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Can Biofortified Orange Fleshed Sweetpotato Make Commercially Viable Products and Help in Combatting Vitamin A Deficiency?

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ABSTRACT

Orange-fleshed sweetpotato (OFSP) varieties rich in beta-carotene, a precursor of vitamin A are one of the least expensive sources of dietary vitamin A in Sub-Saharan Africa, where most sweetpotato is consumed as boiled or steamed roots. One major question is how its use can be expanded among urban African consumers. In many urban centers, access to fresh roots is principally at the wet-markets, thus precluding many high-end urban consumers. One solution is to develop products incorporating OFSP into products typically consumed by middle-class consumers (such as bakery products) that can supply significant amounts of vitamin A. Viable products must have production costs equal to or lower than the equivalent product without OFSP and consumers must like their taste compared to regular products. Sweetpotato can replace upto 50% of wheat-flour in bakery products, depending on product and local tastes. In Rwanda, we produced four products in collaboration with a commercial bakery, using different combinations of ingredients: wheat-flour only; mixture of wheat-flour and OFSP-flour; and mixture of wheat-flour and OFSP-puree. Sensory consumer tests and analysis of data using means, t-tests, and ordered-logit, showed that bread made out of a mix of 30% OFSP-puree and 70% wheat-flour was preferred to that made of 100% wheat-flour. Consumers showed no preference between doughnuts and queen cakes made from 100% wheat-flour and those with mix of 60% wheat-flour and 40% OFSP-puree. Biscuits made of 40% OFSP-puree and 60% wheat-flour were preferred to those made with 100% wheat-flour. Therefore, the OFSP-based products were acceptable to Rwandan consumers.

Keywords: Orange fleshed sweetpotato, Vitamin A, beta carotene, Sensory test, Sweetpotato puree.

Introduction

Sweetpotato is a staple food in Rwanda and is consumed by most of the rural households. Traditionally it is mainly consumed after boiling, with very few other methods of preparation. When people move to the urban areas, they do not use much of the crop mainly for two reasons. First, sweetpotato is not available in supermarkets and other shops, and is only accessed from the wet markets. Secondly, sweetpotato is primarily consumed in the rural areas, where it is considered as a food security crop (which will always be available when other crops fail), and so it often viewed as food for the poor.

The population in Rwanda is increasingly becoming urbanized at a rate of 30% and it is expected that this rate will accelerate. Urban consumers usually demand more processed and faster cooking foods than their rural counterparts. As a result, there is growing demand for wheat-based products, among other food items, but wheat flour is relatively expensive and its world price is steadily increasing. Sweet potato has a lot of starch, and thus may be used to substitute for some percentage of wheat in processing many bakery products. Although production, processing and consumption of sweetpotato have not been fully exploited, it is acknowledged that it can substantially contribute to increased farm incomes, improved food security and development of agro-processing industries. It is in this regard that the Rwanda Sweetpotato Super Foods project sought among other things to add value to this underutilized staple food crop by using it to develop composite products made from a mixture of wheat flour and sweetpotato flour and puree.

Crop commercialization efforts need to be spurred by sufficient demand rather than by a push from a "crop champion". Demand for a crop can typically be considered as demand for products in the marketplace. However, there are other types of demand pull which can stimulate crop commercialization. In some instances, demand can come from farmers seeking an alternative crop to deal with production and marketing challenges such as climate change, diseases and pests, soil quality problems, and unfavorable and erratic prices, among others. Demand can be created by government policy, such as through promotion of traditional high value crops and crop purchasing and export programs. Also, demand can be generated by processors seeking to substitute a traditional expensive core ingredient with an alternative crop. Consumers can also create demand and so commercialization of a crop through their awareness and need for healthier and more nutritious food products. In general, demand from the marketplace presumes that an alternative crop provides products, that are lower in cost, higher in quality, or superior in functionality to the products they replace (Thomas Jefferson Agricultural Institute, 2003). It is crucial that commercialization efforts ensure this "improved substitution product".

This study looks at consumers' perceptions of some products that are processed using a mix of wheat flour and either sweetpotato puree or sweetpotato flour, and others that are made purely (100%) from wheat flour. We used the orange flesh sweetpotato (OFSP) to replace a percentage of wheat flour in various bakery products since it is rich in beta-carotene (provitamin A).

Using OFSP in bakery products and ensuring that they have enough beta-carotene could make a major contribution to alleviating vitamin A deficiency in Rwanda and sub-Saharan Africa in general. Use of such products by urban consumers (instead of the less preferred fresh sweetpotato) can help alleviate vitamin A deficiency in children, pregnant women and lactating mothers (Low, et al, 2001). An efficacy study in South Africa demonstrated that consumption of 125g of OFSP improved the vitamin A status of children, and could play a significant role in developing countries as a viable long-term food-based strategy for controlling vitamin A deficiency (Van Jaarsveld, et al, 2005). However, for sweetpotato to be incorporated in the bakery products, processors have to be sure that consumers will either prefer the new products or be indifferent between them and the regular ones made purely from wheat flour. It is also important to ensure that sweetpotato-wheat based products have appropriate characteristics of appearance, aroma, taste and texture, which are key determinants of consumers' sensory acceptability of bakery products. Other sensory tests of baked products have found that replacing some basic components changes structure and volume of the crumb (Gujral and Rosell, 2004), and also structure and texture (Mezaize, et al., 2009). This study conducted sensory testing of industrial wheat-sweetpotato processed products that have been formulated for markets in Rwanda. This aspect of the project is critical in ensuring that sufficient demand exists to help pull sweetpotato along the value chain and into the market place. Evaluating and confirming the quality and consumer acceptability of the wheat-sweetpotato processed products, will inform the improvement and promotion of best practices along the value chain, enhancement of capacity of farmers and dissemination of technology for commercial production and supply of quality sweetpotato.

Literature review

Sensory evaluation is defined as "a scientific discipline used to evoke, measure, analyze, and interpret those responses to products that are perceived by the senses of sight, smell, touch, taste, and hearing" (Stone and Sidel, 1993). The quality of many products can only be fully measured through sensory evaluation of some of its properties. According to Fogliatto et al, (2000), common methods applied in sensory evaluation include descriptive analysis, magnitude estimation and indirect pairwise comparison. Murray et al (2001) indicate that descriptive sensory tests involve the detection and description of both qualitative and quantitative sensory components of a consumer product by a trained panel of judges. The qualitative aspects of a product include aroma, appearance, flavour, texture, after taste and sound properties, which distinguish it from others. Judges then quantify these product aspects in order to facilitate description of the perceived product attributes. Some of these methods have been used to study various aspects of products made with sweetpotato.

A study conducted in Kenya that sought consumer perceptions and willingness to consume products made with sweetpotato showed that consumers were willing to buy products containing sweetpotato (Dansby and Bovell-Benjamin, 2006). The purpose of the current study is to apply the sensory profiling method (Delarue and Sieffermann, 2004) involving a panel of subjects in order to identify the sensory attributes that best characterize the properties of appearance, aroma, taste and texture of 'normal' wheat flour only products and

other products with a percentage of wheat flour replaced with sweetpotato puree or flour. Singh et al (2008) assessed the textural and sensory properties of cookies in India by supplementing various proportions of sweetpotato flour (0-100%) to wheat flour. The cookie dough was subjected to rheological analysis and texture profile analysis in order to determine dough hardness, cohesiveness, springiness, and adhesiveness, among other things. Spread factor, puncture force and fracture strength of the cookies were also determined. The cookies were evaluated by a panel of 15 members. The panel evaluated the following sensory attributes: texture: crunchy to hard (4.9 to 1); mouth feel: crunchy to teeth clogging (4.9 to 1); taste: sweet to burnt/caramel taste (4.9 to 1); colour: light brown to very dark brown (4.9 to 1) and overall acceptability: outstanding to unacceptable (4.9 to 1). The mean of the 15 evaluations was reported. Sensory evaluation revealed that the cookies prepared with the addition of 40% sweetpotato flour got overall acceptability score of 3.6. However, increasing levels of sweetpotato flour up to 60% lowered the overall acceptability to 2.7 because of taste and distinct flavor developed during baking. In addition, the cookies made from 100% sweetpotato flour were marginally acceptable with an overall score of 2.1, while the score on taste reduced significantly to 1.8. However, the texture of cookies made from 100% sweetpotato flour was tender and acceptable. Generally, the sensory evaluation showed that sweetpotato flour at 40% was acceptable with reference to taste, mouth feel, colour and texture and that incorporation of 40% sweetpotato flour yielded approximately similar results compared with wheat flour cookies, but with improved nutritional value and texture.

Hoover et al (1983) conducted a sensory evaluation of sweetpotato patties. The patties were prepared from Jewel and centennial cultivars which were freshly harvested or cured and stored. The patties were prepared with additions of sugar, starch and other minor ingredients to peeled, cooked sweetpotato and were cooked in peanut oil. They were then presented to a 20-member untrained sensory panel that was issued with coded samples on white plates in fluorescent lighted rooms. They were asked to evaluate colour, flavor and texture on a 5-point scale (5 for excellent, 1 for unacceptable). Analysis of variance (ANOVA) and General Linear Model procedures were applied in analyzing the data. Findings indicated that patties of acceptable quality could be prepared from either freshly harvested sweetpotato or from roots that have been cured and stored for up to 6 months. Wu et al (2009) evaluated the effects of four sweetpotato (TNu57, TNu62, TNu64, and TNu66) pastes in Taiwan, (5%, 10%, 20%, and 30% of wheat flour) on physiochemical properties of dough including a sensory evaluation of the toast. Twenty panelists (male and female between the ages of 18 and 22 years) evaluated the products looking at texture, colour and overall acceptability scores using a seven point hedonic scale. ANOVA was used for the descriptive analysis. Results of the study showed that addition of 20% TNu57 sweetpotato paste, which contained high amount of maltose, was the best variety for toast making. The addition of sweetpotato paste exhibited higher staling rate than the control, but the bread was softer than the control at baking day except for one cultivar. Toast supplemented with sweet potato paste was scored significantly more than that of the control by the panelists (Wu, et al., 2009).

Laurie and Van Heerden (2012) examined consumer acceptability of chips, doughnuts, juice and sweet potato leaves (cooked green vegetable dish) made from β-carotene-rich

sweetpotato. Consumer testing (n=950) was conducted in six target sites in Limpopo, Mpumalanga, North West and KwaZulu-Natal Province of South Africa. A likert scale ranging from 1 to 5 was used. A score sheet was designed first containing a 5-point hedonic scale with facial expressions. The following verbal anchors were used: 'like a lot', 'like a little', 'neither like nor dislike', 'dislike a little' and 'dislike a lot', respectively. Secondly, three 'yes/no' questions were asked, namely: 'Do you like the colour of the product?', 'Will you buy this product?' and 'Would you like to make this product at home?' ANOVA was conducted to analyze the results. The product acceptability was high varying between 85 and 95%, with the highest acceptability being for doughnuts. The results further indicated that on average, 92% of the consumers liked the colour of the four products, 87% would buy the products and 88% indicated that they would like to make the products at home.

Methodology

This study used sweetpotato roots from the Cacearpedo variety to make puree and flour. In preparing the flour, roots were harvested, washed, and the skin removed using a kitchen knife. The roots were cut into very thin pieces to facilitate quick drying. The cut pieces were then soaked in water with Sodium metabisulfite that was used as a disinfectant and antioxidant to prevent oxidation of the OFSP and minimize the loss of beta-carotene. The pieces were dried in a curing room using firewood. The dried chips were then milled into flour, which was used by a commercial baker in combination with wheat flour to make the processed products. To make the puree, Cacearpedo roots were harvested, washed to remove all soil and then boiled. After boiling, the skin was removed and puree prepared using an electric mixer. The processor followed a protocol that had been worked on in collaboration with the post-harvest unit of Rwanda Agricultural Board. All processed products were distributed to different outlets for sale.

Two consumer tests were conducted with products made at two different periods. The first test used 30 trained tasters of various ages in a controlled environment while the other used 90 untrained tasters. The second testing was conducted using students at an urban girls' school and the university in Kigali, Rwanda.

Each panelist was allocated to a desk and the score sheet was explained to the whole group. Panelists were informed that their honest opinion was important. One product was evaluated per session by the whole group, after which the next product would be served and evaluated. Each taster was given bottled water to rinse the mouth after every tasting of a sample and recording the ratings. Tasters were given three samples of each of the following products: bread, cake, queen cakes, doughnuts, and biscuits. One sample product was prepared using 100% wheat flour, while the second sample was made using a mixture of various percentages of wheat and sweetpotato flour, and the third consisted of a mixture of various percentages of wheat flour and sweetpotato puree.

Each of the samples was presented on a disposable paper plate marked with either a circle, diamond or a square and tasters were not informed of the ingredients used to make the

products. Tasters were then instructed to taste one sample at a time and rate the product on a sheet of paper that had the sample symbols for identification. They were asked to rate the product in terms of colour, shape, structure, flavor, texture and acceptability using a five point likert scale. Queen cakes were also rated on the basis of tenderness. After the tasters rated each sample, the last question was on acceptability of the product. This was to summarize their overall feeling about the product, using the same five point likert scale.

Results

Descriptive results

In this section, we present the results on overall acceptability from the consumer tests for the various bakery products. The first analysis compared the mean score for the overall acceptability among the three samples of each of the products.

Figure 1 shows the mean acceptability of bread made with different combinations of wheat flour and sweetpotato flour or puree. Results show that bread made with a mix of 80% wheat flour and 20% sweetpotato puree was preferred to the other two types of bread. The bread made with a mixture of 80% wheat flour and 20% sweetpotato flour was the least preferred; it was less preferred compared to the normal bread made of 100% wheat flour, which was the control.

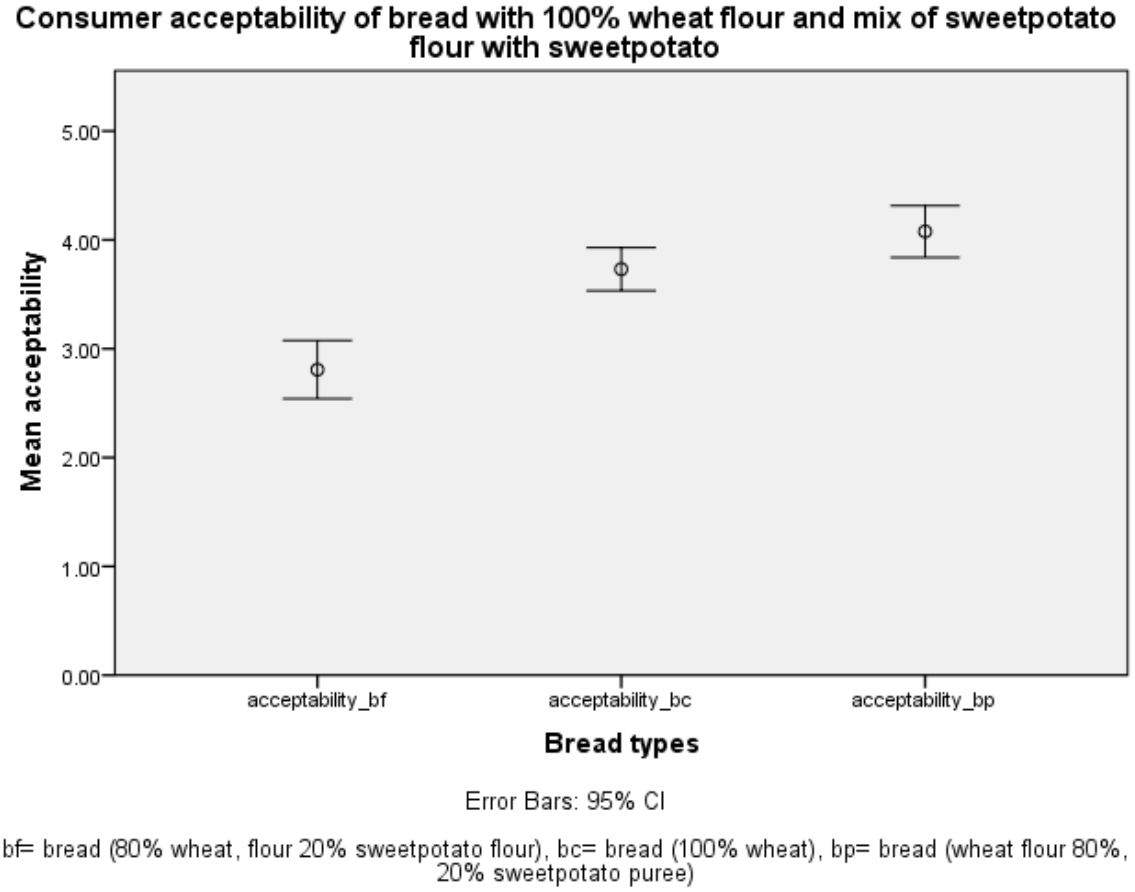

Figure 1: Consumer assessment of normal 100% wheat bread and bread made with a mixture of wheat and sweetpotato flour or puree

The consumer acceptability of cupcakes is as shown in Figure 2. From the results, we find that the mean acceptability of cupcakes made out of 100% wheat was slightly higher than that of cakes made with 60% wheat flour and 40% sweetpotato puree but the difference was not significant since the error bars overwrap. However, panelists clearly preferred these two types of cupcakes compared to those made with 60% wheat flour and 40% sweetpotato flour.

The ratings for doughnuts are presented in Figure 3. Panelists rated doughnuts made with 60% wheat flour and 40% sweetpotato puree higher than the normal doughnuts made with 100% wheat flour and the ones made with 60% wheat flour and 40% sweetpotato flour. However, looking at the error at 95% confidence interval we cannot clearly state that normal doughnuts with 100% wheat flour were more or less preferred compared to the other types of doughnuts.

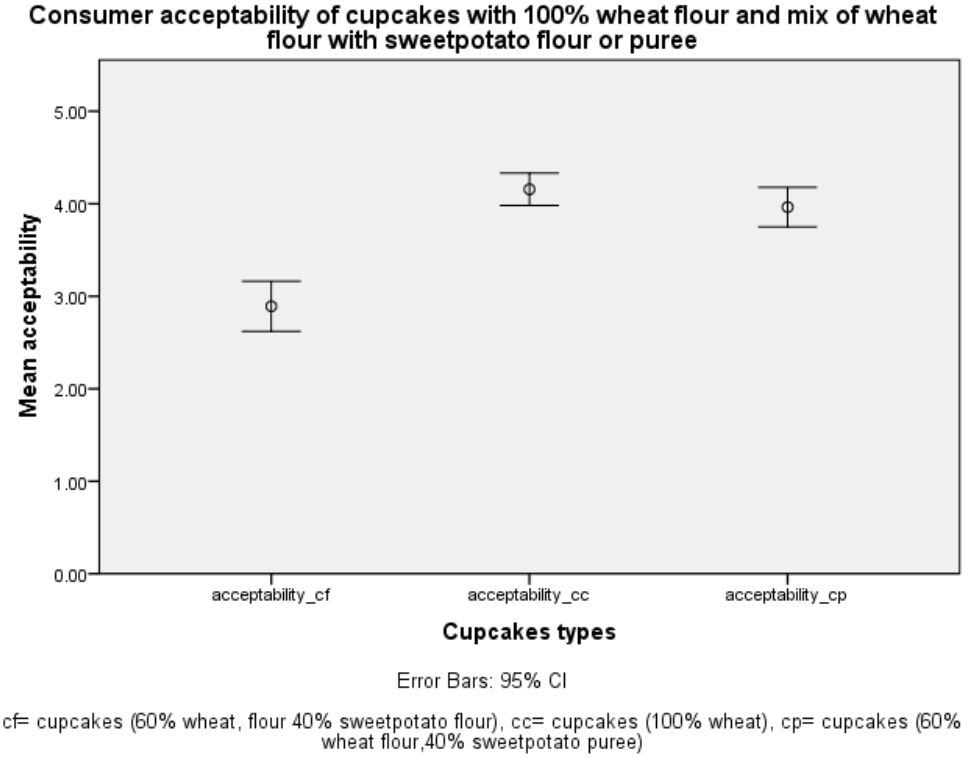

Figure 2: Consumer assessment of normal cupcakes and cupcakes made with a mixture of wheat and sweetpotato flour or puree

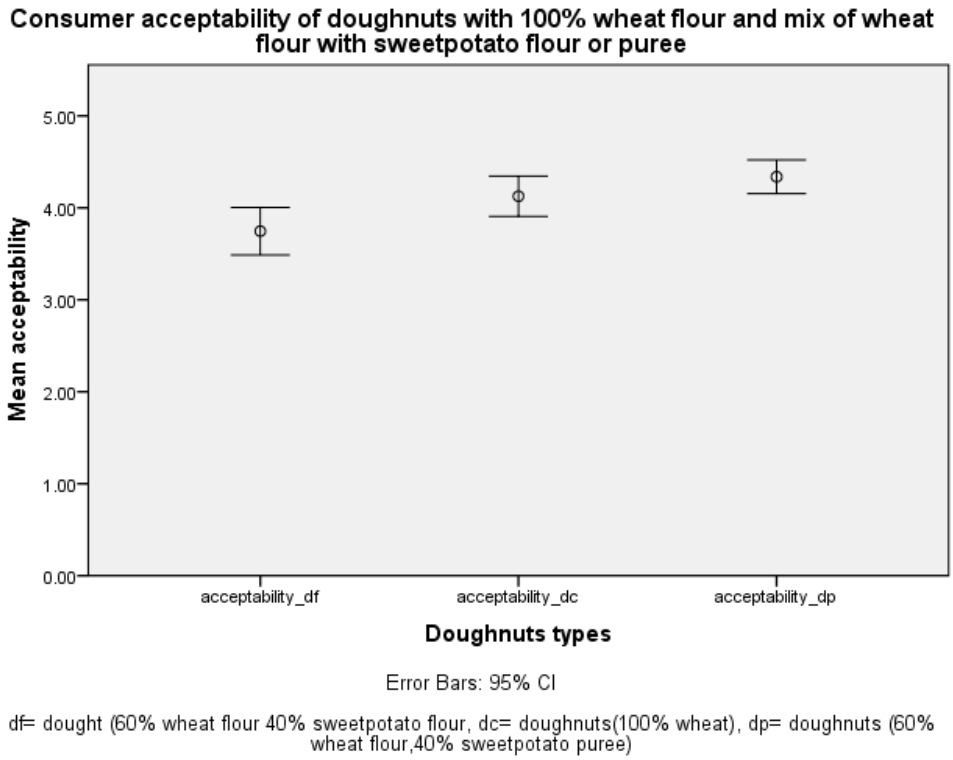

Figure 3: Consumer assessment of normal doughnuts and two types of doughnuts made with a mixture of wheat and sweetpotato flour or puree

Consumer ratings for biscuits are shown in Figure 4. The biscuits made from a mixture of wheat flour and either sweetpotato puree or flour had higher mean acceptability scores than those made from wheat flour only. However, since the error bars overlap, there is no clear pattern of preference among the three types of biscuits.

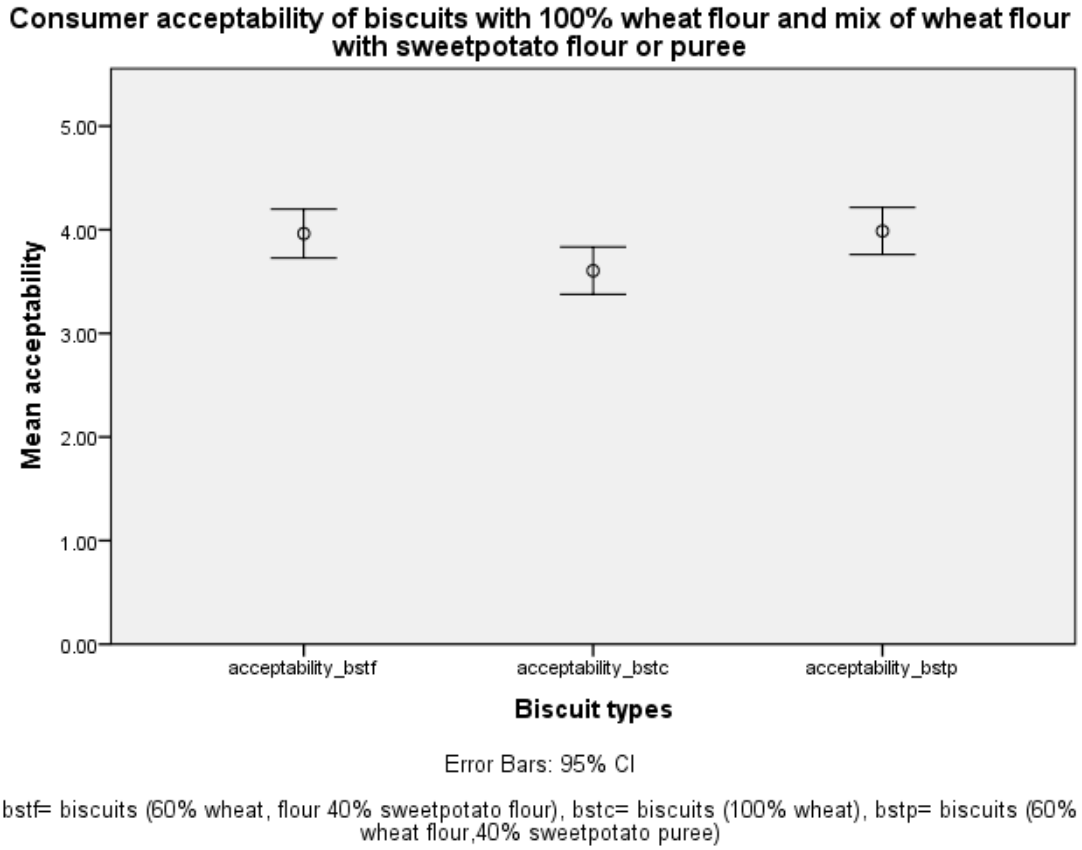

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Figure 4: Consumer assessment of normal biscuits and two types of biscuits made with a mixture of wheat and sweetpotato flour or puree

We then tested the mean differences of the scores given for the products using pair-wise t tests. This is appropriate because the same panelists tasted the control (normal) products made using 100% wheat and the treated products containing a percentage of either sweetpotato flour or puree. Results in Tables 1 and 2 for tests on bread show that differences in means were all statistically significant. Therefore, the panelists clearly preferred bread made with 80% wheat and 20% sweetpotato puree over the other two types of bread. The least preferred bread was that prepared using a combination of wheat and sweetpotato flour. This pattern obeys law of transitivity of utility.

Table 1: Bread acceptability: paired sample statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	SP flour	2.8077	78	1.18495	.13417
	Control	3.7308	78	.87791	.09940
Pair 2	Control	3.7308	78	.87791	.09940
	SP puree	4.0769	78	1.05399	.11934
Pair 3	SP flour	2.8101	79	1.17752	.13248
	SP puree	4.0886	79	1.05235	.11840

Table 2: Paired sample t tests of bread with 100% wheat and others made using a mixture of wheat flour with either 20% sweetpotato flour or puree

		Paired differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	SP flour Control	-.92308	1.40287	.15884	-1.23937	-.60678	-5.811	77	.000
Pair 2	Control SP puree	-.34615	1.29762	.14693	-.63872	-.05359	-2.356	77	.021
Pair 3	SP flour SP puree	-1.27848	1.63250	.18367	-1.64414	-.91282	-6.961	78	.000

The mean differences in acceptability between different pairs of cupcakes are shown in Tables 3 and 4. The differences in acceptability between cupcakes made with sweetpotato flour and the control as well as cupcakes made with sweetpotato puree and the sweetpotato flour were statistically significant. This implies that the panelists preferred cupcakes made with 100% wheat flour compared to those made using a mix of wheat and sweetpotato flour, and also cupcakes made with a mix of wheat flour and sweetpotato puree to those containing both wheat and sweetpotato flour. However, the panelists were indifferent between cupcakes made with 100% wheat flour and those containing a mix of wheat flour and sweetpotato puree.

Table 3: Cupcakes acceptability: paired sample statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Cupcake SP flour	2.8916	83	1.23971	.13608
	Cupcake control	4.1566	83	.80368	.08822
Pair 2	Cupcake control	4.1566	83	.80368	.08822
	Cupcake SP puree	3.9639	83	.98086	.10766
Pair 3	Cupcake SP flour	2.8916	83	1.23971	.13608
	Cupcake SP puree	3.9639	83	.98086	.10766

Table 4: Paired sample t tests of cupcakes made with 100% wheat flour and others made using a mixture of wheat flour with either 40% sweetpotato puree or flour

		Paired differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Cupcakes SP flour Cupcakes control	-1.26506	1.51484	.16628	-1.59583	-.93429	-7.608	82	.000
Pair 2	Cupcakes control Cupcakes SP puree	.19277	1.06448	.11684	-.03966	.42521	1.650	82	.103
Pair 3	Cupcakes SP flour Cupcakes SP puree	-1.07229	1.45488	.15969	-1.38997	-.75461	-6.715	82	.000

Results in Tables 5 and 6 show that the panelists preferred control doughnuts compared to those doughnuts made with a mix of wheat and sweetpotato flour. Also, there was greater preference for doughnuts made with a mix of wheat flour and sweetpotato puree than for those made with a mix of wheat and sweetpotato flour. However, there was no statistically significant difference in acceptability scores for doughnuts made with 100% wheat flour and those made out of a mixture of wheat flour and sweetpotato puree.

Table 5: Doughnuts acceptability: paired sample statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Doughnuts sp flour	3.7500	72	1.08446	.12780
	Doughnuts control	4.1389	72	.92395	.10889
Pair 2	Doughnut control	4.1268	71	.92473	.10975
	Doughnuts sp puree	4.3380	71	.77356	.09180
Pair 3	Doughnuts sp flour	3.7465	71	1.09177	.12957
	Doughnuts sp puree	4.3380	71	.77356	.09180

Table 6: Paired sample t tests of doughnuts made with 100% wheat flour and others made using a mixture of wheat flour with either 40% sweetpotato puree or flour

		Paired differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Doughnuts sp flour Doughnuts control	-.38889	1.44919	.17079	-.72943	-.04835	-2.277	71	.026
Pair 2	Doughnuts control Doughnuts sp puree	-.21127	1.10732	.13141	-.47337	.05083	-1.608	70	.112
Pair 3	Doughnuts sp flour Doughnuts sp puree	-.59155	1.32641	.15742	-.90550	-.27759	-3.758	70	.000

Consumer acceptability for biscuits is as shown in Tables 7 and 8. Results indicate that panelists preferred biscuits made out of a mixture of wheat flour and either sweetpotato flour or puree than those made using 100% wheat flour. Nevertheless, there was no significant difference in preference for biscuits made with a mix of wheat flour and either sweetpotato puree or flour.

Table 7: Biscuits acceptability: paired sample statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Biscuit SP flour	3.9630	81	1.06589	.11843
	Biscuit control	3.6049	81	1.03294	.11477
Pair 2	Biscuits control	3.6049	81	1.03294	.11477
	Biscuits sp puree	3.9877	81	1.03070	.11452
Pair 3	Biscuits sp flour	3.9630	81	1.06589	.11843
	Biscuits sp puree	3.9877	81	1.03070	.11452

Table 8: Paired sample t tests of biscuits made with 100% wheat flour and others made using a mixture of wheat flour with either 40% sweetpotato puree or flour

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Biscuit sp flour Biscuit flour	.35802	1.21767	.13530	.08878	.62727	2.646	80	.010
Pair 2	Biscuit control Biscuit sp puree	-.38272	1.54570	.17174	-.72450	-.04093	-2.228	80	.029
Pair 3	Biscuit sp flour Biscuit sp puree	-.02469	1.47458	.16384	-.35075	.30136	-.151	80	.881

Econometric Results

The preceding descriptive results indicate that in some cases, panelists preferred sweetpotato based products, particularly the puree compared to the control products. We then wanted to determine what the panelists considered as the most important product characteristics that informed the overall product acceptability. Using ordered logit we ran regressions on each of the puree products with acceptability score being the dependent variable in each case. The results are presented in Table 9. The only statistically significant factor in bread acceptability was flavor, while for doughnuts none of the product characteristics was found to be statistically significant. However, increase in age of panelists lowered the likelihood of liking the doughnuts. The location of the panelist was important and in this case we compared panelists from Lycee Girls secondary school and KIST university. Being young and female increased acceptability of doughnuts with sweetpotato puree. For cupcakes, colour, structure and flavor of the product were significant factors that influenced overall acceptability. In the case of biscuits, flavor was the only significant product characteristic.

Table 9: Ordered Logit analysis of factors affecting consumer acceptability of puree products

	(1)	(2)	(3)	(4)
	Bread	Doughnuts	Cakes	Biscuits
Colour	0.062	-0.182	0.886***	0.539
	(0.15)	(0.69)	(2.88)	(1.55)
Shape	0.002		-0.002	0.075
	(1.11)		(1.28)	(0.28)
Structure	0.204	-0.001	0.695**	0.001
	(0.58)	(0.94)	(2.30)	(0.38)
Flavor	2.772***	0.191	1.082***	0.933***
	(5.85)	(0.72)	(3.33)	(2.86)
Texture	-0.001	-0.001	0.005	-0.007
	(0.34)	(0.39)	(0.12)	(0.79)
Age	0.001	-0.001*	0.001	-0.001
	(0.84)	(1.86)	(1.18)	(1.44)
Lycee Girls School (=1)	0.961	0.907*	-0.740	-0.441
	(1.69)	(1.87)	(1.51)	(0.85)
Tenderness			-0.002	
			(1.24)	
Observations	84	85	86	74
Absolute value of z statistics in parentheses				
* significant at 10%; ** significant at 5%; *** significant at 1%				

Cost analysis of substituting sweetpotato puree for wheat flour

An analysis of cost savings associated with substitution of varying percentages of wheat flour with sweetpotato puree in four different commercially produced and marketed bakery products was conducted. Results showed significant cost savings per unit of product (Table 10). This suggests that sweetpotato puree can be a good substitute for wheat flour in the analyzed products. Such substitution confers a number of benefits namely reduced production costs and product (food) prices, and provision of commonly consumed products with significant daily requirement of vitamin A.

Table 10: Costs savings associated with substitution of varying percentages of wheat flour with sweetpotato puree

Product	Percentage of wheat flour replaced with sweetpotato puree	Percentage of costs saved per unit of product
Doughnuts	30	14
Queen cakes	40	10
Biscuits	39	9
Bread	34	20

Conclusions

Rwanda is a highly densely populated country where urbanization is increasing at a high rate, and where fresh sweetpotato is considered a poor man's crop by urban consumers. Urbanization implies that there is a growing demand for wheat-based products, among other food items, but wheat flour is relatively expensive and its world price is steadily increasing. However, sweetpotato has been shown to replace up to 50% of wheat flour in many bakery products. Orange-fleshed sweetpotato (OFSP) varieties rich in Beta-Carotene, a precursor of vitamin A are one of the least expensive sources of dietary vitamin A in Sub-Saharan Africa, and can also substitute for wheat flour in baked products. One major question is how its effective use can be expanded among urban African consumers. Access to sweetpotato roots in urban areas in Rwanda is through wet-markets that preclude many high-end urban consumers. One solution is to develop products incorporating OFSP into products typically consumed by middle income urban consumers (such as baked products) having enough beta-carotene to supply significant amounts of vitamin A. Viable products would preferably have lower production costs, greater consumer acceptability and a nutritious edge over regular products.

In Rwanda, we produced four products using a commercial bakery, using different combinations of ingredients: wheat-flour only; mixture of wheat-flour and OFSP-flour; and mixture of wheat-flour and OFSP-puree. The findings of this study indicate that in a number of cases, panelists preferred baked products containing sweetpotato puree compared to those made from 100% wheat flour. This implies that, sweetpotato puree can be a good substitute of some percentage of wheat for the analyzed products, helping to bring down production costs and food prices, and offering more nutritious food.

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