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PRODUCTION AND EVALUATION OF PASTA FROM ORANGE FLESHED SWEET POTATO AND WHEAT FLOUR BLENDS

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ABSTRACT

The world is tending towards fortification of cereal, root and tubers food products to increase and enhance its macro and micronutrients content for her teaming population. This study is aimed at production and evaluation of pasta produced from orange fleshed sweet potato (OFSP) and wheat flour blends. The dried OFSP chips were milled and sieved to pass through 450 □m sieve and was incorporated into wheat flour at levels of 10 – 50% with 100% wheat as the control. The obtained formulated six samples were analyzed for chemical properties, and sensory attributes using a 9-point hedonic scale of preference. All data were subjected to analysis of variance (ANOVA) significant difference were determined at $p<0.05$, while Duncan multiple range test was used to separate the mean. Results showed that moisture content, crude protein, crude fat, crude fibre, total ash, carbohydrate and □-carotene contents of the products obtained ranged from 8.7 to 10.5%, 13.4 to 16.4%, 8.3 to 12.1%, 0.4 to 0.8%, 1.6 to 2.2%, 60.8 to 63.6%, and 0.3 to 8.9 mg/100g, respectively. Sensory attributes result indicated that there is significant different between whole wheat flour WWP and the other blends, however pasta produced from the blends of 20% OFSP with wheat flour had a good sensory attributes comparable with the control sample. The finding shows that nutritionally improved pasta products could be made from a mixture of OFSP and whole wheat flour within the range of 20 – 50% OFSP..

Keywords: β-carotene, fortification, OFSP, pasta, sensory attributes

INTRODUCTION

Pasta is a staple food that is typically made from unleavened dough of durum wheat flour mixed with egg or water and formed into sheets or various shapes, then cooked by steaming or boiling, and can also be made with flours from other cereals or grains (Gapalakrishman *et al.*, 2011). Pasta is largely carbohydrates (mainly as starch), with moderate amounts of protein and manganese. Pasta is a traditional and globally widespread cereal-based food product because of its convenience, nutritional quality, and palatability (Petitot *et al.*, 2009). Durum wheat (*Triticum durum L.*) semolina is considered the best material for making high quality pasta products due to its unique yellow colour, flavour, and cooking quality. Pasta cooking quality is defined by the physical competition between protein coagulation in a continuous network and starch swelling with exudates losses during cooking (Cocci *et al.*, 2008; Delcour *et al.*, 2000). Pasta is a good source of low glycemic index (GI) carbohydrates, a tight network of gluten proteins which entrap starch granules during the mixing and extrusion process (Kuuku and Beta, 2014; Aravind *et al.*, 2012; Bruneel *et al.*, 2010; Petitot *et al.*, 2009; Gianibelli *et al.*, 2005). Gluten is very important

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in the formation and rheology of the dough, and it is the main determining factor of the pasta cooking quality (Gimenez *et al.*, 2013; Sissons *et al.*, 2007).

Fortification of it with various plant source such as legume flour, mustard protein isolate and OFSP flour has been attempted by several workers with a view to enhance the nutritional value of pasta (Petitot *et al.*, 2010; Sadehi *et al.*, 2008). Orange fleshed sweet potato form an important source of carotene rich food, a rich source of pro-vitamin A, vitamin B, (thiamin) and vitamin C (Woolfe, 1992). Low *et al.* (2007) reported that OFSP is an excellent source of β-carotene containing up to 276.98 mg per g, and contain significant amount of dietary fiber and other micro nutrients (Tumuhimbise *et al.*, 2007). A 125 g serving of boiled OFSP can supply the daily requirement of vitamin A for preschool children and protect them from night blindness (USAID, 2015; Mitra, 2012).

Durum wheat, being the common wheat used at large scale for pasta production is expensive due to limited availability of the wheat flour especially in developing countries; protein in the wheat has also been implicated to be responsible for the causes of celiac disease (Laleg *et al*., 2016; Fasano *et al*., 2003; Volta *et al*., 2001). Food fortification, dietary diversification and vitamin A supplementation are the recommended strategies to control vitamin A deficiency (FAO/WHO, 2002). Incorporation of different food ingredients into pasta can increase the nutritional value of these products, but at the same time when pasta dough is fortified with others than traditional raw materials, such as cereals, it behaves differently (Petitot *et al*., 2010; 2009; Sadehi and Bhygya, 2008). Therefore, this study was aimed at production and evaluation of orange fleshed sweet potato based pasta with wheat flour.

MATERIALS

The raw materials (wheat flour, salt, egg and vegetable oil) used for this study were purchased at Owode market, Offa, Kwara State, while orange fleshed sweet potato was obtained from the experimental farm of Federal Polytechnic, Offa, Nigeria.

METHODS

Preparation of orange fleshed sweet potatoes flour

The method of Singh *et al.*, (2008) was used with slight modification in the processing of the OFSP flours. The non damages OFSP were sorted, washed, peeled, and sliced into 1.4 mm using manual kitchen slicer. The sliced orange fleshed sweet potatoes were dried using oven drier (model: DC 500; serial number 12B154) at 55 ^{o}C for 7 hr, and milled using laboratory hammer mill (model: Fritsch, D-55743, Idar-oberstein-Germany). The OFSP flour obtained was sieved through 450 μm mesh to obtain fine flour. The flour obtained was packaged in a polyethylene bag and stored at room temperature (28 ± 2 ^{o}C) for further use.

OFSP Pasta Formulation

The formulations of composite flour were done according to the method of Islam *et al*., (2011) with slight modification. OFSP flour was mixed with wheat flour in the proportion of 10:90,

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20:80, 30:70, 40:60, 50:50 and 100% and coded as A, B, C, D, E and F. Each sample were blended using a Kenwood mixer (Model: HC 750D, Kenwood, UK) to produce sample A - F. Sample A served as control and contained 100% wheat flour. Sample B, C, D, E consist of wheat flour, OFSP flour and other ingredients for pasta production as shown in Table 4 below.

Table 1: OFSP pasta formulation

Ingredient	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
Wheat flour (%)	100	90	80	70	60	50
OFSP flour (%)	0	10	20	30	40	50
Water (%)	10	10	7.5	6.5	5	15
Egg (%)	20	20	20	20	20	30
Salt (%)	1	1	1	2	2	1
Vegetable oil (%)	4	5	6	7	9	10

Source: Islam *et al.*, (2011).
Sample A = 100% wheat flour, Sample B = 90:10, Sample C = 80:20, Sample D = 70:30, Sample E = 60:40, Sample F = 50:50.

Chemical composition determination

The proximate analysis (moisture content, protein content, ash content, fat content and crude fiber) of the samples were analyzed according the official methods of analysis described by the Association of Official Analytical Chemist (2005), while carbohydrate was calculated by differences. Beta carotene was determined according to the method described by AOAC method (1980) and Mustapha (2008).

Statistical Analysis

All data were statistically analyzed using SPSS version 17.0 for analysis of variance, while Duncan multiple range test (DMRT) at $p<0.05$ was used to separate means where there is a significant difference. For each sample, triplicate determinations were carried out.

RESULTS AND DISCUSSION

Table 2: Chemical composition of OFSP pasta formulated

Sample	Moisture (%)	C. Protein (%)	Crude fat (%)	C. Fiber (%)	Total Ash (%)	NFE (%)	β-carotene mg/100g
A	8.69±0.19^{c}	16.40±0.02^{a}	8.30±0.08^{c}	0.38±0.05^{a}	1.58±0.21^{b}	62.88±0.15^{ab}	0.26±0.02^{f}
B	9.00±0.02^{b}	15.95±0.01^{a}	10.70±0.12^{b}	0.44±0.01^{a}	1.71±0.03^{b}	60.81±0.13^{c}	2.88±0.05^{e}
C	9.40±0.07^{bc}	14.92±0.02^{b}	10.64±0.16^{b}	0.61±0.05^{a}	2.00±0.02^{a}	61.79±0.08^{b}	4.86±0.05^{d}
D	10.06±0.03^{a}	14.34±0.01^{b}	11.02±0.00^{b}	0.69±0.01^{a}	2.05±0.02^{a}	63.21±0.23^{a}	7.55±0.09^{c}
E	10.40±0.03^{a}	13.49±0.03^{c}	11.05±0.05^{b}	0.74±0.02^{a}	2.15±0.01^{a}	63.58±0.11^{a}	8.16±0.12^{b}

F	10.48±0.03[a]	13.36±0.03[c]	12.05±0.05[a]	0.82±0.01[a]	2.21±0.02[a]	62.12±0.14[b]	8.9±0.25[a]

Mean value with different superscripts within the same column are significantly different ($p < 0.05$). Sample A = 100% wheat flour, Sample B = 90:10, Sample C = 80:20, Sample D = 70:30, Sample E = 60:40, Sample F = 50:50.

The results of chemical composition of the pasta formulated products were shown in Table 2. The table shows that moisture content, crude protein, crude fat, crude fiber, total ash, NFE, and beta carotene ranged from 8.69 to 10.48%, 13.36 to 16.40%, 8.30 to 12.02%, 0.38 to 0.82%, 1.58 to 2.21, 60.81 to 63.58% and 0.26 to 8.9 mg/100g, respectively. The ranged of moisture content of this study is similar to that reported by Omeire *et al*. (2014), who reported a range of 6.42 to 12.26% on noodle from blends of wheat, acha and soybean composite flours. However the finding showed that 100% wheat flour pasta had the least value of moisture content (8.69%) while the moisture content of the pasta from the blend of wheat and OFSP flour ranges from 9.00 to 10.48%. Studies have showed that low moisture of food product increases nutrient composition and shelf life of the food product (Amankwah *et al.*, 2009; Olaoye *et al.*, 2006). Bolarinwa and Raji (2017) reported that the lower the moisture contents the longer the shelf life of food product. Also low moisture content of food product inhibits biochemical activities of invading microorganism and thereby preventing food spoilage during storage (Kikafunda, 2006). This result shows that the storage stability of the formulated pasta will be high because of its low moisture content.

The protein content of the pasta ranged from 13.36 to 16.40%. The protein content of the pasta significantly decreased with increase in addition of OFSP flour or with a decrease in wheat flour used. Sample A contains the highest protein content (16.40%), while lowest protein content (13.36%) was found in sample F. This may be attributed to low protein content of OFSP flour that was incorporated into the wheat flour. Egnin and Prakash (1997) reported that sweet potatoes are low in protein quality and quantity, while high protein content in 100% wheat flour maybe attributed to the presence of gluten protein in wheat flour (Gopalakrishnan *et al*., 2011). Similar result was reported by Suparat *et al.* (2008) reported a ranged of 9.99 to 16.00% on instant noodles from high – iron rice and iron fortified rice flour however; higher than the maximum level (14.5%) of National standard quality for dry noodle (Indonesian National council for standardization, INCS, 2000).

Protein of orange fleshed sweet potatoes are good for human body as they serve as building blocks (Jessie, 2014), while the protein in wheat flour (gluten) has been implicated to be responsible for the causes of celiac disease (Mansueto et al. 2014; Fasano *et al*., 2003; Volta *et al*., 2001). According to Gasbairini and Mangiola (2014), celiac disease is a chronic inflammatory condition affecting the gastrointestinal tract, in particular the small intestine and jejunum which result into gastrointestinal problem such as chronic diarrhea, abdominal distention, loss of appetite and among children failure of grow normally (Fasano, 2005). Hence, pasta from the blends of wheat and OFSP flour will have low level of gluten content thereby preventing celiac disease in its consumer.

The fat content of the pasta ranged from 8.30 to 12.05%. The fat content of the pasta increased significantly with increasing in OFSP flour added to wheat flour. Sample A has the lowest fat content (8.30%), while sample F has the highest fat content which is (12.05%). The increase of fat content in the pasta enriched with OFSP flour maybe attributed to the quality of vegetable oil

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added to the mixture during extrusion. The more the OFSP flour incorporated, the harder it becomes for the extrudates to come out, while the vegetable oil served as a lubricant. The result obtained is higher than that reported by Omeire *et al*. (2014), who reported a ranged of 3.94 to 9.25%. Studies have showed that the fat provides more than twice as much as energy as the carbohydrate on a weight / weight basis (Iwe, 2003). High fat content of the product may not provide a conducive environment for microbial growth and its activities hence improving the shelf life of the product (Okaka, 2005). According to Edet *et al*. (2017), fat played important role in retention of amylose in pasta starch during cooking. The higher the fat content in the pasta, the better its insolubility in water during cooking.

The crude fiber content of the pasta ranged from 0.38 to 0.82% which is similar to the report of Edet *et al.*, (2017), who reported a range of 0.33 to 0.79% on noodles from composite blends of rice, acha and soybean. Crude fiber content of the pasta increased significantly with increasing in portion of OFSP flour added to the wheat flour. Sample A has the lowest crude fiber content (0.38%), while sample F has the highest crude fiber content (0.82%). The finding showed that OFSP flour increases the crude fiber content of the wheat flour; thereby contributing to the crude fiber content of the pasta product. High dietary fiber content in food product, have been reported to promote beneficial physiologic effect on health by improving satiety, bowel function, and help to overcome constipation (Kumoro *et al.*,2015). However, crude fiber has recently received much importance, as it is believed to reduce the incidences of colon cancer, diabetes, heart disease and certain digestive diseases (Alam *et al.,* 2016; Ingabire and Vasanthakaalam, 2011). This reports shows that pasta with high crude fiber will be good for human consumption and may promote good health of the consumer.

Results showed that there was significant increase in ash content of the pasta with the increase in the OFSP added to the wheat flour. Sample A has the lowest ash content (1.58%), while sample F has the highest ash content (2.21%). The increased could be attributed to the reported fact that OFSP are higher in mineral than wheat flour (Omeire *et al*., 2014). Edet *et al,* (2017) reported that ash is non organic compound containing mineral content of food, and nutritionally aids in the metabolism of other compounds (Ayo *et al.*, 2014). The ash content represents the total mineral content in food and serves as available tool for nutrition evaluation (Lienel, 2002). Since, ash content indicates the presence of minerals, the pasta containing high ash content could be a source of minerals for biochemical activities of the body.

The carbohydrate content of the pasta ranges from 60.81 to 63.58%, which is similar to that reported by Edet *et al*. (2017) who reported a ranged of 57.63 to 74.94%. Sample E contained the highest carbohydrate content (63.58%), while sample B has the lowest carbohydrate content (60.81%). Brand-miller (2017) reported that despite the high carbohydrate content of OFSP, it has a low glycemic index (GI); indicating low digestibility of starch. GI is a ranking of carbohydrates on a scale of 100 according to the extent to which they raise blood sugar levels after eating. Foods with high GI are those which are rapidly digested, absorbed, metabolized and marled fluctuations in blood sugar levels, while low GI carbohydrates is the ones that produce smaller fluctuation in blood glucose and insulin levels. Low GI is one of the secrets to long term health, reducing risk of type 2 diabetes, heart disease, and the keys to maintaining weight loss (Brand-miller, 2017; Evert *et al.,* 2013). Therefore the consumption of pasta made from wheat

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and OFSP flour will decreases the risk of obesity, diabetes, heart disease, mortality and promote a healthy complexion.

Beta carotene of the formulated pasta ranged from 0.26 to 8.0 mg / 100g, which is similar to the report of Alam *et al.,* (2016), who reported a ranged of 0.38 to 8.0 mg/100g on comparison of the proximate composition, total carotenoid and total polyphenol content of nine OFSP varieties. The β–carotene content of the pasta significantly increased with increase in addition of OFSP flour. Sample A contains the lowest β–carotene content (0.26 mg / 100g), the highest β–carotene content was found in sample F. This may be attributed to high beta carotene content of OFSP flour that was incorporated into the wheat flour. Low *et al.* (2007) and Bechoff *et al.* (2011) reported that orange fleshed sweet potatoes are an excellent source of beta carotene. Studies have showed that beta carotene, a pro-vitamin A is essential nutrient required for maintaining immune function (Stephensen, 2001). It also helps in the maintenance of healthy teeth, skeletal bone, soft tissue, and skin. It is often known as retinol because it produces the pigment in the retina of the eye (Bibiana *et al*., 2014). Hence, pasta containing high beta carotene content can be used to correct vitamin A deficiency for good vision, healthy skin, and prevention of night blindness in its consumer.

Table 3: Sensory analysis of OFSP pasta formulated

Sample	Taste	Colour	Firmness	Chewiness	Appearance	Overall acceptability
A	7.1 ± 0.08^{a}	7.1 ± 0.24^{a}	7.1 ± 0.01^{a}	6.9 ± 0.00^{ab}	8.0 ± 0.01^{a}	8.0 ± 0.03^{a}
B	6.1 ± 0.11^{bc}	5.9 ± 0.15^{b}	6.3 ± 0.27^{b}	6.5 ± 0.01^{b}	6.1 ± 0.04^{b}	6.9 ± 0.01^{b}
C	5.7 ± 0.20^{c}	5.6 ± 0.22^{b}	6.5 ± 0.00^{ab}	6.6 ± 0.12^{b}	6.1 ± 0.03^{a}	7.0 ± 0.17^{b}
D	6.4 ± 0.21^{b}	5.7 ± 0.00^{b}	6.8 ± 0.04^{a}	7.2 ± 0.00^{a}	5.4 ± 0.22^{b}	6.6 ± 0.11^{b}
E	5.6 ± 0.00^{c}	5.3 ± 0.11^{bc}	5.9 ± 0.03^{bc}	6.0 ± 0.05^{c}	6.1 ± 0.01^{a}	6.1 ± 0.01^{c}
F	4.8 ± 0.03^{d}	5.2 ± 0.15^{c}	5.2 ± 0.00^{c}	5.4 ± 0.26^{d}	5.6 ± 0.07^{ab}	6.3 ± 0.04^{c}

Mean value with different superscripts within the same column are significantly different ($p < 0.05$). Sample A = 100% wheat flour, Sample B = 90:10, Sample C = 80:20, Sample D = 70:30, Sample E = 60:40, Sample F = 50:50.

Table 3 showed the results of sensory attributes of the pasta formulated products. There was significant different ($p < 0.05$) between the samples in terms of taste. According to Muhimbula, (2011), taste is an important parameter when evaluating sensory attribute of food. The product might be appealing and having high energy density without good taste such product is likely to be unacceptable. Sample D was observed to be more acceptable in term of taste apart from the control sample. There was no significant different ($p > 0.05$) between the samples except sample A. Food colour has shown to be informative, attract, appeal, and increase consumer appetite. In terms of firmness, there was no significant different ($p > 0.05$) between the samples except sample A.

Apart from sample A, sample D was observed to be most acceptable in terms of firmness. There was significant different in terms of chewiness between the samples especially sample D. Edet *et*

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al., (2017) reported that firmness and chewiness of the product at the point of consumption determines whether such food is swallow able or chewable. This result showed that firmness and chewiness of both the control and blends are almost same. In terms of appearance, there was significant different ($p < 0.05$) between the samples and the control. Appearance is an important attribute in food choice and acceptance (Muhimbula *et al*., 2011). Outcome of sensory evaluation indicates that other samples were similar in appearance to one another. Sample B - F appearance could be attributed to the presence of OFSP flour. There was significant different in terms of overall acceptability between the blended samples and the control. The 100% pasta produced was more accepted than other formulated samples. However, sample C of 20% OFSP fortification was more accepted among the blended pasta samples.

CONCLUSION

The study shows that pasta made from wheat and OFSP flour are nutritionally better than 100% whole wheat flour pasta. The blended products showed good potential, improved product quality in terms of nutritional value, and beta carotene content. The sensory attributes result indicated that pasta produced with 20% of OFSP flour had a good sensory attributes when compared with the control sample. However, the study shows that nutritionally improved pasta products could be produced from mixture of OFSP and wheat flour within the range of 20 – 50% OFSP.

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