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PRODUCTION AND QUALITY EVALUATION OF BAKED CAKE FROM BLEND OF SWEET POTATOES AND WHEAT FLOUR

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ABSTRACT

Investigations on the use of Sweet potato (Ipomea_batatas)_flour and wheat (Triticum aestivum) flour composite at various levels of substitution (10-15%) in cake production were carried out. The proximate composition showed that wheat flour had higher protein content (18.64%) and lower carbohydrate content (73.72%) while sweet potato had lower protein (11.89%) and higher carbohydrate content (79.29%). The result also showed that there were increased nutrient content (fat, ash and moisture) as the dilution of wheat flour with sweet potato flour increased followed by reduction in crude fibre and carbohydrate contents. However, sensory evaluation results revealed that composite cake (B, C, D, E % F) had no significant difference (p>0.05) in colour and aroma but at 20% sweet potato substitution, C was the best in volume increase, softness and overall acceptability.

Keywords: Quality evaluation, Sweet potato, wheat flour composite, cake

INTRODUCTION

Sweet potato (*Ipomoea Batatas Lam)* is the seventh most important food crop in the world. It is grown in many tropical and subtropical regions. Among the world's major food crops, sweet potato produces the highest amount of edible energy per hectare per day (Horton & Fano, 1985; Singh *et al.,* 2008). Among the root and tuber crops, sweet potato is the only one that has a positive per capita annual rate of increase in production in sub-Saharan Africa (Bashaasha and Mwanga, 1992). Because of its distinct properties, the use of sweet potato flour in the preparation of bread is restricted. Most of the research results reported in this aspect found a substitution level of 10 – 15% for wheat flour on a dry weight basis as the most acceptable (El-sahy & Siliha, 1988; Lopez & Villagarcia, 1984) and when this proportion increased to about 20%, bread loaf volume significantly decreased (Kun-Lun, 2009). Options for the use of sweet potato in the formulation of different food products are numerous, and based on recent diagnostic assessments carried out in developing countries; dried chips, starch, and flour were identified as among the most promising (Collins, 1989).

In Nigeria, sweet potato is an important food security crop (Odebode, 2004) and a short-term crop consumed boiled and mashed or fried. It is mono-cropped or intercropped or intercropped in complex cropping systems with some staple crops such as yam and maize. It has also been identified as the least expensive, year round source of dietary, vitamin A, especially the orange-fleshed type among the poor (Low *et al.,* 1997). The crop is cheap, can be purchased in affordable units and is easily cultivated, yet it is facing a lot of production and post-harvest challenges. Sweet potato products have been reported to have good profit margin and suitable for income generation. Flour from sweet potato can be made when prices are low early in the season and may be stored for the future. Identifying and breeding the varieties that will be suitable for different end products will enhance the production of sweet potato.

Currently in Nigeria, there is little sweet potato processing, more than half of the sweet potato produced is boiled or fried. Other sweet potato products such as chips, starch, puff-puff, chin-chin, buns, bread, jam, crisps, cake when introduced into the Nigerian food industry, will enhance the demand for new sweet potato varieties (Odebode, *et al.,* 2008). Flour for the production of these products is mainly obtained from wheat or other cereals and availability of adequate supply of wheat

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flour has been a major political and economic issues. But Ngoddy & Onuoha (1983) & Sanni *et al.,* (2006) reported that composite flour can be made from legumes and nuts, root and tubers such as yam, cassava, sweet potatoes and sensory qualities of yam and sweet potatoes flours has been has also been reported.

However, cake is a baked product from the mixture of flour, egg, butter, etc. which can be taken as lunch, snack or stewed as breakfast (Aykroyl & Doughty 1982). The production of wheat compared to its demand is alarmingly low and far below domestic consumption level in Nigeria, thus there has been tremendous quantities of importation of wheat flour which has resulted to loss in foreign currency (Karibi, 1991). To this effect, composite flours have been developed to supplement and reduce the loss resulting from our over dependence on wheat.

The current study aimed at producing and evaluating the quality properties of cake made the composite of wheat and local Nigerian potato flours as a strategy to improve sweet potato utilization and improvement of smallholder income and livelihood.

MATERIALS AND METHODS

The Sweet potato *(Ipomea batata)* tuber, wheat *(Triticum aestivum)* flour, 'crown band', granulated sugar, vanilla essence, breaden bunkey fat, eggs, baking powder and powdered milk were purchased from Ekeonunwa local market in Owerri, Imo State, Nigeria

Production of Sweet Potato Flour

The procedures reported by Adeyemi & Ogazi (1985) were used for production of sweet potato flour. Four kilogramme (4.0kg) of sound sweet potato tubers were weighed out after cleaning and sorting, band peeled, washed and bleached in hot water at 98^0C for 3 mins. They were then sliced into chips of about 2-4mm thickness with variable lengths and weighed again. The chips were oven dried at temperature of 70^oC for about 8hrs in the Gallen kamp oven drier. The chips were then milled, sieved and the fraction passed through the laboratory test sieve with aperture size of 300 microns to obtain fine flour.

Production of Cake

Sugar butter was mixed according to the method as described by Bennion & Bamford (1983). The baking fat and granulated sugar were creamed together with the Kenwood mixer for 20 mins until light. The eggs were beaten for 5 mins with the homogenizer. Six additions (100% wheat, 10%, 20%, 30%, 40% & 50% substitution with sweet potato flour) were made over a period of 7 mins with good creaming between the additions. This was done to prevent the curdling of batter. After batter development of a soft velvety feel, the vanilla essence (flavouring) was added. The mixed batter, each at (80g) were mixed with milk and water to proportion and poured into greased cake pans. These were put in the oven and baked at temperature of 190^oC for 15 mins. The cakes were cooled and removed from the pan after 1hr. The cooled cake, were packaged in aluminum foils and kept in shelf until required for sensory evaluation.

Proximate Composition Evaluation

The proximate analysis of the composite flours was carried out by the flour method described by AOAC (2000). The ash content of sample (5g) was determined by the method described by Melon & Pomeranz (1980). The fat content was determined as described by AOAC (2000). Five grams (5g) of each flour sample was wrapped in filter paper and fat extracted using soxhlet extractor at 60^oC for 5hrs. The apparatus was disconnected and the lipid free sample removed from the extractor. The filter paper and its content were reweighed after expelling the solvent and the difference in weight recorded as the lipid content. Crude fibre content was determined using the method of AOAC (2000). Two grams (2g) of each flour sample was introduced into a boiling 200ml of 1.25% H_2SO_4 and boiled for 30 mins. The acid solution was filtered and neutralized by addition of water. The residue was added to 200ml boiling NaOH solution and boiled for 30mins and subsequently 1% HCL was added,, then boiled with water to free it from acid. The residue was washed 2 times with water for 2 times and the third time was petroleum either (minute quantity). The residue was then drained and cooled, weighed and incinerated at 600^0C for 2hrs.The cooled ash was weighed. Micro Kjeldhal method (AOAC,

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Vol. 3, No. 2, September 2012

2000) was used for protein determination. 0.2g each of samples were weighed and wrapped in filter paper and placed in respective 250ml KjeldahL digestion flask containing boil magnesium in chips each spatula full of $CuSO_4$ and Na_2SO_4 were added to each of the flask to assist oxidation. They were allowed to cool and then diluted to 100ml with deionized water. A blank experiment was also set up in the same procedure. 10ml each of digest was transferred to the distillation flask. Twenty milliliters (20ml) of 2% boric acid solution and 2 drops of methylated indicator were placed in each of the receiving flask under the condenser. Thirty-five milliliters (35ml) each of 40% NaOH solution was added and the plug was quickly replaced. The mixtures were distilled until about 30ml distillate was collected from each of them. The distillation from the sample and blank were then titrated with 0.1N sodium chloride solution. The percentage nitrogen determined and the value multiplied by 6.25 to obtain the crude protein content. While carbohydrate content was calculated by difference (% carbohydrate = 100 % - (% Protein + % Ash + % Crude fibre + % Fat + % Moisture).

Sensory Evaluation

Twenty five (25) untrained panelists assessed coded cake samples for color, softness, aroma, taste and overall quality acceptability using 9 point hedonic scale with 9 indicating "like extremely" and 1" dislike extremely''.

Statistical Analysis

The scores obtained were evaluated using the analysis of variance (ANOVA) method to determine the difference among the samples. The deviation of the scores from the mean was added and the mean recorded.

RESULTS AND DISCUSSION

The proximate composition of wheat flour and sweet potato flour is presented in Table 1. The crude protein of wheat flour was 18.64%, its carbohydrate and moisture were 73.72% and 15.65% respectively. The ether extract, ash and crude fiber were 1.60%, 1.10% and 3.2% respectively. These results are comparable to the result reported by Ihekoronye & Ngoddy (1985) who reported that the carbohydrate content of wheat ranged between 65 to 75%, protein, 8 to 10%, fat, 1 to 2%, crude fiber, 1.5 to 2.5% and ash 0.4 to 1.2%.

The result of proximate analysis of sweet potato flour indicated that it contained 79.29% carbohydrate, 11.87% crude protein, 1.05% ether extract, 0.70% ash and 0.65% crude fibre. This was within the range reported by Adeyemi & Ogazi (1985). The high level of carbohydrates is desirable in baked products because on heating starch granules in the presence of water, it swells and forms a gel which is important for the characteristic textures and structures of baked goods (Amendole, 1972).

Table 1. Proximate composition of sweet potato-wheat blend

Flour	Proximate composition (%)					
	Moisture	Protein	Lipid	Ash	Fibre	Carbohydrate
Wheat	18.64±0.20	1.60±0.10	1.1±0.10	15.65±o.50	3.2±0.40	73.72±0.60
Potato	11.87±0.70	1.05±0.14	0.70±0.20	18.00±0.70	0.65±0.30	79.29±0.60

Table 2. Proximate composition of different wheat-potato blends

Formulations	Protein	Lipid	Ash	Moisture	Fibre	CHO
90 : 10	4.49± 0.40	1.60± 0.50	1.18±0.10	11.57±0.50	1.19±0.60	73.81± 0.80
80 : 20	3.43± 0.30	1.45± 0.40	1.43±0.40	11.33 ±0.90	1.19±0.60	75.03± 0.70
70 : 30	1.77±0.80	1.20± 0.20	1.65±0.60	11.21± 0.80	1.26±0.50	76.27± 0.70
60 : 40	0.53±0.20	1.05± 0.50	1.87±0.80	11.02 ±0.60	1.07±0.70	78.03±0.80
50 : 50	0.34±0.30	0.85± 0.80	2.07±0.70	10.90 ±0.90	0.87±0.80	80.05±0.80
Mean						
LSD (5%)						

Table 3. Proximate Analysis of Wheat Cake and Wheat – Sweet potato

Sample	Fat	Protein	Ash	Moisture	Carbohydrate
A	20.02 ± 0.07	6.85±0.14	0.89±0.07	23.99±0.14	47.25±0.49
B	20.59 ± 0.14	6.64±0.10	0.90±0.07	26.01±0.14	44.76±0.49
C	21.19 ± 0.14	6.41±0.10	0.92±0.07	26.50±0.14	43.99±0.49
D	21.84 ± 0.14	6.16±0.10	0.97±0.07	26.72±0.14	43.32±0.49
E	21.90 ± 0.21	6.02±0.07	0.99±0.42	27.00±0.24	40.40±0.28
F	22.50 ±0.21	5.83±0.14	1.04±0.07	27.22±0.21	40.40±0.28
Mean					
LSD (5%)					

Values are means of triplicate analysis ± Standard deviation, A= Control (100% wheat, cake), B=90% wheat / 10% sweet potato cake, C=80% wheat / 20% sweet potato cake, D=70% wheat / 30% sweet potato cake, E=60% wheat / 40% sweet potato cake, F=50% wheat/ 40% sweet potato cake.

Table 4. Mean sensory scores of cake samples

Sample	Colour	Taste	Aroma	Softness	Overall acceptability
A	5.84 ± 1.02^{c}	6.24 ± 0.14^{bc}	6.00 ± 0.14^{b}	6.04 ± 0.21^{cd}	6.20 ± 0.21^{d}
B	6.52 ± 0.21^{bc}	7.20 ± 0.21^{ab}	6.36 ± 0.21^{ab}	7.08 ± 0.28^{b}	7.08 ± 0.28^{b}
C	7.12 ± 0.28^{ab}	8.20 ± 0.28^{a}	6.96 ± 0.28^{a}	8.04 ± 0.35^{a}	8.04 ± 0.35^{a}
D	7.36 ± 0.21^{a}	6.96 ± 0.70^{bc}	6.56 ± 0.14^{ab}	$6.80.\ \pm0.21^{bc}$	6.96 ± 0.28^{bc}
E	7.12 ± 0.35^{ab}	6.08 ± 0.28^{c}	6.76 ± 0.21^{a}	5.96 ± 0.56^{cd}	6.32 ± 0.21^{cd}
F	7.24 ± 0.28^{ab}	6.04 ± 0.14^{c}	6.32 ± 0.21^{ab}	5.76 ± 0.21^{d}	5.72 ± 0.14^{d}
Mean					
LSD (5%)					

A,B,C,D,E,F MEANS ± S.D. WITH THE SAME LETTER IN THE SAME COLUMN ARE NOT SIGNIFICANTLY DIFFERENT ($P<0.05$).

The sweet potato flour had less oil content and this decreased from the 10% dilution of the potato flour with the least in 50% dilution. This could be an indication that the occurrence of oxidative rancidity might be reduced in the composite cakes. The sweet potato flour also had lesser (11.87%) protein compared to the wheat flour (18.64%). Most non wheat flours have less protein but higher carbohydrate content than wheat flour (Tindall, 1968). Crude fiber content of sweet potato was 0.65 (Table 2). Flour having high fiber content should not be used as composite flour diluents (Bijtrebier, 1982).The low fiber content of sweet potato flour therefore makes it a good diluents in composite flour technology. Generally, there was decreased in protein, ether extract, moisture content and crude fiber contents of the composite flour as the level of substitution with potato flour increased while increase in ash and carbohydrate contents were observed as the substitution level also increased.

Proximate composition of cakes

The result of the proximate analysis of cake made from wheat flour and sweet potato flour blends are shown in Table 3. There was an increase in moisture, fat and ash contents of the composite cake as the level of potato flour substitution increased. There was however, a decrease in the protein, crude fiber and carbohydrate content of the composite cakes. This may be due to heat employed which led to destruction of nutrients due to high temperature and duration of heating and the pH of the batter (Erdman & Erdman, 1982). The moisture content of the wheat cake was lower (23.99%) than those diluted with sweet potato flour (26.01%, 26.50%, 26.72%, 27.00% and 27.22% respectively).This moisture content of the cake was below the values reported for several cakes (Peckman & Free land-Graves, 1979). This deviation may be attributed to method and recipe used. There was virtually no detectable crude fiber in the cake samples. This may be due to dilution occasioned by the dilution of batter which resulted in the quantity of fibre left which was minute. Though fiber has been reported to have no nutritional value added to human foods, they add bulk to the foods and aids in bowl movement. Protein content of the composite flours reduced with increasing substitution with sweet

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Vol. 3, No. 2, September 2012

potato flour , the protein content of wheat cake was higher (6.85%) than the composite cakes (6.64%, 6.41%, 6.61%, 6.0% and 5.83% respectively) This may have been due to loss of nitrogen at elevated temperature (165^{o}C) (Singh & Singh, 1991). The cakes made with the sweet potato flour substitutions had higher fat and ash contents than the cake made with wheat flour (Table 2). The fat content of composite cakes was close to the value of 22.4% obtained (Bennion & Bamford, 1983). However, the carbohydrate content of the composite cakes decreased (44.76%, 43.99%, 43.32%, 42.89% and 40.40% respectively) appreciably.

The result of the mean sensory scores of quality attributes of the cake samples are given in the table 4. Cakes samples (C, D, E & F) made with composite flours differed significantly ($p < 0.05$) from whole wheat cake (A) in terms of color. In terms of aroma, cake samples (B, C, D, E & F) compared very well ($p > 0.05$) while cake sample C was significantly better ($p < 0.05$) from the other sample in softness and overall acceptability. Only sample B and C compared very well ($p > 0.05$) in terms of taste. Samples E and F had inferior taste, soft texture and poor overall acceptability.

CONCLUSION

This work revealed that the utilization of sweet potato flour in baking merits attention. The substitution of wheat flour with sweet potato up to 30% (flour basis) indicated that cakes baked with composite wheat flour improved their sensory attributes.

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Vol. 3, No. 2, September 2012

APPENDIX

Table 1. Proximate Composition of the Composite Flour Wheat: Potato

90 : 10	4.49± 0.40	1.60± 0.50	1.18±0.10	11.57±0.50	1.19±0.60	73.81± 0.80
80 : 20	3.43± 0.30	1.45± 0.40	1.43±0.40	11.33 ±0.90	1.19±0.60	75.03± 0.70
70 : 30	1.77±0.80	1.20± 0.20	1.65±0.60	11.21± 0.80	1.26±0.50	76.27± 0.70
60 : 40	0.53±0.20	1.05± 0.50	1.87±0.80	11.02 ±0.60	1.07±0.70	78.03±0.80
50 : 50	0.34±0.30	0.85± 0.80	2.07±0.70	10.90 ±0.90	0.87±0.80	80.05±0.80

Tables Are Means Of Triplicates With ± S.D.

Table 2: Proximate Analysis of Wheat Cake and Wheat – Sweet Potato Composite

SAMPLE	FAT	PROTEIN	CRUDE FIBRE	ASH	MOISTURE CONTENT	CARBOHYDRATE CONTENT
A	20.02 ± 0.07	6.85±0.14	0	0.89±0.07	23.99±0.14	47.25±0.49
B	20.59 ± 0.14	6.64±0.10	0	0.90±0.07	26.01±0.14	44.76±0.49
C	21.19 ± 0.14	6.41±0.10	0	0.92±0.07	26.50±0.14	43.99±0.49
D	21.84 ± 0.14	6.16±0.10	0	0.97±0.07	26.72±0.14	43.32±0.49
E	21.90 ± 0.21	6.02±0.07	0	0.99±0.42	27.00±0.24	40.40±0.28
F	22.50 ±0.21	5.83±0.14	0	1.04±0.07	27.22±0.21	40.40±0.28

Values Are Means Of Triplicate Analysis ± S.D.
A - Control (100% wheat cake)
B - 90% wheat / 10% sweet potato cake
C - 80% wheat / 20% sweet potato cake
D - 70% wheat / 30% sweet potato cake
E - 60% wheat / 40% sweet potato cake
F - 50% wheat/ 40% sweet potato cake.

Table 3. Mean Sensory Scores of Cake Samples

SAMPLE	COLOUR	TASTE	AROMA	SOFTNESS	OVERALL ACCEPTABILITY
A	5.84 ± 1.02^{c}	6.24 ± 0.14^{bc}	6.00 ± 0.14^{b}	6.04 ± 0.21^{cd}	6.20 ± 0.21^{d}
B	6.52 ± 0.21^{bc}	7.20 ± 0.21^{ab}	6.36 ± 0.21^{ab}	7.08 ± 0.28^{b}	7.08 ± 0.28^{b}
C	7.12 ± 0.28^{ab}	8.20 ± 0.28^{a}	6.96 ± 0.28^{a}	8.04 ± 0.35^{a}	8.04 ± 0.35^{a}
D	7.36 ± 0.21^{a}	6.96 ± 0.70^{bc}	6.56 ± 0.14^{ab}	$6.80.\ \pm0.21^{bc}$	6.96 ± 0.28^{bc}
E	7.12 ± 0.35^{ab}	6.08 ± 0.28^{c}	6.76 ± 0.21^{a}	5.96 ± 0.56^{cd}	6.32 ± 0.21^{cd}
F	7.24 ± 0.28^{ab}	6.04 ± 0.14^{c}	6.32 ± 0.21^{ab}	5.76 ± 0.21^{d}	5.72 ± 0.14^{d}

A,B,C,D,E,F Means ± S.D. With The Same Letter In The Same Column Are Not Significantly Different ($P<0.05$).