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Full Length Research Paper

Evaluation of tigernut (*Cyperus esculentus*) -wheat composite flour and bread

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Consumer interest in dietary fiber has continued to increase as more information about its potential impact on health has become available. Among the underutilized crops in Nigeria is tigernut which could find useful application in baking industry because of its high level of dietary fibre and other inherent properties. This study therefore aimed at widening tigernut utilization in the country. Substituted wheat flour (WF) with tigernut flour (TF) at varying proportions (100:0; 90:10; 80:20; 70:30; 60:40; 50:50) was evaluated for proximate composition and physico-chemical properties. Physico-chemical properties of dough as well as sensory and physical properties of the bread produced from the different flour samples were also evaluated. The proximate composition of the flour samples showed a reduction of about 14 to 38% in protein content but with a significant enhancement in the fibre content (167 to 967%) depending on the level of substitution. The fat and ash contents, as well as the pH of the flour samples increased with increase in the proportion of the tigernut. Dough with good viscoelastic properties and acceptable bread with qualities similar to 100% wheat bread was produced from 10% tigernut flour addition.

Key words: Wheat, tigernut, composite flour, bread, proximate composition.

INTRODUCTION

Bread is an important staple food in Nigeria. It is however, relatively expensive, being made from imported wheat that is not cultivated in the tropics for climatic reasons (Olaoye et al., 2006).The idea of substituting part of wheat with other starchy crops is not new. Several institutions, including FAO, have carried out research designed to find ways of partially substituting wheat flour with other sources of flour or replacing wheat altogether (Bokanga, 1995). With the constant increasing consumption of bread and other baked products in many countries, the composite flour programme promises to save significant amount of foreign exchange, provide a traditional nutritious food to more people at lower cost and to utilize indigenous crops to a greater extent. Previous efforts in Nigeria on the use of composite flour for bread have concentrated on the use of flour from cassava. Different levels of success have also been recorded with the use of flours from legume, cereals, roots and tubers in baked goods (Kure et al., 1998; Dhingra and Jood, 2002; Basman et al., 2003).

Tigernut (*Cyperus esculentus*), an underutilized crop, was reported to be high in dietary fibre content, which could be effective in the treatment and prevention of many diseases including colon cancer, coronary hearth diseases, obesity, diabetics and gastro intestinal disorders (Anderson et al., 1994). Tigernut flour has been demonstrated to be a rich source of quality oil and contains moderate amount of protein. It is also an excellent source of some useful minerals such as iron and calcium which are essential for body growth and development (Oladele and Aina, 2007). Its tubers are also said to be aphrodisiac, carminative, diuretic, emmanogogue, stimulant and tonic (Chopra et al., 1986; Chevallier, 1996). Tigernut has also been reported to be used in the treatment of flatulence, indigestion, diarrhoea, dysentery, and excessive thirst (Chevallier, 1996). In addition, tigernut has been demonstrated to contain higher essential amino acids than those proposed in the protein standard by the FAO/WHO (1985) for satisfying adult needs (Bosch et al., 2005). Therefore, tigernut, with its inherent nutritional and therapeutic advantage, could serve as good alternative to cassava in baking industry.

With the progressive increase in the consumption of bread and other baked products in many countries, the

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Table 1. Proximate composition of the composite flour samples.

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbohydrate(By Diff)
A	14.7 ± 0.1^{c}	15.1 ± 0.3^{f}	1.3 ± 0.3^{a}	0.45 ± 0.01^{a}	0.3 ± 0.1^{a}	68.7
B	14.4 ± 0.1^{bc}	12.9 ± 0.5^{de}	4.6 ± 0.2^{b}	0.8 ± 0.02^{b}	0.8 ± 0.1^{ab}	66.5
C	14.4 ± 0.0^{bc}	12.0 ± 0.4^{cd}	7.7 ± 0.3^{c}	1.1 ± 0.02^{c}	1.4 ± 0.4^{bc}	63.4
D	14.2 ± 0.0^{b}	11.1 ± 0.3^{bc}	11.0 ± 0.3^{d}	1.2 ± 0.01^{d}	2.0 ± 0.4^{cd}	60.5
E	13.8 ± 0.2^{a}	10.2 ± 0.3^{ab}	14.0 ± 0.2^{e}	1.4 ± 0.01^{e}	2.6 ± 0.3^{de}	58.0
F	13.8 ± 0.1^{a}	9.4 ± 0.5^{a}	17.3 ± 0.4^{f}	1.6 ± 0.01^{f}	3.2 ± 0.1^{e}	54.7

Means followed by different superscript within a column are significantly different ($p\geq0.05$)
A-100%WF; B- 90%WF,10%TF; C- 80%WF,20%TF; D-70%WF,30%TF; E- 60%WF, 40%TF; F-50%WF, 50%TF

composite flour programme, especially in developing countries, has the potential to conserve foreign exchange, provide nutritious food to more people at affordable cost and widen the utilization of indigeneous crops in food formulation.

Information on the use of tigernut in baked goods is scanty. Thus, this study evaluated the proximate composition, physico-chemical and visco-elastic properties of flour and sensory properties of bread produced from wheat-tigernut composite flour at varying levels of tigernut substitution (10 - 50%).

MATERIALS AND METHODS

Dry tigernut (brown variety) was purchased locally. Wheat flour and other principal ingredients like yeast, sugar, fat and salt were also obtained from a local market in the southwestern part of Nigeria.

Preparation of tigernut flour

The method of Adeyemi (1988) was used in the preparation of tigernut flour. Dry tigernuts were sorted to remove unwanted materials like stones, pebbles and other foreign seeds, before washing with tap water. The cleaned nuts were dried in a cabinet dryer at 60°C for 24 h to a moisture content of about 13%. The dried nuts were milled and sieved through 600 µm aperture size. The resultant flour was packed and sealed in polythene bags until analyzed.

Preparation of the various flours blends

Flour blends containing varying proportions of tigernut flour (10 - 50%) together with wheat flour were prepared by mixing required amounts of respective flours.

Production of bread

The procedure for the production of bread in AACC (1984) was used, which employs a bulk fermentation process. Two hundred gram of each of the composite flour sample was weighed along with the required amount of water to obtain dough, which was kneaded on a pastry-board to smoothen it. The dough was initially fermented for 2 h at 30°C before being subsequently knocked back by kneading to expel carbon dioxide and tighten-up the dough to improve the texture of the final product. The secondary fermentation also lasted for 2 h at 30°C. The dough were then sized and moulded into the baking pans for final proving at 30°C for 2 h. Dough baking was carried out in the oven at a temperature of 230°C for 25 min.

Proximate analysis

Protein (N* 6.25), moisture, fat, ash and crude fibre contents were determined using AOAC (1990) methods. Carbohydrate content was determined by difference.

Other analyses

The pH and titratable acidity (TTA) of the composite flour were determined by the methods of AOAC (1990). Water absorption capacity (WAC) was determined using the method of Mbofung et al (2006). Bulk density was determined following the method describe-ed by Wang and Kinsella (1976). The visco-elastic property of dough from the composite flour was determined using alveograph mixer as described by Gilles and Medcalf (1965).

Sensory evaluation

The baked, cooled bread samples were presented to 10 semi - trained panelists using the method described by Taiwo et al. (1997). The panelists were asked to indicate their observations using a 6 point hedonic scale for crust colour, crumb colour, crumb grain texture, aroma, taste, flavour, symmetry, and overall acceptability. Excellent and very poor were ranked 6 and 1 respectively.

Statistical analysis

All analyses were carried out in duplicates and the data collected were analyzed using Plot IT software (SPE, 1993). Data were subjected to analysis of variance (ANOVA) and Turkey's test was used for comparison of means. Significance was accepted at p = 0.05.

RESULTS AND DISCUSSION

Proximate composition

Proximate composition of the flour samples are presented in Table 1. The protein content (%) of the composite flour decreased from 12.9 to 9.40 with increase in tigernut flour substitution. This may be attributed to low protein content of tigernut (Addy and Eteshola, 1984). Although there was a reduction in the protein content of substituted

Table 2. Physico-chemical properties of the flour samples.

Sample	Titratable acidity (%)	pH	Water absorption capacity (%)	Bulk density (g/ml)
A	0.057[e]	5.80[a]	85.17[a]	0.57[a]
B	0.054[e]	5.95[b]	85.36[ab]	0.59[ab]
C	0.045[d]	6.02[bc]	85.5.0[b]	0.60[bc]
D	0.041[c]	6.06[bcd]	85.61[bc]	0.61[bc]
E	0.036[b]	6.10[cd]	85.85[cd]	0.62[cd]
F	0.024[a]	6.16[d]	86.01[d]	0.64[d]

Means followed by different superscript within a column are significantly different ($p \geq 0.05$)
A, B, C, D, E, and F are as defined in Table 1

Table 3. Visco-elasticity properties of dough from wheat-tiger nut flour mixes.

Samples	P (mmHg)	L (mm)	G	W (J)
A	130[e]	79[e]	19.8[e]	402[f]
B	106[d]	63[d]	17.7[d]	276[e]
C	90[c]	52[c]	16.1[c]	190[d]
D	76[b]	42[b]	14.4[b]	134[c]
E	62[a]	38[b]	13.7[b]	100[b]
F	58[a]	22[a]	10.5[a]	60[a]

P- Resistance to deformation of the dough; L- Dough extensibility; G- Index of swelling; W-Deformation work. Means followed by different superscript within a column are significantly different ($p \geq 0.05$)
A, B, C, D, E, and F are as defined in Table 1

wheat flour samples with tigernut flour, a notable enhancement of fiber content in the range of 167 - 967% was achieved. Tigernut addition also resulted in 71 to 256% improvement in the ash content of the composite flour. The fat content (%) of the composite flour increased from 1.3 to 17.3 proportionately as tigernut flour increase-ed. This might be due to high fat content (32.88%) of the tigernut flour (Addy and Eteshola, 1984). Hence, defatting the nut before utilization may yield better result. The carbohydrate content (%) of the composite flour de-creased from 68.7 to 54.7% indicating low carbohydrate content of the tigernut flour.

Physico-chemical properties of the flour

Water absorption capacity (WAC) of the composite flour ranged from 85.17 to 86.01% as indicated in Table 2. The rate at which each sample absorbed water increased with increase in tigernut addition. No significant difference was found between pure wheat flour and substituted wheat flour with 10% tigernut flour. However there were signi-ficant differences among 100% wheat flour and other substituted wheat flour samples. Alobo and Ogbogo (2007) reported that the WAC of gelatinized tigernut starch was 70%. The increase in WAC of the composite flour may be attributed to higher fibre and starch contents with increasing tigernut substitution. The ability of flour to absorb water was reported to have a significant correla-tion with its starch content (Mbofung et al., 2006).

Result of the bulk density of the samples is also presented in Table1. The values ranged from 0.57 to 0.64 g/ml which showed an increasing trend with increase in tigernut flour addition. Earlier work has reported bulk density of 0.48 - 0.66 g/ml for raw and malted wheat flour (Magnesia and Wafflemix, 2007), which is comparable to that obtained in this study. There was increase in pH values with corresponding decrease in titratable acidity values of the flour samples as the content of tigernut flour increased (Table 2). The titratable acidity values ranged from 0.024 to 0.057% while the pH values were between 5.80 and 6.16. An earlier report has shown that the pH of cassava flour was 6.55 (Chinma and Ocheme, 2007).

Visco-elastic properties of dough from the flour samples and physical characteristic of bread

Result of the visco-elastic characteristics of the dough is presented in Table 3. The index of swelling of the dough ranged from 10.5 to 19.8 with the dough from pure wheat flour having the highest value and the sample substituted with the highest level of tigernut had the least value. A decreasing trend (60 - 402 J) in the deformation work was observed with increase in the level of tigernut addi-tion. The extensibility of the dough ranged from 22 to 79 mm while the dough resistance to deformation ranged between 58 and 130 mmHg. Pure wheat dough had the highest values in all the parameters evaluated. Wheat produces white flour that has a unique property of wheat proteins, which can produce dough with sufficient strength and elasticity required to produce low density bread. This observation suggests that an increase in tigernut flour addition result in reduced dough exten-sibility. The high fat and fibre contents in tigernut may be responsible for the reduction in the dough elasticity of the substituted wheat flour with tigernut flour. However, the visco-elastic property of dough produced from flour sub-stituted with 10% tigernut flour was close to that of pure wheat flour, suggesting its potential utilization in the baking sector.

The loaf volume ranged from 145 to 350 cm^3 as shown

Table 5. Scores for sensory attributes of bread samples from the composite flour.

	Quality attributes						
Sample code Attributes	**Crust colour**	**Crumb colour**	**Crumb grain texture**	**Symmetry**	**Taste**	**Aroma**	**Overall acceptability**
A	5.3[a]	5.3[a]	5.4[a]	5.8[a]	4.7[a]	4.3[b]	5.8[a]
B	5.[3a]	5.2[a]	5.3[a]	5.6[a]	4.8[a]	4.6[a]	5.6[a]
C	4.4[b]	4.3[b]	4.8[b]	5.4[a]	5.3[a]	5.[0a]	5.5[a]
D	4.0[b]	4.0[b]	4.1[c]	4.7[b]	4.9[a]	5.0[a]	4.9[b]
E	3.6[b]	3.6[b]	3.5[c]	4.3[b]	4.8[a]	5.0[a]	4.6[b]
F	2.8[c]	3.0[c]	3.0[c]	3.4[c]	5.1[a]	5.2[a]	3.4[c]

Means followed by different superscript within a column are significantly different ($p \geq 0.05$)
A, B, C, D, E, and F are as defined in Table 1.

Table 4. Loaf volume (100 g dough) of bread produced from the composite flour samples.

Samples	**Volume (cm^3)**
A	350[f]
B	315[e]
C	290[d]
D	240[c]
E	175[b]
F	145[a]

Means followed by different superscript within a column are significantly different ($p \geq 0.05$) A, B, C, D, E, and F are as defined in Table 1.

in Table 4, with 100% wheat bread having the highest value. This result showed reduced loaf volume as proportion of tigernut increased in the flour mixes. However, volume of bread produced from 90:10 wheat- tigernut mixes was comparable to those produced from pure wheat flour.

Sensory properties

The mean sensory scores for the bread produced from the composite flour are presented in Table 5. The result of the sensory evaluation revealed that bread from pure wheat flour and those produced from composite flour with 10% and 20% tigernut flour were rated alike in almost all the quality attributes evaluated indicating the feasibility of adding tigernut to baked goods. This result suggests the potential application of tigernut flour either as full fat or defatted flour in baking industry.

Conclusion

Inclusion of tigernut flour in wheat flour at levels of 10 to 50% resulted in notable increase in fibre and ash contents while protein content decreased. The significant increase in the fibre content (167 to 967%) could be nutritionally advantageous in Nigeria, where white bread is one of commonest staples among all classes of people. Evaluation of the viscoelastic properties of dough from the composite flour, physical and sensory properties of bread revealed that a 10% wheat flour substitution with tigernut flour yielded bread product that was similarly rated with that produced from pure wheat flour. From the result of this study, it could be suggested that tigernut flour might find useful application in the Nigerian baking industry.

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