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Full Length Research Paper

Effect of substitution on the functional properties of flour, proximate and sensory properties of wheat/plantain composite bread

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Bread was prepared from different levels of substitution of wheat flour (WF) and plantain flour (PF) ranging from 0 to 50%, including 100% wheat flour (WF) and 100% plantain flour (PF). Functional properties of the composite flours, proximate and sensory properties of the product (bread) were investigated. The highest value for bulk density of 0.47 g/cm^3 was observed in 100% plantain flour (sample G) while the lowest of 0.34 g/cm^3 was recorded in 100% wheat flour (sample A). Water absorption and foaming capacities decreased with an increase in the level of substitution of plantain flour from 84% for sample A (100% wheat) to 49% in sample G (100% plantain flour) and 50 ml in 100% wheat to 20 ml in 100% plantain flour. Proximate composition showed the following results. Moisture (28.20 to 33.49), ash (0.60 to 1.6), fat (1.11 to 1.55), crude protein (8.15 to 12.00) and total available carbohydrate (57.08 to 60.20). All sensory attributes reduced as substitution increased with the 10% substitution of plantain flour showing no significant difference (p<0.05) in color and taste while texture and overall acceptability showed significant difference (p>0.05) in all the samples. No sensory panelist showed a total dislike for any of the composite bread samples except the bread made from 100% plantain flour. Therefore it was concluded that wheat flour could be substituted with plantain flour up to the 20% level in bread making which will not adversely affect its nutritional and sensory properties.

Key words: Substitution, wheat, plantain, bread, proximate, sensory.

INTRODUCTION

Bread is an important staple food in Nigeria, with an exponential increase in consumption in recent years. The price of bread is on the increase as demand is increasing due to the fact that wheat, one of the major ingredients in bread is not cultivated in the tropics for climatic reasons (Edema et al., 2005). Efforts are on going to find alternative sources of flour for baking. There have been reports of bread made from flour of other cereal grains such as rye, maize, barley and oats; roots like cassava in combination with wheat flour (Spiekemann, 2006). FAO (2005) reported that flour from indigenous raw materials could be added in proportion that will not affect the original and intended color, flavor and the particle size of the product adversely.

Plantain (*Musa paradisiacal*) belongs to the family of banana and is plant producing fruits that are starchy at maturity and need processing before consumption (Marriot and Lancaster, 1983). The fruit is an excellent source of nutrient and mostly eaten as boiled, fried or as the popular roasted delicacy in south-south Nigeria known as “bole” accompanied with fish. It can also be processed into more durable products such as flour that can be stored for later use (Dadzie, 1995; Wainwright and Burdon, 1991). It is widely grown in the southern states of Nigeria and it is used both in Nigeria and many African countries as a cheap source of calories, excellent for weight control, slow in the release of energy after consumption with a low glycermic index (Mendosa, 2008), high in potassium and good for diabetic patient (Akubor, 2003). Plantain is also a good source of Iron, and β – Carotene (Pro-Vitamin A) as reported by Ogazi (1988). It contains 32% carbohydrate, 1% protein, 0.02

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fat, 60% water, some vitamins and mineral elements (Kure et al., 1998).

With the progressive increase in the consumption of bread and related baked products in Nigeria, the composite flour program if adopted has the potential to add value to indigenous crops like plantain and at the same time conserve foreign exchange spent on wheat importation. The aim of the study therefore is to evaluate the effect of substitution on the functional properties of the wheat/ plantain composite flour and the proximate/sensory properties of wheat/plantain bread.

MATERIALS AND METHODS

Two bunches of fresh matured unripe plantain were obtained from mile 111 market in Port Harcourt, Rivers State. Virgin wheat flour was purchased from Port Harcourt Flour Mills Plc, Rivers State. Nigeria. Other ingredients used for baking were all of good quality and also obtained from the same markets in Port Harcourt, South- South Nigeria.

Production of plantain flour

The plantain fingers were washed, peeled, sliced into thin sizes of about 5 m thickness using a slicer. The slices were soaked in 1.25% sodium metabisulphite solution, for 5 min and steam blanched for 5 min to inactivate polyphenol oxidase (PPO) as reported by Olaoye et al. (2006). The pulp was drained and dried in an oven (Model DHG 9140A China) at 60°C for 24 h. The dried plantain was milled using a harmer mill (Universal Hammer Mill FOBA Engineering Limited, Ibadan, Nigeria). The flour was then sieved through a 0.25 m size sieve and packaged in a low density polyethylene bags and stored at room temperature (28 ± 2 °C).

Preparation of various flour blends

10, 20, 30 and 40 part by weight of plantain flour were homogenously mixed with 90, 80, 70 and 60 part by weight of wheat flour using a Binatone 210W food mixer to obtain 10 to 40% wheat/plantain composite flour respectively.

Baking process

The flour blends were baked using the straight dough method (Chuahan et al., 1992). The recipe used was 500 g of flour, 9 g baker's yeast, 5 g common salt, 10 g sugar, 10 g margarine, and 280 ml of water. All ingredient were mixed in a dough mixer (model SPS, Italy for 5 min). The dough was fermented in a stainless bowl covered with clean muslin cloth for 60 min at room temperature, punched and scaled to 250 g dough pieces, proofed in a proofing cabinet for 90 min at 30°C, 85% relative humidity and baked at 250°C for 30 min (Giami et al., 2004).

Chemical analysis

The bread samples were analyzed for moisture, ash crude protein, and crude fat using the AOAC method (1990). Total available carbohydrate was determined using the method described by Osborne and Voogt (1979).

Functional properties of flour blends

Bulk density of flour was determined using the method described by Falade and Omojola (2008); water absorption opacity was determined according to the method of Sathe et al. (1981). Foaming capacity and stability was determined by the method of Coffman and Garcia (1977); and oil absorption capacity was done according to the method of Buchat (1977).

Sensory evaluation

The sensory attributes of the bread samples including crust color, taste texture and general acceptability were evaluated by a semi-trained 20 member panel who were used to eating bread and were neither sick nor allergic to bread and related products; using a 9 – point hedonic scale with 1 representing the least score (dislike extremely and 9 the highest score (like extremely).

Statistical analysis

All analysis was conducted in triplicates, mean scores of some of the results and their standard deviations reported. Data were subjected using analysis of variance and Duncan's multiple range (Duncan, 1955) test was used to separate the means.

RESULTS AND DISCUSSION

Table 1 shows the functional properties of wheat/plantain flour blends. Bulk density ranged from values 0.34 to 0.47 g/cm^3 with 100% wheat and plantain flour having the lowest and highest values respectively. This means that the higher the bulk density, the denser the flour, suggesting that 100% plantain flour is denser than the other substituted samples. This is in agreement with findings of Abioye et al. (2011) who reported a bulk density of 0.46 g/cm$^{3.}$ for 100% plantain flour. Substitution

Table 1. Functional properties of wheat/ plantain flour blend.

Wheat/plantain flour (%)	Bulk density 2/cm^3	Foaming capacity (ml)	Oil absorption	Water absorption (%)
Sample A	0.34^c	50^a	0.71^b	84^a
Sample B	0.40^b	40^b	0.77^a	58^c
Sample C	0.35^c	40^b	0.72^b	75^b
Sample D	0.40^b	50^a	1.10^a	71^b
Sample E	0.40^b	30^c	0.33^d	62^c
Sample F	0.40^b	39^b	0.72^b	61.0^c
Sample G	0.47^a	20^d	0.59^c	49^d

Sample A: 100% wheat flour, B= 90% wheat and 10% plantain flour, sample C= 80% wheat and 20% plantain flour, Sample D= 70% wheat and 30% plantain flour, sample E= 60% wheat and 40% plantain flour sample F= 50% wheat flour and 50% plantain flour, Sample G = 100% plantain flour.

Table 2. Proximate composition of wheat/plantain flour composite bread.

Sample	Moisture content (%)	Ash (%)	Fat (%)	Crude protein (%)	Total available carbohydrate (%)
A (100% wheat)	33.48^a	0.60^c	1.37^a	12.00^a	57.08^b
B (90%WF:10%PF)	30.41^b	0.95^b	1.21^a	11.71^a	60.20^a
C (80% WF: 20% PF)	31.21^b	1.30^b	1.22^a	10.20^a	56.51^b
D (70% WF: 30% PF)	29.60^b	1.30^a	1.11^a	8.92^b	58.20^b
E (60% WF:40 PF)	28.29^c	1.60^a	1.55^a	8.15^b	59.91^a

Sample A: 100% wheat flour, B =90% wheat and 10% plantain flour, sample C= 80% wheat and 20% plantain flour, Sample D= 70% wheat and 30% plantain flour, sample E= 60% wheat and 40% plantain flour.

showed a significant difference ($p<0.05$) in bulk density. Foaming capacity ranged from 20 to 50 ml with 100% plantain flour having the least value and 100% wheat flour the highest. Increase in foaming in substitution decreased the foam capacity. Oil and water absorption capacities ranged from 0.59 to 1.10 and 49 to 84% respectively. In both cases 100% plantain flour had the least value while composite flour 80:20 had the highest oil absorption and 100% wheat flour the highest water absorption capacity. The oil absorption capacity (OAC) is comparable to the work of Voutsinas and Nakai (1983). The water absorption capacity is a function of water holding ability of the flour sample. The water absorption capacity of 100% plantain flour (sample G) is the lowest (49%) while 100% wheat flour the highest value of 84% (sample A). Water absorption capacity is important in bulking and consistency of products as well as in baking applications. Niba et al. (2001) further described water absorption capacity as an important processing parameter that has implication for viscosity. Water absorption capacity decreased with an increase in substitution. This may be attributed to decrease in protein content of the various bread samples and in agreement with the work of Kinsella (1976) who reported that the ability of food materials to absorb water is sometimes attributed to the protein content. WAC showed a significant difference ($p<0.05$) among the samples.

Table 2 shows the proximate composition of wheat/plantain composite bread. Moisture content of bread ranged from 28.20 to 33.48%, with sample E(60:40) blend having the least and 100% wheat bread the highest. This is expected as moisture decreased with increase in substitution, giving rise to bread with extended shelf life. This finding falls within the range 30.98 to 33.84% reported by Olaoye et al. (2006) for wheat/plantain composite bread. Fat, protein and total available carbohydrate (TAC) decreased with increase in substitution and ranged from 1.11 to 1.55%, 8.15 to 12.00% and 56.51 to 60.20% respectively. The decrease in protein value may also be as a result of the presence of plantain flour which is low in protein. Protein content of bread in the present study is higher than that reported (6.67 to 8.39%) by Olaoye et al. (2006). There was a significant difference ($p<0.05$) in carbohydrate with substitution. Olaoye et al. (2006) carbohydrate content report of 57.28 to 60.28% in wheat/plantain composite bread agrees with the result in the present study. Ash content increased with progressive increase in substitution ranging from 0.60 to 1.60%. This could be due to the high ash content of green plantain over wheat flour (Ogazi, 1988; Asiedu, 1989).

Table 3 shows the mean sensory scores for wheat/plantain bread. Color ranged from 4.1 to 8.7, taste ranged from 3.8 to 7.8, texture 4.0 to 7.7 and overall acceptability ranged from 2.9 to 8.3 with 100% plantain flour as the least and 100% wheat as highest in all cases.

Table 3. Mean sensory evaluation of wheat/plantain composite bread.

Sample	Color	Taste	Texture	Overall acceptability
100% WF	8.7^a	7.8^a	7.7^a	8.3^a
90:10 WF:PF	8.1^a	7.2^a	6.1^b	5.8^b
80:20 WF:PF	6.4^b	7.0^a	5.5^c	5.0^c
70:30 WF:PF	5.5^c	5.6^b	4.9^c	4.2^d
60:40 WF:PF	4.7^d	4.9^{bc}	4.3^c	3.1^e
50:50 WF:PF	4.7^d	4.6^c	4.9^c	3.0^e
100%:PF	4.1^d	3.8^d	4.0^d	2.9^e

Figures with the same superscript within the same column do not differ significantly. Sample A: 100% wheat flour, B= 90% wheat and 10% plantain flour, sample C= 80% wheat and 20% plantain flour, Sample D= 70% wheat and 30% plantain flour, sample E= 60% wheat and 40% plantain flour sample F= 50% wheat flour and 50% plantain flour, Sample G = 100% plantain flour.

The results of this study show that the level of substitution of plantain flour in composite bread did not affect the caramelization process which is responsible for the brown color during baking. Panelists showed no total dislike for any of the composite bread but showed dislike for the 100% plantain flour bread. All sensory attributes reduced as substitution increased with the 10% substitution of plantain flour showing no significant difference ($p<0.05$) in color and taste while texture and overall acceptability showed significant difference ($p>0.05$) in all the samples.

Conclusion

Results of the present study have shown that wheat/plantain composite flour have the potential to produce bread of acceptable quality in terms of moisture content, ash, protein and carbohydrate. Bread of good nutritional and sensory qualities could be produced up to 20% plantain flour substitution without affecting the bread quality adversely and at the same time reduce the economic and domestic load on wheat importation and usage.

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