NUTRITIONAL EVALUATION AND CONSUMER ACCEPTABILITY OF BISCUITS MADE FROM BLENDS OF ORANGE SWEET POTATO (OSP) PUREE AND WHEAT FLOUR

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ABSTRACT

The potential of biofortified Orange Sweet Potato (OSP) has been successfully evaluated in the search of interventions to reduce the burden of Vitamin A deficiencies. Production of biscuits with inclusion of OSP, particularly its puree, to improve pro-vitamin A intake (through its high β-carotene) has not been fully explored. This study therefore evaluated nutrient and anti-nutrient composition of biscuits produced from different ratio blends of OSP puree-Wheat flour and also tested their acceptability. Varying proportions of OSP puree-Wheat flour: 10:90 (A2), 20:80 (A3), 30:70 (A4), 40:60 (A5), were evaluated. Proximate, β-carotene, mineral, phytate, and tannin content were determined. The moisture, protein, fat, ash and carbohydrate content of the biscuits ranged thus: 9.41– 15.27%, 11.56–13.10%, 5.19–6.69%, 0.61–0.97% and 62.20–68.43% respectively. Substitution increased β-carotene from 1.81 µg/g in 100% wheat to 8.78 µg/g in sample A5. Additionally, substitution lowered anti-nutrient content (phytate and tannins) from 10.30mg and 11.94GAE in 100% wheat to 4.10mg and 6.30GAE in the biscuits. These increases and decreases were found to be statistically significantly ($p<0.05$). Sensory attributes of the OSP blends showed that the 30:70 and 10:90 proportions had highest and lowest overall acceptability respectively. Overall, this study shows that addition of OSP puree to wheat flour to produce biscuits improved the β-carotene contents of the resulting products. Willingness to buy/feed children also indicate a favourable stance towards the new products. These biscuits can be used as food vehicles in addressing deficiencies of Vitamin A which are still common among children in Sub-Saharan Africa.

Keywords: Biscuits, Children, Consumer acceptability, Potato, β-carotene

INTRODUCTION

Vitamin A deficiency (VAD) is still a prevalent public health problem in developing countries with an estimated 250 million preschool children being vitamin A deficient and a further estimate of about half a million of the children becoming blind every year (World Health Organization (WHO), 2018). In Nigeria, VAD has been implicated in recurrent infections which considerably increase the risk of severe illness and death, particularly diarrheal diseases, measles and undernutrition in children (WHO, 2018). Among several strategies being deployed to reduce this deficiency, biofortification is recognized as a sustainable approach to addressing micronutrient malnutrition by increasing the density of vitamins and minerals in a crop through either conventional plant breeding, agronomic practices or biotechnology (Bouis *et al.*, 2013; Listman *et al.,* 2019).

Biofortification efforts have found success with staples (such as cassava, maize and sweet-potato) which are commonly consumed in sub-Saharan Africa (Bouis and Saltzman, 2017; Listman *et al.,* 2019). Sweet potato is a popular root crop in Nigeria, mainly because of its ability to thrive in a typical sandy loamy soil and its broad agro-ecological adaptability (Low, 2013). It is a low input, low risk crop that is mainly grown for consumption of its processed roots and in few cases its leaves.

Production occurs in most Nigerian agro-ecological zones and also has a short production cycle (3 – 4 months) while its roots and vines can also be used for animal consumption (Low, 2013). It has the white, yellow, cream, purple and orange varieties (Low, 2013). In Sub Saharan Africa, the dominant varieties currently grown are white or yellow – fleshed and not the orange – fleshed. Orange sweet potato (OSP) refers to the varieties of sweet potato (*Ipomoea batatas*) that are rich in β-carotene, a vitamin A precursor and is a flagship crop among the roots and tubers to combat Vitamin A deficiency (Laurie *et al.,* 2015; Neela and Fanta, 2019). Nigeria is Africa's largest producer and second largest globally with an annual average production capacity of 3.5 metric tonnes (Bouis *et al*. 2013; Bouis and Saltzman, 2017).

Research evidence (Mitra, 2012; Tanumihardjo *et al*. 2017) had also proven the bioefficacy of OSP, thus confirming it could play a significant role in developing countries as a viable long-term food-based strategy for controlling vitamin A deficiency in VAD populations. Previous experiments on substitution have found some success with using orange sweet potato (OSP) in the form of its flour to enrich baked products (Okorie and Onyeneke 2012; Laelago *et al.,* 2015; Kolawole *et al*. 2020). Despite the reported literature on the utilization of sweet potato flour, the use of OSP puree for making bakery products biscuits is still not fully explored (Owade *et al.*, 2018). Since snacks constitute a major proportion of daily energy intake among young children across the world (Wang *et al.,* 2018), this opens up an opportunity to substitute popular wheat-based snacks with ingredients which could provide added nutritional value for children. Improving the nutritional quality of commonly consumed snacks by children could then help reduce the burden of micronutrient deficiencies such as VAD.

Even though the production of biscuits is based on wheat flours, biscuits can also be prepared by incorporating sweet potato flours to wheat flour (Srivastava *et al*. 2012). It has been reported that sweet potato flour was found useful as a dough conditioner for bread, biscuit and cake processing as well as in gluten-free pastry products (Omran and Hussein, 2015). The use of OSP puree is particularly of interest due to its confirmed higher carotene retention as compared to its flour and dried chips (Muzhingi *et al*. 2016; Chilungo *et al.*, 2019).

This study therefore aimed to develop pro-vitamin A rich biscuits from blends of Wheat and OSP puree, determine their nutrient and anti-nutrient content and assess the acceptability of these biscuits among mothers catering for children of 6 – 24 months.

MATERIALS AND METHODS

Purchase of OSP roots and Biscuit ingredients

Mature orange sweet potato (OSP) roots were purchased from a farm in Ilorin East, Kwara state, North Central Nigeria. The OSP roots were packed in sacks and transported to the dietetics kitchen of the Department of Human Nutrition and Dietetics, University of Ibadan, Ibadan, Nigeria. The roots were processed under 24 hours after harvest. The wheat flour and other ingredients for biscuit production were purchased from Bodija Market, Ibadan Nigeria.

Processing of OSP into Puree and preparation of Wheat-OSP blends

The method followed by Chilungo *et al.*, (2019) in producing OSP puree was followed. The OSP roots were washed in water and then peeled. They were sliced into cubes, steamed in boiling water for an hour; they were then allowed to cool before mashing. Four different blends of OSP puree and wheat flour was prepared. Hundred grams of wheat flour was used as control. As the case applied, OSP puree with wheat flour were weighed and mixed with 100ml water to form a slurry which formed the base to which other ingredients were added for biscuit preparation. The OSP biscuits were processed from OSP puree and wheat flour blends of ratios: 90/10, 80/20, 70/30; 60/40.

Preparation of biscuits

Biscuits were prepared using the recipes described by Srivastava *et al.*, (2012). The ingredients used in the development of biscuits were orange sweet potato puree, wheat flour, egg (26ml), milk (16ml), sugar (12g), margarine (10g), baking powder (2g), flavor (1g) and a pinch of salt was added to all samples. All the different blends of the biscuit were baked at the same temperature (170^{o} Celsius) and baked for the same time (20 minutes).

Laboratory Analysis

The first phase of the study was completed with a laboratory analysis of the formulated biscuits to determine nutrient and anti-nutrient composition. Proximate analysis for moisture content protein, fat, ash, mineral and anti-nutrients determination was determined according to the standard methods of Association of Official Analytical Chemists (AOAC, 2005). Carbohydrates content was calculated by difference. Iron (Fe), calcium (Ca), magnesium (Mg) and zinc (Zn) were determined using a standard method (AOAC, 2005). The method described by Kimura and Rodriguez-Amaya (2003) was followed for β-carotene determination. For tannin and phytate analysis, the method described by Ogungbenle and Otemuyiwa (2015); Adediran *et al.* (2017) were adopted.

Acceptability test

The second phase of this study was carried out to test acceptability of the formulated biscuits among selected mothers. Mothers who had at least a child aged 6-24 months were respondents used in this study. Mothers were selected purposively from the attendees at an immunization center of the University Health Services, University of Ibadan. A preference test questionnaire using a nine-point hedonic scale was used to assess product acceptability as described by Meilgaard and Civile (2007).

The 9-point hedonic scale was described as follows: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely. Mothers' willingness to buy and/or feed the products was also tested. The mothers were also asked whether they would be willing to feed their babies with each of the formulated biscuits using a yes or no response. They were instructed to rinse their mouths with water that was provided after tasting each sample.

Ethical considerations

Approval for the acceptability study was obtained from the University of Ibadan/University College Hospital (UI/UCH) ethical review committee. Verbal informed consent was obtained from the respondents after they had been informed about the objectives of the study.

Statistical analysis

Descriptive statistics such as frequencies, percentages, were used to present results as analyzed by using Statistical Package for Social Sciences (SPSS) version 21. The laboratory results were expressed as mean of triplicates ± standard deviation. Inferential statistics such as Analysis of Variance (ANOVA) and Duncan's Post-hoc test was used to separate the means. The level of statistical significance for all tests was $p<0.05$

RESULTS

Proximate composition of the developed biscuits

Results from proximate composition of the developed biscuits are presented in Table 1 and it showed that the levels of protein in all the blends ranged from 11.56 – 13.10g/100g, for fat (5.19 – 6.69g/100g), and for carbohydrate (62.20 – 68.43g/100g). The biscuit used as control (100% wheat) had the highest value for protein and ash. The composition 40% OSP and 60% wheat flour (A5) had the least value for protein. The moisture contents of blends from OSP puree and wheat flour biscuits were significantly ($p < 0.05$) higher than the A1 (control, 10.55 ± 0.06%) as shown in Table 1. The ash content of the 100% wheat flour (control-A1) (0.97 ± 0.01%) was significantly ($p < 0.05$) higher than the other blends.

The results of this study revealed that the crude protein content of the blends was significantly ($p < 0.05$) lower than the (control) except the 10% OSP and 90% wheat flour (A2) where the value was the same with the control. The 10% OSP and 90% wheat flour (A2) had the same value of protein with A1, and the highest value for carbohydrate. The carbohydrate content of 10% OSP and 90% wheat flour (A2) biscuits (68.43%) were higher than the 100% wheat flour A1 (control) biscuit (67.25%). The 40% OSP and 60% wheat flour (A5) had the least value for carbohydrate. The crude fiber content of OSP substituted biscuits were significantly ($p < 0.05$) higher than the 100% wheat flour biscuit.

TABLE 1 Proximate Composition of The Developed Biscuits

Composition	A1	A2	A3	A4	A5
Moisture (g/100g)	10.55 ± 0.06^{b}	9.41 ± 0.02^{a}	14.9 ± 0.03^{d}	15.08 ± 0.13^{c}	15.27 ± 0.03^{e}
Protein (g/100g)	13.10 ± 0.05^{b}	13.10 ± 0.05^{b}	11.67 ± 0.13^{a}	11.63 ± 0.48^{a}	11.56 ± 0.08^{a}
Fat (g/100g)	6.35 ± 0.05^{c}	6.69 ± 0.04^{c}	6.50 ± 0.01^{d}	5.60 ± 0.01^{b}	5.19 ± 0.01^{a}
Crude Fiber (mg/100g)	1.78 ± 0.04^{a}	1.88 ± 0.15^{a}	2.73 ± 0.08^{b}	2.99 ± 0.01^{b}	3.43 ± 0.24^{c}
Ash (g/100g)	0.97 ± 0.01^{d}	0.69 ± 0.01^{b}	0.61 ± 0.01^{a}	0.7 ± 1.36^{b}	0.85 ± 0.05^{c}
Carbohydrate (mg/100g)	67.25 ± 1.14^{c}	68.43 ± 0.02^{c}	64.93 ± 1.55^{b}	64.00 ± 0.04^{b}	62.20 ± 0.08^{a}
β-carotene (ug/g)	1.81 ± 0.00^{a}	7.38 ± 0.00^{b}	8.39 ± 0.00^{cd}	8.41 ± 0.00^{cd}	8.78 ± 0.00^{e}
Calcium (mg/100g)	35.00±0.05^{c}	32.04±0.04^{a}	34.03±0.02^{b}	35.05±0.02^{c}	44.00±0.35^{d}
Iron (mg/100g)	1.59±0.02^{cd}	1.79±0.01^{de}	0.84±0.00^{a}	0.89±0.03^{ab}	0.88±0.01^{ab}
Zinc (mg/100g)	1.94±0.01^{c}	1.42±0.04^{b}	0.95±0.01^{b}	0.97±0.08^{a}	0.99±0.01^{a}
Magnesium (mg/100g)	16.30±0.01^{d}	14.91± 0.03^{c}	14.62±0.01^{b}	14.43±0.58^{a}	14.24±0.55^{a}
Phytates (mg/100g)	10.30± 0.00^{c}	6.20± 0.00^{b}	6.20± 0.00^{b}	6.20± 0.00^{b}	4.10± 0.00^{a}
Tannins (GAE/100g)	11.94± 0.00^{e}	8.87± 0.00^{d}	7.28± 0.00^{c}	8.13± 0.00^{a}	6.30± 0.00^{b}

Where A1 = 100% wheat, A2 = 10% OSP / 90% Wheat, A3 = 20% OSP / 80% Wheat, A4 = 30% OSP / 70% Wheat, A5 = 40% OSP / 60% Wheat.

Values are mean ± standard deviation. Values within the same row with different superscript letters are significantly different from each other ($p < 0.05$).

Micronutrient contents of the developed biscuits

The micronutrient contents of the developed biscuits are also presented in Table 1. The composition 40% OSP and 60% wheat flour (A5) had the highest β-carotene content with value (8.78 ug/g). The β-carotene composition of 100% wheat flour A1 (control) biscuit was lowest and had a value of 1.81 ug/g. The values for calcium and iron ranged from 32.04±0.04 (A2) to 44.00±0.35 mg/100g (A5) and 0.84±0.00 (A3) to 1.79±0.01 mg/100g (A2) respectively. Also, the values for zinc and magnesium ranged from 0.95±0.01 (A3) to 1.94±0.01 mg/100g (A1) and 14.24± 0.55 (A5) to 16.30±0.01 mg/100g (A1) respectively. The composition of 10% OSP puree and 90% wheat flour had the highest values for iron. However, those values were followed by the 100% wheat composition (A1). For iron, 20% OSP and 80% wheat flour (A3) had the least value. While for calcium content there was a gradual increase with substitution.

Anti-nutrients content of the developed biscuits

The antinutrients contents of the developed biscuits are presented in Table 1. The phytate contents of biscuits ranged from 4.10 to 10.30mg/100 g. The phytate content of 100% wheat flour A1 (control) biscuit was significantly ($p < 0.05$) higher than the other blends. The composition 100% wheat flour had the highest values for both phytates and tannins. For phytates, A2, A3 and A4 had the same values while A5) had the lowest value which corresponded with the highest proportion of OSP. The tannins content of the products significantly reduced with substitution as found in A1 (control) having a higher content than the other blends.

TABLE 2 SENSORY PREFERENCE TEST FOR THE MOTHERS (N=31)

	A1	A2	A3	A4	A5
Taste	7.45 ± 1.65^{c}	7.13 ± 2.21^{a}	7.26 ± 1.61^{b}	7.45 ± 1.89^{c}	7.45 ± 1.71^{c}
Color	6.97 ± 1.7^{a}	6.58 ± 2.13^{a}	7.26 ± 1.23^{b}	7.26 ± 1.63^{b}	7.42 ± 1.26^{b}
Texture	6.90 ± 2.00^{d}	6.10 ± 2.50^{a}	6.16 ± 2.02^{a}	6.65 ± 1.99^{bc}	6.39 ± 2.45^{b}
Aroma	7.26 ± 1.6^{b}	6.97 ± 1.45^{a}	7.48 ± 0.93^{c}	7.42 ± 1.31^{bc}	7.03 ± 2.07^{b}
Overall acceptability	7.29 ± 1.35^{c}	7.00 ± 1.79^{a}	7.10 ± 1.42^{b}	7.19 ± 1.47^{ab}	7.16 ± 1.53^{ab}

Where A1 = 100% wheat, A2 = 10% OSP / 90% Wheat, A3 = 20% OSP / 80% Wheat, A4 = 30% OSP / 70% Wheat, A5 = 40% OSP / 60% Wheat.

Values are mean ± standard deviation. Values within the same row with different superscript letters are significantly different from each other ($p < 0.05$).
1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely

Preference tests

The results of mean values ± standard deviation of the acceptability scores after testing the developed biscuits are shown in Table 2. The acceptability results using a nine-point hedonic scale showed that the biscuits were acceptable in taste, colour, texture, flavour, aroma and overall acceptability. The overall acceptability test score of the biscuits was within an acceptable range of 7.00±1.79 to 7.29±1.35 ($p<0.05$). The results showed that the 100% wheat flour A1 (control) biscuit scored the highest (7.29 ± 1.35) and 10% OSP and 90% wheat flour (A2) biscuits scored the lowest (7.00±1.79) values for overall acceptability. Also, for taste, the results showed that the 100% wheat flour A1 (control) biscuit scored the highest (7.45±1.65) and 10% OSP and 90% wheat flour (A2) biscuits scored the lowest (7.13±2.21) values. The taste score for different blends were significantly ($p < 0.05$) different except for biscuits in A4 and A5 having the same value. The biscuit prepared from 100% wheat was also found to be having texture value (6.90±2.00) which is significantly ($p < 0.05$) higher than others, while the lowest value was recorded for A2 (6.10±2.50). The aroma values of biscuits developed from the 40% OSP and 60% wheat flour (A3) was highest (7.48±0.93), while biscuit in 10% OSP and 90% wheat flour (A2) biscuits was lowest (6.97±1.45). The colour of the developed biscuits from 30% OSP and 70% wheat flour (A5) was the most acceptable (7.42±1.26) while 10% OSP and 90% wheat flour (A2) biscuit was the lowest (6.58±2.13).

TABLE 3 WILLINGNESS TO FEED AND BUY BISCUIT SAMPLES (N=31)

Willingness to feed child with the biscuit samples?					
SAMPLES	**A1**	**A2**	**A3**	**A4**	**A5**
YES (%)	23 (74.2)	23 (74.2)	24 (77.4)	25 (80.6)	24 (77.4)
NO (%)	8 (25.8)	8 (25.8)	7 (22.6)	6 (19.4)	7 (22.6)
Willingness to buy the biscuit samples?					
SAMPLES	**A1**	**A2**	**A3**	**A4**	**A5**
YES (%)	24 (77.4)	24 (77.4)	23 (74.2)	25 (80.6)	24 (77.4)
NO (%)	7 (22.6)	7 (22.6)	8 (25.8)	6 (19.4)	7 (22.6)

A1 = 100% wheat, A2 = 10% OSP / 90% Wheat, A3 = 20% OSP / 80% Wheat, A4 = 30% OSP / 70% Wheat, A5 = 40% OSP / 60% Wheat.

Willingness to buy and feed children with the biscuit samples

The responses given by the mothers are presented in Table 3. More than half of the respondents (74.2%) were willing to feed products A1 and A2 to their children. For A3 and A5, 77.4% were willing to feed their children with them while 80.6% of the respondents were willing to feed their children with A4. The responses given by the mothers on willingness to buy the biscuits are also presented in Table 3. Most of the respondents (77.4%) were willing to buy A1, A2 and A5 for their children. For A3, 74.2% were willing to buy the biscuits for their children while 80.6% of the respondents were willing to buy biscuit sample A4 for their children.

DISCUSSION

This study was designed to develop and determine the acceptability of biscuits made from orange – fleshed sweet potato puree and wheat flour blends. The comparative proximate composition of the different biscuits produced changed as the proportion of OSP puree increased in the blends. The exception to an upward trend was the protein composition. Expectedly, the increase in pro-vitamin A content was the most improved with increased substitution, whereas, tannins and phytate contents generally decreased with addition of OSP puree.

With the exception of protein contents, results from this study revealed that the levels of protein, fat, and carbohydrate of the developed biscuits in the different blends were within similar range from previous studies that had attempted product formulation and substitution using orange sweet potato (Mahmoud and Anany, 2014; Neela and Fanta, 2019; Kolawole *et al.*, 2020). Specifically, the result of this study revealed that the moisture contents of OSP puree and wheat flour biscuits were significantly ($p < 0.05$) higher than that of the control biscuits which means moisture content increased as the proportion of OSP puree increased in the blends. The reason for this trend is related to the hygroscopic nature of flours made from root crops which causes them to absorb water easily. In terms of the shelf life of the products, this higher moisture may be unfavourable since higher water activity may increase spoilage time.

The ash content of the 100% wheat flour (control) was significantly ($p < 0.05$) higher than the other blends, however, the result also showed that as the OSP puree proportion increased in the composite blends, the ash contents of the blend increased. This observation is in concordance with results presented by a similar attempt of OSP substitution reported by Okorie and Onyeneke (2012). The reduced protein contents of the developed biscuits with addition of OSP puree proportion in the blends is not a new observation. Previous studies have reported that OSP being a root crop (with relatively low protein), will reduce the cumulative protein value of the mixtures (Singh *et al.*, 2013; Laelago *et al*., 2015).

The values of fat content in blend proportion did not really show a progressive increment with addition of OSP puree to wheat flour. The result of this study contradicted a similar experiment by Laelago *et al*. (2015) where results indicated an increase in fat content of blend proportions due to addition of OSP and that reported fats were present in a smaller extent in wheat than OSP. Generally, the fat content of roots and tubers especially OSP is low (Neela and Fanta, 2019) and therefore may not have been efficiently extracted during the analysis. There was an observable higher fiber content in OSP substituted compositions than 100% wheat flour. This is confirmed from previous literature (Singh *et al.*, 2013) where the crude fiber values of cookies increased when more OSP was added to the wheat. However, results from this study show that the values for crude fiber was low compared to a review report (Neela and Fanta, 2019). Variations as found in this study in nutrient composition of the products have been attributed to the botanical origin and diversity of OSP varieties (Laurie *et al*. 2012; Christides *et al*. 2015; Neela and Fanta, 2019).

Regarding the micronutrient composition of the biscuits, there was an observable good retention of minerals even after processing. However, there was no major observable improvement in the mineral content with increased substitution (with the exception of calcium). In this study, the most improved nutritional component across the different levels of substitutions was the pro-vitamin A composition (β-carotene). This outcome found semblance in studies reported in literature (Laelago *et al.*, 2015; Kolawole *et al.*, 2020) where the β-carotene content of cookies increased with addition of OSP compared to the control (100% wheat). In African diets which are mainly plant based, foods rich in β-carotene are the major source and precursor of dietary vitamin A. These foods when minimally processed as with the OSP puree, could also retain more β-carotene.

Food based approaches which can increase this vitamin A or pro-vitamin A intake could provide a sustainable solution to a pressing challenge of VAD (Neela and Fanta 2019). With the β-carotene results presented in this study, consumption of the biscuits from OSP puree and wheat blends with different ratios could be leveraged on, which could contribute to reducing the burden of VAD. The phytate content of the control biscuit was significantly higher than the other blends. It was noticed that the phytate content decreased when more OSP puree was added in the wheat flour. This could be attributed to a similar observation in literature (Christides *et al*., 2015) where phytate found in wheat flour was higher than that of OSP. A decrease in phytate content is expected to generally enhance the bioavailability of nutrients of the food products. This trend was also noticed in the tannins content, as more OSP puree was added in the blends. This trend was also reported by Laelago *et al.*, (2015). Thus, indicating another comparative advantage, the products from this study may offer.

The acceptability results presented in this study using a nine-point hedonic scale showed that the developed biscuits were acceptable in taste, color, texture, flavour, aroma and all the different blends had an overall acceptability. Each developed biscuit blend had different scores for each descriptor but they all fell within the like moderately and like slightly rating. Such acceptability has been reported with bakery products of similar composition (Sindi *et al*., 2012). The participation of mothers has also been reported to successfully assess the consumer acceptance of complementary foods (Muoki *et al*., 2012). The present study's texture scores were in line with the texture value of cookies developed by Singh (2013) in which they reported texture scores decreasing as OSP ratio increased.

The score for aroma in this current study disagrees and was in contrast to results by Laelago *et al*., (2015) where the aroma values of cookies developed from 100% wheat (control) was highest. In this study the value of aroma scores increased as the amount of OSP puree increased in the blends. This could be due to the freshness of the puree as against its flour form and could have positive impact on the mother's willingness to accept the newly developed product. The taste score of cookies decreased as more OSP was supplemented to the wheat flour. Singh (2013) reported similar results of cookie taste decreasing as the amount of OSP supplementation increased in wheat flour.

The overall acceptability value of the cookies decreased when more OSP was added to the wheat flour though the scores were within a narrow range. This may be due to the cumulative results of organoleptic properties of the newly developed biscuits which are new to the mothers. Despite this, it is worthy of note that the overall acceptability of the new product by the mothers was high. Similarly, majority of the mothers who were respondents in this study were both willing to buy the biscuits and to feed their children. The limitation of this study is the preference test which was carried out by the mothers in proxy for their children. The acceptance reported by the mothers may not represent the preference of their children.

CONCLUSION

Overall, this study shows that addition of OSP puree to wheat flour to produce biscuits improved the β-carotene contents of the resulting products. High acceptability and the willingness to buy/feed children indicate a favorable stance towards the new products. However, the study was limited regarding information on contribution to dietary requirements, albeit, the observations from this study show that OSP puree could be leveraged on to serve as a dietary source of pro-Vitamin A in the form of snacks which are commonly consumed by children.

REFERENCES

Adediran, O. A., Avwioro, O. G., Ibikunle, D.E. and Funsho-Agun, A. G., 2017. Histochemical Studies of the Efficacy of an Anti-Ulcer Herbal Mixture on the Gastrointestinal Tract of Albino Rats. *European Journal of Medicinal Plants*, 1 – 11.

AOAC. (2005). International Official Methods of Analysis, 18th ed, AOAC International, Gaithersburg, Maryland, USA (accessed on 8 September 2018).

Bouis, H, Low, J, McEwan, M and Tanumihardjo, S. (2013). *Biofortification: evidence and lessons learned linking agriculture and nutrition*. The Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), 23.

Bouis, H. E and Saltzman, A. (2017). Improving nutrition through biofortification: A review of evidence from HarvestPlus, 2003 through 2016. *Global Food Security*, 12, 49 – 58. https://doi.org/10.1016/j.gfs.2017.01.009

Chilungo, S, Muzhingi, T, Truong, V. D and Allen, J. C. (2019). Effect of processing and oil type on carotene bioaccessibility in traditional foods prepared with flour and puree from orange-fleshed sweet potatoes. *International Journal of Food Science and Technology*, 54(6), 2055 – 2063. https://doi.org/10.1111/ijfs.14106.

Christides, T, Amagloh, F. K and Coad, J. (2015). Iron bioavailability and provitamin A from sweet potato-and cereal-based complementary foods. *Foods*, 4(3), 463 – 476. https://doi.org/10.3390/foods4030463.

Kimura, M, Rodriguez-Amaya, D. B. (2003). Carotenoid composition of hydroponic leafy vegetables. *Journal of Agriculture and Food Chemistry*, 51(9), 2603 – 2607. https://doi.org/10.1021/jf020539b.

Kolawole, F. L, Akinwande, B. A and Ade-Omowaye, B. I. (2020). Physicochemical properties of novel cookies produced from orange-fleshed sweet potato cookies enriched with sclerotium of edible mushroom (*Pleurotus tuberregium*). *Journal of Saudi Society for Agricultural Sciences*, 19(2), 174 – 178. https://doi.org/10.1016/j.jssas.2018.09.001.

Laelago, T, Haile, A and Fekadu, T. (2015). Production and quality evaluation of cookies enriched with β-carotene by blending orange-fleshed sweet potato and wheat flours for alleviation of nutritional insecurity. *International Journal of Food Science and Nutrition Engineering*, 5(5), 209 – 217.

Laurie, S., Faber, M., Adebola, P. and Belete, A. (2015). Biofortification of sweet potato for food and nutrition security in South Africa. *Food Research International*, 76, 962 – 970. https://doi.org/10.1016/j.foodres.2015.06.001.

Laurie, S. M, Van Jaarsveld, P. J, Faber, M, Philpott, M. F, Labuschagne and M. T. (2012). Trans-β-carotene, selected mineral content and potential nutritional contribution of 12 sweet potato varieties. *Journal of Food Composition and*

Analysis, 27(2), 151 – 159. https://doi.org/10.1016/j.jfca.2012.05.005.

Listman, G. M, Guzmán, C, Palacios-Rojas, N, Pfeiffer, W. H, San Vicente, F. and Govindan, V. (2019). Improving nutrition through biofortification: Preharvest and postharvest technologies. *Cereal Foods World*, *64*(3), 1 – 7. https://doi.org/10.1094/CFW-64-3-0025.

Low, J. W. (2013). Biofortified Crops with a Visible Trait: the example of Orange-fleshed Sweetpotato in Sub-Saharan Africa. *In: Handbook of Food Fortification and Health*. Humana Press, New York, NY, 371 – 384. https://doi.org/10.1007/978-1-4614-7076-2_29.

Mahmoud, A. H, Anany, A. M. (2014). Nutritional and sensory evaluation of a complementary food formulated from rice, faba beans, sweet potato flour, and peanut oil. *Food Nutrition Bulletin*, 35(4), 403 – 413. https://doi.org/10.1177/156482651403500402.

Meilgaard, M. C, Civile, G. V. (2007). *Sensory evaluation techniques*, Fourth ed., CRC Press LLc, New York, p 300.

Mitra, S. (2012). Nutritional status of orange-fleshed sweet potatoes in alleviating vitamin A malnutrition through a food-based approach. J. Nutr. Food Sci. 2(8), 160. https://doi.org/10.4172/2155-9600.1000160.

Muoki, P. N, de Kock, H. L and Emmambux, M. N. (2012). Effect of soy flour addition and heat-processing method on nutritional quality and consumer acceptability of cassava complementary porridges. *Journal of Science and Food Agriculture*, 92(8), 1771 – 1779. https://doi.org/10.1002/jsfa.5545.

Muzhingi, T., Mbogo, D., Low, J., Magnaghi, A., Heck, S. and Gule, S. (2016). Effect of Baking on the β-carotene Content of Orange Flesh Sweetpotato (Ipomoea batatas) Puree Bread and OFSP Flour Bread. *FASEB Journal*, Supplement 1, lb433.

Neela, S, Fanta, S. W. (2019). Review on nutritional composition of orange-fleshed sweet potato and its role in management of vitamin A deficiency. *Food Science and Nutrition*, 7(6), 1920 – 1945. https://doi.org/10.1002/fsn3.1063.

Ogungbenle, H. N. and Otemuyiwa, F. F., (2015). Food properties and amino acid composition of Celosia Spicata leaves. *Advances in Analytical Chemistry*, 5, 1-7.

Okorie, S. U, Onyeneke, E. N. (2012). Production and quality evaluation of baked cake from blend of sweet potatoes and wheat flour. *Academic Research International*, 3(2), 171.

Omran, A. A and Hussien, H. A. (2015). Production and evaluation of gluten-free cookies from broken Rice flour and Sweet Potato. Advan. *Food Science*, 37(4), 184-191.

Owade, J. O, Abong, G. O, Okoth, M. W. (2018). Production, utilization and nutritional benefits of Orange Fleshed Sweet potato (OFSP) puree bread: A review. *Current Research in Nutrition and Food Science*, 6, 1 – 2. https://doi.org/10.12944/crnfsj.6.3.06.

Sindi, K, Ndirigwe, J, Mukantwali, C, Low, J. W. and Kirimi, L. (2012). What is the consumers' perception of bakery products made with vitamin A rich sweet potato and wheat? *In: 16th triennial symposium International Society for Tropical Root Crops*, 23- 28 September, 2012, Federal University of Agriculture, Abeokuta, Nigeria.

Singh, S, Riar, C. S, Saxena, D. C. (2013). Effect of incorporating Sweet potato flour to Wheat flour on the quality characteristics of cookies. *African Journal of Food Science*, 2, 65 – 72.

Srivastava, S, Genitha, T. R. and Yadav, V. (2012). Preparation and quality evaluation of flour and biscuit from sweet potato. *Journal of Food Processing Technology*, 3(12), 113 – 118. https://doi.org/10.4172/2157-7110.1000192.

Tanumihardjo, S. A., Ball, A. M., Kaliwile, C. and Pixley, K. V. (2017). The research and implementation continuum of biofortified sweet potato and maize in Africa. *Annals of the New York Academy of Sciences*, 1390 (1), 88 – 103. https://doi.org/10.1111/nyas.13315.

Wang, D., van der Horst, K., Jacquier, E. F., Afeiche, M. C. and Eldridge, A. L. (2018). Snacking patterns in children: A comparison between Australia, China, Mexico, and the US. *Nutrition*, 10(2), 198.https://doi.org/10.3390/nu10020198.

World Health Organization. (2018). Global prevalence of vitamin A deficiency in populations at risk 1995-2005: WHO global database on vitamin A deficiency. https://apps.who.int/iris/handle/10665/44110 (accessed 18 August 2018).