-0.63	0.46
	(0.09)	(0.11)	(0.47)	(0.32)
Dummy like taste (1 if like)	0.84**	0.29	-4.80	-0.11
	(0.29)	(0.30)	(2712.78)	(0.38)
Taste consistent (1 if consistent)	0.59*	5.69	-4.92	0.35
	(0.24)	(10.02)	(2315.81)	(0.38)
Dummy like color (1 if like)	0.17	0.24	-5.48	0.65
	(0.19)	(0.21)	(2032.44)	(0.45)
Dummy buy weekly (1 if buy weekly)	0.08	0.00	0.38	0.21
	(0.19)	(0.20)	(0.74)	(0.35)
Dummy affordable (1 if Yes)	-0.29	-0.08	-6.13	-5.20*
	(0.28)	(0.29)	(3222.90)	(2.03)
N	944	944	944	944
Sigma	0.34	0.39	0.34	1.06
Lambda	0.09	-0.27	0.03	-1.06

Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Determinants of juice preference

The juice preference is influenced by both juice related attributes such as taste, color, aroma, mouthfeel, aftertaste, and price. Other factors playing roles are consumer related characteristics such as age, sex, number bought, buying frequency, knowledge on Vitamin A and the importance of the juice continents. The market location (proxy for income) highly influences the juice preferences (Chowdhury et al. 2011) . In this study, three (low, middle and high) market types were represented in the survey with the aim of getting representative samples from different income categories. Compared to ordinary juices, preference to OFSP-based juices was affected significantly by the demographic characteristics of consumers. The marginal coefficient of sex of the consumer is positive (negative) significant for 100%-OFSP ($p<10\%$), and blend ($p<1\%$) juices, indicating male consumers prefer 100%-OFSP juice, while, female consumers prefer blended juice, compared to their counterparts. Since, 100%-OFSP juice is less sweet than blend juice, and females prefer sweeter taste than males, the result was expected. For 100%-OFSP juice, right amount of sugar ($p<1\%$), aroma of the juice ($p<5\%$), and dummy like taste ($p<1\%$), has positive and significant effect on the probability of being chosen, among the alternative juices. However, the dummy that the juice is tasty negatively influences the decision to choose the 100%-OFSP juice. This is expected result as the OFSP juices are less tasty. Three market dummies were used to capture the income differences in juice preferences. Compared to the lowest market, consumers in the higher market end appreciate the blend juice than other juices. Given the fact that emerging middle-income consumers and expected increase in the demand for OFSP products, this is an encouraging message to further increase the supply of processed OFSP products in Rwandese market. Moreover, consumers in the high - end market were less likely to consume the traditional SINA-pineapple juice; further, creating additional evidence for shifting in consumer's preference towards healthier products such as OFSP juice. Knowledge about the vitamin A plays an important role in consumer's acceptance, and provision of nutritional information increase the willingness to pay for Biofortified products. However, in this stud, the impact of prior knowledge of vitamin A is negative and insignificant for OFSP-Based juice (100%-OFSP, and blend), which is an unexpected result. Comparison of the mean willingness to pay, between consumers who heard of vitamin A and those who did not reveal that the latter were willing to pay 8%, and 14%, more for the 100%-OFSP and blend juices, respectively, than the alternative juice types. The insignificance of the coefficients on the vitamin A knowledge could be explained by the quality of the information sources about the health importance of vitamin A, and needs further investigation of the causes.

Table 10 Juice choice Multinomial logit model (marginal effect coefficients)

Variables (Best juice)	100%-OFSP	Blended	P-Inyange	P-SINA
Sex (1= male 0 otherwise)	0.04*	-0.11***	0.03	0.04
	(0.02)	(0.03)	(0.03)	(0.03)
Age (in years)	-0.00	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
LnPrice	0.01	-0.02	0.00	0.01
	(0.01)	(0.01)	(0.02)	(0.02)
Dummy right sugar (1 Yes, 0 No)	0.18***	-0.09	-0.09	-0.01
	(0.02)	(0.07)	(0.07)	(0.06)
Dummy like aroma (1 Yes, 0 No)	0.06**	-0.00	-0.02	-0.03
	(0.02)	(0.03)	(0.03)	(0.03)
Dummy like taste (1 Yes, 0 No)	0.09***	-0.01	-0.11***	0.03
	(0.02)	(0.03)	(0.03)	(0.03)
Taste consistent (1 Yes, 0 No)	0.01	-0.02	-0.08*	0.09**
	(0.02)	(0.03)	(0.03)	(0.03)
Dummy like color (1 Yes, 0 No)	0.01	-0.06*	-0.02	0.07
	(0.02)	(0.03)	(0.03)	(0.03)
Dummy buy weekly (1 Yes, 0 No))	0.04	-0.07	0.01	0.01
	(0.03)	(0.04)	(0.05)	(0.04)
Dummy affordable (1 Yes, 0 No)	-0.02	0.01	0.13*	-0.12*
	(0.03)	(0.05)	(0.06)	(0.05)
Dummy tasty (1 Yes, 0 No)	-0.08*	-0.01	0.07	0.02
	(0.03)	(0.05)	(0.06)	(0.05)
Dummy healthy (1 Yes, 0 No)	-0.07*	-0.04	0.08	0.03
	(0.03)	(0.05)	(0.06)	(0.05)
Number bought (package/bottle)	-0.00	0.01	0.00	-0.00
	(0.00)	(0.01)	(0.01)	(0.01)

Dummy heard vitamin A (1 if Yes)	-0.01	-0.02	0.03	-0.00
	(0.02)	*(0.03)*	*(0.04)*	*(0.03)*
2.Medium market dummy	-0.03	-0.05	0.01	0.07
	(0.03)	(0.04)	(0.04)	(0.04)
3.High market dummy	-0.06	0.19*	0.05	-0.18**
	(0.04)	(0.09)	(0.08)	(0.05)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, P-Inyange juice is used as reference for multinomial logit model, lower market is used as a base, the Blend juice is used as a base in multinomial logit model.

Conclusion and recommendation

The main objective of this study was testing whether it is viable to develop Biofortified beta-carotene-rich OFSP based juice, which is economically viable and acceptable by the consumers compared to the traditional pineapple juice. The ultimate goal of the study understanding the link between consumer behavior and preferences and willingness to pay for OFSP juices. The Naturally Biofortified sweetpotato juice, offer an alternative, cheap and easily accessible means to reduce the prevalence of vitamin A deficiency in Rwanda. However, the success of such agriculture-based intervention depends largely on the existing market for the product, acceptance, and consumers' willingness to pay. Therefore, understanding the marketing condition for OFSP juices, consumer's preference, prior vitamin A knowledge, and willingness to pay has an important implication to scale-up the intervention effort. In this study, two-stage analysis was employed: one focusing on the determinants of juices preference and the other on willingness to pay for locally available traditional pineapple juice and new orange-fleshed sweetpotato based juices.

It is concluded that targeting different socioeconomic groups of consumers and their economic class, are among the main factors that need attention in product development. Buying frequency, income classes, gender and age of the consumers influences the juice choice and willingness to pay. The sensory study indicated that willingness to pay, and preference, for OFSP-based juice depends primarily on whether or not nutritional information is provided or not. Without nutritional information on the OFSP juice, consumers inclined to prefer other juices types and their willingness is significantly higher for pineapple juice than OFSP juice. However, incorporating nutritional information significantly changed the perception and willingness to pay for OFSP juice. Nutrition information has a sizable impact: when informed about the nutritional value of OFSP, consumers were willing to pay a substantial premium for the OFSP based juice. Our results suggest that an information campaign may be a key tool to increase acceptance and willingness to pay to OFSP juice in Rwanda. Programs and activities interested in dissemination of OFSP varieties, consumption of OFSP roots and processed products, and marketing should incorporate the nutritional education, to achieve reduction in vitamin A deficiency via agricultural nutrition linkage. Irrespective of the information provided, OFSP juice is most preferred in terms of color. The other interesting result emerged from this study is that the middle-income consumers were interested to consume nutritious OFSP juice compared other juices type; this is an encouraging finding to further scale-up agriculture-nutrition intervention as the Rwanda is one of the countries with expanding the middle class consumers; hence, improve both the nutritional and wealth status of smallholder farmers. Moreover, middle-income consumers were in different regarding their WTP for the ordinary juice, this further highlight, the potential market for the OFSP products.

When it comes to a conclusion, nutrition information has more likely to influence the acceptance of the OFSP based juice and it is strongly recommended to include the vitamin A information on the juice in order to increase its acceptability and increase the willingness to pay by the consumer. At the same time, value addition such as developing juice from sweetpotato is an effective way to address VA deficiency and increase the earnings from sweetpotato production by the smallholder farmers.

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