International Food Research Journal 18: 1283-1287 (2011)

Breadfruit starch-wheat flour noodles: preparation, proximate compositions and culinary properties

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Abstract: Proximate compositions, culinary and sensory properties of noodles prepared from proportionate combinations of breadfruit starch and wheat flour were investigated. Breadfruit starch (BS) isolated from matured breadfruit (*Artocarpus altilis*) was used to produce noodles in combination with hard red wheat flour (WF) at a ratio of 100% WF:0% BS, 80% WF:20% BS, 60% WF:40% BS, 40% WF:60% BS, 20% WF:80% BS. The protein, fat, ash, crude fibre and moisture contents of the Breadfruit starch-Wheat flour (BSWF) noodles prepared from the above blends ranged from 0.65 to 10.88%, 0.35 to 3.15%, 1.28 to 2.25%, 1.18 to 1.45% and 4.65 to 5.45%, respectively. The contents of protein, fat, ash and crude fibre increased as the percentage breadfruit starch decreased. However, values of moisture content did not follow the same trend, instead higher values were found for 100% BS:0% WF (5.35%) and 20% BS:80% WF (5.45%). The cooking yield of the BSWF noodles ranged from 21.02 (60% BS:40% WF) to 23.75 g (100% BS:0% WF), cooking loss ranged from 5.49 (20% BS:80% WF) to 9.19% (100% BS:0% WF), while swelling index ranged from 3.1 (20% BS:80% WF) to 3.4 (100% BS:0% WF). Throughout the study, noodles produced from blends of 20% breadfruit starch and 80% wheat flour showed superior proximate, culinary and sensory attributes.

Keywords: Breadfruit starch, wheat flour, noodle preparation, culinary properties, sensory evaluation

Introduction

Breadfruit is found in many parts of the world, especially in the tropical countries. Being a rich source of carbohydrates, lipids and proteins, some varieties have been studied and valued for their nutritional properties (Rincon *et al*., 2004). Breadfruit (Figure 1) has been processed into many forms such as starch (Akanbi *et al*., 2009) and flour (Olaoye *et al*., 2008) for its utilization in the food industries. Starches are of great importance in the food industry. They have been used as thickeners or filler in products like custard, soup, baby foods, ice cream and pharmaceuticals (Ihekoronye and Ngoddy, 1985). They have also been used in salad dressings (Singhal and Kulkarni, 1990), cookies preparation (Kulp *et al*., 1991), coating in dehydrated fruits, thickening in pie filling, soup mixer and instant puddings (Ihekoronye and Ngoddy, 1985).

Wheat flour has been extensively used for producing alimentary pastes such as macaroni, spaghetti and other noodle forms. Noodles are important foods throughout the world especially in Asian countries such as China, Korea, Malaysia, the Philippines and Thailand. Noodles can be generally classified into Chinese types (Ramen), Japanese types (Soba), Korean types (Naengmyon), rice and starch noodles (Nagao, 1996). However, no information is available on the direct use of breadfruit starch for the production of noodles either as major raw material or in combination with other raw materials such as wheat flour.

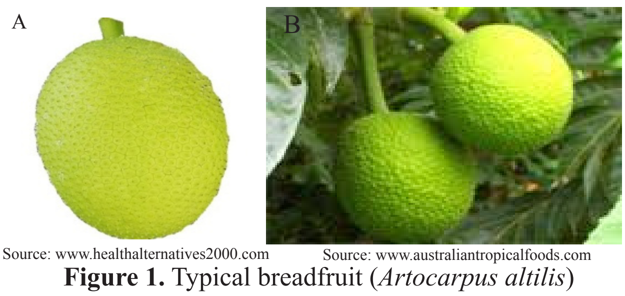

Figure 1. Typical breadfruit (*Artocarpus altilis*)

Starch (basically amylose and amylopectin) is a predominant component of wheat flour, as it helps to improve the appearance and structure of wheat flour foods. Breadfruit starch has also been reported to contain high amylose (22.52%) and amylopectin

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(77.48%) (Akanbi *et al*., 2009). Studies have shown that moderately high amylose foods are helpful in reducing risk factors for diabetes and cardiovascular diseases (Behall and Howe, 1995). High amylopectin presence in food has also been reported to increase human insulin levels (Behall *et al*., 1988). A study that was approved by the Human Studies Committees of the United States Department of Agriculture (USDA) and Georgetown University showed that the insulin levels of 12 women increased after being fed with cornstarch crackers containing 70% amylopectin (Behall *et al*., 1988). Furthermore, diets high in complex carbohydrates including high levels of starches according to Behall *et al*. (1989) have been reported to normalize blood insulin and lipid levels in carbohydrate sensitive, diabetic, and hyperlipidemic individuals. Therefore, noodles produced from the blends of breadfruit starch and wheat flour with moderately high amylose and amylopectin might be explored as functional foods for normalizing the blood insulin levels and imparting other health benefits. Hence, the objective of this study is to produce noodles from breadfruit starch-wheat composite flour and investigate their proximate, culinary and sensory properties.

Materials and Methods

Materials

Breadfruit starch was previously isolated from breadfruits obtained from Ile-Ife Osun State, Nigeria (Akanbi *et al*., 2009) and hard red wheat flour was obtained from Honey-well Flour Mill, Lagos, Nigeria.

Preparation of breadfruit starch – wheat flour Noodles

Breadfruit starch–wheat flour noodles were prepared using Chen *et al*. (2002) method. Following the combinations presented in Table 1, a total of 120 g of composite flour (breadfruit starch–wheat flour) was weighed. Carefully weighed 12 g of the composite flour was put into a clean beaker, mixed with 10 ml warm water (55°C) and then stirred completely after adding 24 ml of boiling water. The remaining 108 g of composite flour and 52 ml of warm water were added and stirred for 30 min at 60°C. The mixture was then kneaded with water to dough consistency before the noodle was injected using an "Extruder"– Lab-scale Cylindrical Extruder (100 – 500 g dough capacity) through the holes (1.5 cm diameter) of the stainless steel cylinder by gravity, using a well fitted 2.25 kg stainless steel piston into hot water (95 – 98°C), and heated for 50-70 seconds at this temperature before transferring into cold water. When noodles were floated, they were taken out and dried. No additive was added during the whole procedure. The dried noodles were equilibrated at room temperature for 4 h, packed in clean pre-sterilized polyethylene bags and stored at room temperature before further analyses.

Table 1. Proximate composition of breadfruit starch - wheat flour noodles

Sample	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Moisture Content (%)
100% BS:0% WF	$0.65^{e} \pm 0.3$	$0.35^{e} \pm 0.2$	$1.28^{e} \pm 0.4$	$1.18^{e} \pm 0.2$	$5.45^{a} \pm 0.3$
80% BS:20% WF	$4.88^{d} \pm 0.7$	$0.88^{d} \pm 0.7$	$1.96^{d} \pm 0.3$	$1.20^{d} \pm 0.7$	$4.97^{c} \pm 0.5$
60% BS:40% WF	$6.75^{c} \pm 0.2$	$2.55^{c} \pm 0.1$	$2.09^{c} \pm 0.7$	$1.22^{c} \pm 0.3$	$4.65^{e} \pm 0.6$
40% BS:60% WF	$9.55^{b} \pm 0.5$	$2.64^{b} \pm 0.6$	$2.18^{b} \pm 0.2$	$1.28^{b} \pm 0.6$	$4.87^{d} \pm 0.3$
20% BS:80% WF	$10.88^{a} \pm 0.6$	$3.15^{a} \pm 0.4$	$2.25^{a} \pm 0.3$	$1.45^{a} \pm 0.0$	$5.35^{b} \pm 0.4$

Results are means of three independent determinations. Mean values having different superscripts within the column are significantly different ($p<0.05$)
BS – Breadfruit Starch
WF – Wheat Flour

Proximate compositions of Breadfruit starch-wheat flour noodles

Moisture, ash, fibre and fat contents of the noodles were determined by the AOAC (1990) official methods and crude protein content by Kjeldahl method. Meanwhile, the proximate properties of the breadfruit starch have been previously determined (Akanbi *et al*., 2009).

Culinary properties of breadfruit starch-wheat flour noodles

Cooking yield and cooking loss

Cooking yield and cooking loss of the noodles were determined as described in the AACC (American Association of Cereal Chemists, 2000) method. Ten grams of the noodles were added to a beaker containing about 150 ml boiling water. The beaker was covered with a watch glass and noodles cooked for 10 min with slight agitation. The cooked noodles were allowed to drain for 5 min and then weighed. The cooking yield was then calculated. The gruel was poured into a 200 ml volumetric flask and adjusted to volume with distilled water. Ten millilitre of the solution was pipetted into an aluminium dish and dried to a constant weight at 105°C. The cooking loss during cooking was calculated as given below.

Cooking yield (g) = Weight of Noodles after cooking (g) – Weight before cooking (g)

$$\text{Cooking loss (\%)} = \frac{\text{Weight of gruel and dish - Constant weight after drying} \times 100}{\text{Constant weight after drying}}$$

$$\text{Swelling index} = \frac{\text{Weight after cooking (g)}}{\text{Weight before cooking (g)}}$$

Sensory evaluation of breadfruit starch – wheat flour noodles

Uncooked noodles

Panellists were presented with five (5) samples of uncooked noodles and a reference sample "R" (the reference sample was a commercial brand of wheat noodles) to compare for appearance in terms of colour and also to compare for breakage, indicating the amount of difference that exists between the samples and the reference. A scale of 1 to 5 was used where 1 represents better than R and 5 represents extremely poorer than R.

Cooked noodles

Panellists were presented with five (5) samples of cooked noodles and a reference (R) to compare for colour, slipperiness, glossiness, taste, aroma and texture, predicting the difference that exists between the samples and the reference.

Statistical Analysis

All experiments were run in triplicate and data analyzed statistically using Microsoft Excel and SPSS v. 12.0.

Results and Discussion

Proximate properties of breadfruit starch - wheat flour noodles

Proximate properties of BSWF noodles are shown in Table 1. The proximate properties of all noodle samples varied significantly ($p<0.05$) different. The mean protein and fat contents of BSWF noodles ranged from 0.65 (100% BS:0% WF) to 10.88% (20% BS:80% WF) and 0.35 (100% BS:0% WF) to 3.15% (20% BS:80% WF), respectively. This trend portends that the higher the percentage wheat flour in the blend, the higher the protein content. Results obtained for the protein and fat contents are not surprising because the protein and fat contents of wheat flour (Olaoye *et al*., 2008) exceed those of breadfruit starch (Akanbi *et al*., 2009). The result also supports the findings of Iwaoka *et al*. (1994) who reported that starch has very low fat content. The ash contents ranged from 1.28 (100% BS:0% WF) to 2.25% (20% BS:80% WF) which might be due to the fact that breadfruit starches are high in ash (Adebowale *et al*., 2004; Akanbi *et al*., 2009). The content of crude fibre was noted to be increased as the percentage wheat flour increased, ranging from 1.18±0.00 (100% BS:0% WF) to 1.45±0.00% (20% BS:80% WF). Olaoye *et al*. (2008) reported similar results for crude fibre content of blends of wheat and breadfruit flour used for the production of baked products. Studies have shown that crude fibre is best obtained from foods than supplement and can reduce symptoms of chronic constipation (Odes *et al*., 1993), heart diseases associated with high cholesterol (hyperlipidemia) (Odes *et al*., 1993), diverticular disease (Gear *et al*., 1979), and reduce the risk of colon cancer (Reddy, 1999). Hence, BSWF noodles could be acceptable in places where fibre diets and lower fatty foods are desired. Meanwhile, the moisture content of the noodles ranged from 4.65 (60% BS:40% WF) to 5.45% (100% BS:0% WF). These values are far lower than the Joint FAO/WHO standards for fried and non-fried instant noodles, which are 10 and 14%, respectively (FAO/WHO, 2003). An inference can therefore be drawn that BSWF noodles apart from being healthy, free of additives, also conform to the standards of world food and health regulatory agencies.

Culinary properties of breadfruit starch-wheat flour noodles

The results of culinary properties of BSWF noodles are presented in Table 2. There were significant ($P<0.05$) differences observed in the cooking yield, cooking loss and swelling index of the noodles tested. The highest cooking yield of 23.75% was obtained from 100% BS:0% WF, while the lowest being 21.02% was from 60% BS:40% WF. The mean values of cooking loss ranged from 5.49 (20% BS:80% WF) to 9.19% (100% BS:0% WF). Meanwhile, the mean swelling indexes ranged from 3.04 (20% BS:80% WF) to 3.4 (100% BS:0% WF).

Table 2. Culinary properties of breadfruit starch – wheat flour noodles

Samples	Cooking yield (g)	Cooking Loss (%)	Swelling Index
100% BS:0% WF	$23.75^{a} \pm 0.4$	$9.19^{a} \pm 0.4$	$3.40^{a} \pm 0.5$
80% BS:20% WF	$22.00^{b} \pm 0.5$	$8.17^{b} \pm 0.5$	$3.28^{b} \pm 0.5$
60% BS:40% WF	$21.02^{c} \pm 0.4$	$6.23^{c} \pm 0.5$	$3.17^{b} \pm 0.3$
40% BS:60% WF	$22.03^{b} \pm 0.3$	$6.01^{d} \pm 0.3$	$3.11^{c} \pm 0.5$
20% BS:80% WF	$21.27^{c} \pm 0.2$	$5.49^{e} \pm 0.3$	$3.04^{d} \pm 0.2$

Results are means of three independent determinations. Mean values having different superscripts within the column are significantly different ($p<0.05$)
BS – Breadfruit Starch
WF – Wheat Flour

Sensory evaluation of breadfruit starch-wheat flour noodles

Tables 3 and 4 show the results obtained for the sensory evaluation of the uncooked and cooked BSWF noodles compared to the reference sample (R). The lower the mean values, the closer the noodles in attributes to the reference sample. There were significant ($p<0.05$) differences observed for the colour and colour difference among the uncooked noodles (Table 3). The least mean scores for colour

Table 3. Mean sensory scores of uncooked breadfruit starch –wheat flour noodles

Sample	Colour	Colour difference	Ease of breakage	Ease of breakage difference
100% BS:0% WF	$3.0^a \pm 0.3$	$4.7^a \pm 0.4$	$2.3^a \pm 0.2$	$2.9^a \pm 0.2$
80% BS:20% WF	$3.0^a \pm 0.4$	$4.2^b \pm 0.3$	$2.3^a \pm 0.3$	$2.9^a \pm 0.1$
60% BS:40% WF	$2.9^a \pm 0.4$	$3.8^c \pm 0.5$	$2.2^b \pm 0.1$	$2.6^b \pm 0.3$
40% BS:60% WF	$2.9^a \pm 0.5$	$3.6^{bc} \pm 0.3$	$2.0^c \pm 0.5$	$2.4^c \pm 0.6$
20% BS:80% WF	$2.5^b \pm 0.2$	$3.2^d \pm 0.5$	$1.8^d \pm 0.2$	$2.3^d \pm 0.5$

Results are means of three independent determinations. Mean values having different superscripts within the column are significantly different ($p<0.05$)
BS – Breadfruit Starch
WF – Wheat Flour

Table 4. Mean sensory scores of cooked breadfruit starch-wheat flour noodles

Sample	Colour	Colour difference	Slipperiness	Slipperiness difference	Gloss	Gloss difference	Taste	Taste difference	Aroma
100% BS:0% WF	$3.0^a \pm 0.5$	$4.9^a \pm 0.8$	$1.4^d \pm 0.5$	$1.5^e \pm 0.6$	$1.4^d \pm 0.5$	$1.4^d \pm 0.5$	$3.0^a \pm 0.5$	$4.9^a \pm 0.8$	$3.0^a \pm 0.7$
80% BS:20% WF	$3.0^a \pm 0.3$	$4.9^a \pm 0.8$	$2.0^c \pm 0.7$	$2.3^d \pm 0.7$	$2.0^c \pm 0.7$	$2.3^c \pm 0.7$	$3.0^a \pm 0.4$	$4.6^a \pm 0.6$	$3.0^a \pm 0.5$
60% BS:40% WF	$3.0^a \pm 0.3$	$4.5^b \pm 0.6$	$2.3^b \pm 0.6$	$2.7^c \pm 0.8$	$2.2^{bc} \pm 0.7$	$2.8^b \pm 0.6$	$2.9^{ab} \pm 0.3$	$4.3^b \pm 0.4$	$2.9^a \pm 0.4$
40% BS:60% WF	$2.9^a \pm 0.4$	$4.2^c \pm 0.4$	$2.5^{ab} \pm 0.4$	$3.4^b \pm 0.7$	$2.5^{ab} \pm 0.5$	$3.4^a \pm 0.5$	$2.8^b \pm 0.5$	$3.9^c \pm 0.3$	$2.4^b \pm 0.7$
20% BS:80% WF	$2.5^b \pm 0.2$	$3.4^d \pm 0.5$	$2.7^a \pm 0.6$	$3.7^a \pm 0.8$	$2.7^a \pm 0.5$	$3.7^a \pm 0.8$	$2.4^c \pm 0.7$	$3.0^d \pm 0.7$	$2.0^c \pm 0.3$

Results are means of three independent determinations. Mean values having different superscripts within the column are significantly different ($p<0.05$)
BS – Breadfruit Starch
WF – Wheat Flour

(2.5) and colour difference (3.2) were obtained for 20% BS:80% WF, while the highest scores (3.0 for colour and 4.7 for colour difference) were observed for 100% BS:0% WF. This indicates that as the percentage breadfruit starch decreases, the noodle's colour improves. Similar trends were observed for ease of breakage and ease of breakage difference although with different mean scores. There was significant ($p<0.05$) difference in all sensory parameters for the cooked noodles (Table 4). For slipperiness, slipperiness difference, glossiness and glossiness difference, the lowest mean values were found to be 100% BS:0% WF. In terms of taste, taste difference and aroma, the mean scores decreased as the percentage breadfruit starch decreased, with 20% BS:80% WF having the lowest score. This implies that with reference to "R", Noodles from 20% BS:80% WF had better taste and aroma compared to the remaining samples.

Conclusion

The results of the present study revealed that beneficial noodles with health promoting factors can be produced from blends of wheat flour and breadfruit starch. Throughout the study, noodles produced from blends of 20% breadfruit starch and 80% wheat flour showed superior proximate, culinary and sensory attributes. Since both breadfruit starch and wheat flour are high in crude fibre which has been reported to reduce symptoms of chronic constipation, heart diseases associated with high cholesterol, diverticular disease and risk of colon cancer, therefore, an inference can be drawn that BSWF noodles are more than just noodles, but important functional foods.

Acknowledgments

Appreciation goes to all the staff of food processing laboratory of the University of Agriculture Abeokuta (UNAAB). Also, big thanks go to Mr. and Mrs. P.A. Akanbi (JP), Mrs. Abidemi Odelade (Nee Akanbi) and Mrs. Kehinde Akanbi (Nee Olunlade) for their financial and moral supports.

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