African Journal of Biotechnology Vol. 6 (21), pp. 2473-2476, 5 November, 2007
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2007 Academic Journals

Full Length Research Paper

Chemical composition and functional properties of flour produced from two varieties of tigernut (*Cyperus esculentus*)

Oladele A. K.[1]* and Aina J. O.[2]

[1]Department of Food Technology, FCFFT, P. M. B. 1500, New Bussa, Niger State, Nigeria.
[2]Department of Food Technology, University of Ibadan, Ibadan, Nigeria.

Accepted 29 June, 2007

The chemical composition and functional properties of flour produced from two varieties (yellow and brown) of tigernut (*Cyperus esculentus*) seeds were studied. The seeds were obtained in dried form, sorted, wet cleaned, dried, milled and sieved to produce flour. The flours were tagged YTF and BTF for yellow and brown varieties, respectively. The protein contents of YTF and BTF were 7.15 and 9.70%, respectively. BTF has higher fat, ash, potassium, magnesium, manganese and iron contents than YTF. On the other hand, YTF has higher carbohydrate, crude fibre, calcium, sodium and copper contents. The zinc and copper levels were low in both flours (0.01 - 0.02 mg/100 g). A low bulk density (0.55 - 0.62 g/cm^3), setback viscosity (6.58 - 13.75 RVU) and breakdown viscosity (0.58 - 1.50 RVU) were recorded for the flours.

Key words: Tigernut, flour, setback viscosity, pasting property, swelling power, retrogradation.

INTRODUCTION

The search for lesser known and underutilized crops, many of which are potentially valuable as human and animal foods has been intensified to maintain a balance between population growth and agricultural productivity, particularly in the tropical and sub-tropical areas of the world. Tigernut (*Cyperus esculentus*) is an underutilized sedge of the family Cyperaceae which produces rhizomes from the base and tubers that are somewhat spherecal. In Egypt, it is used as a source of food, medicine and perfumes (De Vries, 1991).

Tigernut is commonly known as “earth almond”, “chufa”, “chew-fa” and “Zulu nuts”. It is known in Nigeria as “Ayaya” in Hausa, “Ofio” in Yoruba and “Akiausa” in Igbo where three varieties (black, brown and yellow) are cultivated. Among these, only two varieties, yellow and brown, are readily available in the market. The yellow variety is preferred to all other varieties because of its inherent properties like its bigger size, attractive colour and fleshier body. The yellow variety also yields more milk upon extraction, contains lower fat and more protein and possesses less anti-nutritional factors especially polyphenols (Okafor et al., 2003). Tigernut can be eaten raw, roasted, dried, baked or be made into a refreshing beverage called “Horchata De Chufas” or tigernut milk. It also finds uses as a flavouring agent for ice cream and biscuits (Cantalejo, 1997), as well as in making oil, soap, starch and flour.

Although many researchers have worked on tiger nut (Eteshola and Oraedu, 1996; De Vries, 1997; Cortes et al., 2005), there is paucity of information on the properties of its flour. This project therefore aimed at determining the chemical composition and functional properties of tiger nut flour in order to be able to explore its potentials in food formulation.

MATERIALS AND METHODS

Sample preparation

The two varieties of tiger nut used (yellow and brown) were obtained from a local market in Yola, Adamawa state, Nigeria. The nuts were cleaned, sorted, washed, drained, dried in an oven and ground into flour. The flour samples were passed through a 45 µm mesh size sieve. The brown and yellow tigernut flour was tagged BTF and YTF, respectively (Table 1).

*Corresponding author. E-mail: dekanmiscientist@yahoo.com.

Table 1. Proximate composition of tigernut flour.

Constituent	YTF (%)	BTF (%)
Moisture	3.50	3.78
Fat	32.13	35.43
Protein	7.15	9.70
Ash	3.97	4.25
Carbohydrate	46.99	41.22
Crude fibre	6.26	5.62
Energy value (KJ)	1343	1511

*Values are mean of duplicate samples.

Proximate analysis

Kirk and Sawyer (1991) methods were used to determine moisture, protein, fat, crude fibre and ash contents while carbohydrate was calculated by difference. Energy values (KJ) were calculated by multiplying the amounts of protein and fat by the factors of 17 and 38 KJ g^{-1} respectively as reported by Paul and Southgate (1978).

Mineral analysis

The method described by AOAC (1990) was used for mineral analysis. The ash was digested with 3 cm^3 of 3M HCl and made up to the mark in a 100 cm^3 standard flask with 0.36 M HCl before the mineral elements were determined by atomic absorption spectrophotometer (PYE Unicon, UK, model SP9). Colorimetric method using phosphovanado molybdate was used for phosphorus determination.

Water and oil absorption capacities

Water and oil absorption capacities of the flour samples were determined by Beuchat (1977) methods. One gram of the flour was mixed with 10 ml of water or oil in a centrifuge tube and allowed to stand at room temperature (30 ± 2°C) for 1 h. It was then centrifuged at 200 x g for 30 min. The volume of water or oil on the sediment water measured. Water and oil absorption capacities were calculated as ml of water or oil absorbed per gram of flour.

Foam capacity and foam stability

The method described by Narayana and Narasinga Rao (1982) was used for the determination of foam capacity (FC) and foam stability (FS). Two grams of flour sample was added to 50 ml distilled water at 30 ± 2°C in a 100 ml measuring cylinder. The suspension was mixed and properly shaken to foam and the volume of the foam after 30 s was recorded. The FC was expressed as a percentage increase in volume. The foam volume was recorded 1 h after whipping to determine the FS as a percentage of the initial foam volume.

Bulk density

A 50 g flour sample was put into a 100 ml measuring cylinder. The cylinder was tapped continuously until a constant volume was obtained. The bulk density (g cm^{-3}) was calculated as weight of flour (g) divided by flour volume (cm^3) (Okaka and Potter, 1979).

Swelling power

This was determined with the method described by Leach et al. (1959) with modification for small samples. One gram of the flour sample was mixed with 10 ml distilled water in a centrifuge tube and heated at 80°C for 30 min. This was continually shaken during the heating period. After heating, the suspension was centrifuged at 1000 ×g for 15 min. The supernatant was decanted and the weight of the paste taken. The swelling power was calculated as: swelling power = weight of the paste / weight of dry flour

Pasting properties

Three grams of the flour sample was mixed with 25 ml distilled water in the canister of a Rapid Visco- Analyzer (RVA, model 3D; Newport Scientific, Sydney, Australia) monitored with RVA control software and operated. The following parameters were obtained from the plotted graphs: peak viscosity, pasting temperature, setback viscosity, breakdown viscosity, final viscosity and time to reach the peak viscosity.

RESULTS AND DISCUSSION

Chemical composition

The BTF contained higher amounts of protein, fat, moisture and ash than YTF. The BTF protein content was 9.70% while YTF was 7.15%. The protein compares favourably with the value of 9.8% reported for wheat flour (Akubor and Badifu, 2004), 6.34 – 8.57% reported for jackfruit seed flour (Mukprasirt and Sajjaanantakul, 2004) but lower than the values 26.3, 22.5 and 11.4% reported for conophor nut flour (Odoemelan, 2003), benniseed flour and pearl millet flour (Oshodi et al., 1999), respectively. The fat content (32.13 to 35.43%) is relatively high when compared to pearl millet (7.6%) and quinoa (6.3%) (Oshodi et al., 1999), pigeon pea flour (1.80%; Okpala and Mammah, 2001) and wheat flour (3.10%; Akubor and Badifu, 2004) but low compared to some commonly consumed oil seeds in Nigeria; *Pentaclethra macrophylla* (46.0%; Achinewhu, 1982), *Telfairia occidentalis* (49.2%; Fagbemi and Oshodi, 1991).

Table 2 shows the mineral composition of the flour. YTF is higher in calcium, sodium and copper while BTF is higher in potassium, magnesium, manganese and iron. Both YTF and BTF have similar phosphorus and zinc values. The values of calcium found in the flours, 140 and 155 mg/100 g, are adequate for bone and teeth development in infants. The presence of other minerals such as iron is highly important because of its requirement for blood formation.

Functional properties

The water absorption capacity was 1.37 and 1.26 ml/g for YTF and BTF, respectively. The values obtained are lower than 3.4 ml/g reported for raw conophor flour (Odoemelam, 2003) but comparable to 1.7 ml/g reported for

Table 2. Mineral composition of tigernut flour (mg/100 g flour).

Mineral element	YTF	BTF
Calcium	155	140
Sodium	245	235
Potassium	216	255
Magnesium	51.2	56.3
Manganese	33.2	38.41
Phosphorus	121	121
Iron	0.65	0.80
Zinc	0.01	0.01
Copper	0.02	0.01

*Values are mean of duplicate samples.

Table 3. Functional properties of tigernut flour.

Property	YTF	BTF
Water absorption capacity (ml/g)	1.37	1.26
Oil absorption capacity (ml/g)	1.07	1.13
Foam capacity (%)	10.28	11.07
Foam stability (%)	50.60	58.99
Bulk density (g/cm^3)	0.62	0.55
Swelling power	2.47	2.10

*Values are mean of triplicate samples.

Table 4. Pasting properties of tigernut flour.

Property	YTF	BTF
Peak time (min)	6.53	5.33
Pasting temperature (^{o}C)	82.85	83.55
Peak viscosity (RVU)	9.75	16.33
Breakdown viscosity (RVU)	0.58	1.50
Final viscosity (RVU)	15.75	28.58
Setback viscosity (RVU)	6.58	13.75

*Values are mean of duplicate samples.

African yam bean (Eke and Akobundu, 1993). Water absorption capacity describes flour – water association ability under limited water supply. This result suggests that tigernut flour may find application in baked products e.g. cookies. The YTF and BTF were found to have oil absorption capacity of 1.07 and 1.13 ml/g. The result shows that tigernut may be a lower flavour retainer than raw winged bean (1.4 ml/g) and (1.2 ml/g) flours (Narayana and Narasinga, 1982) and African yam bean (1.42 ml/g) flour (Eke and Akobundu, 1993). The lower oil absorption capacity of tigernut flour might be due to low hydrophobic proteins which show superior binding of lipids (Kinsella, 1976). The foam capacity (FC) of BTF (11.07%) was higher than that of YTF (10.28%). The values are in line with 11.30 and 9% reported for pearl millet flour and quinoa flour, respectively (Oshodi et al., 1999), but comparatively lower than 20 and 40% reported for African breadfruit kernel flour and wheat flour respectively, (Akubor and Badifu, 2004). The low foam capacity may be attributed to the low protein content of the flour since foamability is related to the amount of solubilized protein (Narayana and Narasinga Rao, 1982) and the amount of polar and non-polar lipids in a sample (Nwokolo, 1985). The foam stability (FS) for YTF and BTF, 50.6 and 58.99%, are higher than 14.6 and 20% reported for soyflour and pigeon pea flour, respectively (Oshodi and Ekperigin, 1989), but comparatively lower than 60 and 80% reported for wheat flour and African breadfruit kernel flour (Akubor and Badifu, 2004), respectively.

The sample YTF has the highest bulk density of 0.62 g/cm^3 as shown in Table 3. The 0.55 g/cm^3 obtained for BTF compares favourably with 0.54 g/cm^3 reported for African breadfruit kernel flour but lower than 0.71 g/cm^3 reported for wheat flour (Akubor and Badifu, 2004). Bulk density is a measure of heaviness of a flour sample.

Pasting properties

From Table 4, the pasting temperature, peak viscosity, breakdown viscosity, final viscosity and setback viscosity of BTF are higher than YTF. The peak viscosity of YTF (9.75 RVU) is lower than that of BTF (16.33 RVU) but the time to reach peak viscosity is in contrast, 6.53 min for YTF and 5.33 min for BTF. Both YTF and BTF have low setback and breakdown viscosities. This shows that they are both stable to heat and mechanical shear. This could be attributed to the high fat content of the samples. Both YTF and BTF are characterized by little decrease in viscosity on cooling as indicated by setback viscosity values, a pointer towards low retrogradation property of the flour.

Conclusion

Tigernut flour is a rich source of oil and contains moderate amount of protein. It is also a rich source of some useful mineral elements such as iron and calcium which are necessary for body growth and development. The low bulk density, setback and breakdown viscosities show that tigernut flour can be used in food formulation with less fear of retrogradation.

REFERENCES

Achinewhu SC (1982). Composition and food potential of African oil bean (*Pentaclethra macrophylla*) and Velvet bean (*Mucuna uriens).* J. Food Sci. 47: 1736–1737.

Akubor PI, Badifu GIO (2004). Chemical composition, functional properties and baking potential of African breadfruit kernel and wheat flour blends. Int. J. Food Sci. Tech. 39: 223–229.

A.O.A.C. (1990). Official methods of analysis. 15th edn. Washington, D. C.. Association of Official Analytical Chemists.

Beuchat LR (1977). Functional and electrophoretic characteristics of succinylated peanut flour protein, J. Agric. Food Chem. 25: 258 – 261.

Cantalejo MJ (1997). Analysis of volatile components derived from raw and roasted earth – almond (*Cyperus esculentus L.*). J. Agric. Food Chem. 45: 1853 – 1860.

Cortes C, Esteve M, Frigola A, Torregrosa F (2005). Quality characteristics of horchata (a Spanish vegetable beverage) treated with pulsed electric fields during shelf-life. Food Chem. 91(2): 319–325.

De Vries, Femke T (1991). Chufa (*Cyperus esculentus, Cyperaceae*): A weedy cultivar or cultivated weed? Econ. Bot. 45: 27–37.

Eke OS, Akobundu ENT (1993). Functional properties of African yam bean (*Sphenostylis stenocarpa*) seed flour as affected by processing. Food Chem. 48: 337-340.

Eteshola E, Oraedu ACI (1996). Fatty acid composition of tigernut tubers (*Cyperus esculentus L.*), baobab seeds (*Adasonia digitata L.*) and their mixture. J. Am. Oil Chem. Soc. 73(2): 255–257.

Fagbemi TN, Oshodi AA (1991). Chemical composition and functional properties of full fat fluted pumpkin seed flour. Nig. Food J. 9: 26 – 32

Kinsella JE (1976). Functional properties of protein foods. Crit. Rev. Sci. Nutr. 1: 219- 229

Kirk SR, Sawyer R (1991). Pearson's Composition and Analysis of foods, 9th edn., Longman Scientific and Technical, UK.

Leach HW, McCowen LD, Schoch TJ (1959). Structure of the starch granules. In: Swelling and solubility patterns of various starches. Cereal Chem. 36: 534-544.

Mukprasirt A, Sajjaanantakul K (2004). Physico-chemical properties of flour and starch from jackfruit seeds (*Artocarpus heterophyllus Lam.*) compared with modified starches. Int. J. Food Sci. Tech. 39: 271-276.

Narayana K, Narasinga Rao MS (1982). Functional properties of raw and heat processed winged bean flour. J. Food Sci. 47: 1534-1538.

Nwokolo E (1985). Nutritional quality of the seeds of the African breadfruit (*Treculia Africana Decne*). Trop. Sci. 27: 39-47.

Odoemelan SA (2003). Chemical composition and functional properties of conophor nut flour (*Tetracarpidium conophorum*) flour. Int. J. Food Sci. Tech. 38: 729-734.

Okafor JNC, Mordi JI, Ozumba AU, Solomon HM, Olatunji O (2003). Prliminary studies on the characterization of contaminants in tigernut (Yellow variety). In Proceedings of 27th annual Nigerian Institute of Food Science and Technology (NIFST) conference.13-17 October, 2003. pp. 210-211.

Okaka JC, Potter NN (1979). Physicochemical and functional properties of cowpea powders processed to reduce beany flavour. J. Food Sci. 44: 1235-1240.

Okpala LC, Mammah EN (2001). Functional properties of raw and processed pigeonpea (Cajanus cajan) flour. Int. J. Food Sci. Nutr. 52: 343-346.

Oshodi AA, Ekperigin MM (1989). Functional properties of Pigeon Pea *(Cajanus cajan*) flour. Food Chem. 34: 187-191.

Oshodi AA, Ogungbenle HN, Oladimeji MO (1999). Chemical composition, nutritionally valuable minerals and functional properties of Benniseed, pearl millet and quinoa flours. Int. J. food Sci. Nutr. 50: 325 – 331.

Paul AA, Southgate DAT (1978) McCance and Windowson's, The composition of Foods, Her Majesty's stationary office, London, UK. pp. 56-57.