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Full Length Research Paper

Some physicochemical properties of flour obtained from fermentation of tigernut sourced from a market in Ogbomoso, Nigeria

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Yellow variety of tiger nut used was obtained from Sabo market, in Ogbomoso, Nigeria The nuts were cleaned, sorted, washed, and were soaked in water and left to ferment for 24, 48 and 72 h respectively. The nuts were drained, dried in an oven and ground into flour. The flour samples were passed through a 45 m mesh size sieve. The flour was analyzed for proximate composition and some functional properties. There were changes in some constituents of the flour with fermentation time. There was an increase in protein content (7.73 - 9.23%) and reduction in fat content, likewise with the ash, and starch content. There was also an increase in the sugar content over the fermentation time (7.31 - 9.69%). For the functional properties, 0.56 - 0.62 g/ml were recorded for loose bulk density, within the fermentation time of 24 – 72 h. For packed bulk density 0.83 - 0.91 g/ml were recorded, 123 – 141 g/100 g for water absorption, 67.6 - 71.3 g/ml for oil absorption capacity within the fermentation time of 24 - 72 h. Changes in the pasting characteristics of the flour samples were also noticed.

Key words: Tigernut flour, fermentation, proximate composition, functional properties.

INTRODUCTION

Tigernut (*Cyperus esculentus*) is an underutilized crop of the family *Cyperaceae* which produces rhizomes from the base and tubers that are somewhat spherical. It is com-monly 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 over others because of its inherent properties like its large size, attractive colour and fleshier nature. The yellow variety also yields more milk, contains lower fat and higher protein and less anti- nutritional factors espe-cially polyphenols (Okafor et al., 2003). Tigernut can be consumed raw, roasted, dried, baked or made into a refreshing beverage (Cantalejo, 1997). In addition, tiger-nut is used for making oil, soap, starch and flour. Although many researchers have worked on tiger nut (Eteshola and Oraedu, 1996), there is little information on the effect of fermentation on the flour properties. Fermen-tation a value addition to the food product .This project therefore aimed at determining the effect of fermentation on the proximate composition of tigernut flour in order to be able to explore its potentials in food formulation.

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MATERIALS AND METHODS

Sample preparation

Yellow variety of tiger nut used was obtained from a local market in Ogbomoso, Oyo state, Nigeria. The nuts were cleaned, sorted, washed, and were soaked in water and left to ferment for 24, 48 and 72 h respectively. The nuts were drained, dried in an oven and ground into flour. The flour samples were passed through a 45 m mesh size sieve.

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.

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 centri-fuged at 200 x g for 30 min. The volume of water or oil in the sediment water was measured. Water and oil absorption capacities were calculated as ml of water or oil absorbed per gram of flour.

Table 1. Effect of fermentation period on the proximate composition of Tiger nut flour.

	Period (hours)			
Properties	**0 h**	**24 h**	**48 h**	**72h**
Crude protein	6.67±0.16d	7.73±0.08c	8.40±0.09b	9.23±0.09a
Fat	14.41±0.04a	13.66±0.02b	11.86±0.04 c	11.24±0.04c
Dry mater	90.10±0.04a	89.80±0.02ab	89.67±0.04 ab	89.57±0.02 ab
Starch	21.25±0.02a	19.07±0.04b	17.93±0.03c	15.88±0.04d
Crude fiber	2.04±0.03a	1.90±0.04ab	1.73±0.02c	1.64±0.02cd
Sugar	6.58± 0.04d	7.31±0.02c	8.77±0.03b	9.69±0.02a
Ash	2.72±0.04 a	2.60±0.02a	2.49 ±0.04a	2.37±0.03 a
Moisture content	9.93±0.04ab	10.22±0.02a	10.31±0.04a	10.42±0.02a

Means followed by different letters within a row are significantly different ($p < 0.05$).

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 and tapped to a constant volume. 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, and setback viscosity, breakdown viscosity, final viscosity and time to reach the peak viscosity.

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

Chemical composition

The results of the proximate composition are shown in Table 1. There are changes in some constituents of the flour with fermentation time. There was an increase in protein content and reduction in fat and ash content. There was an increase in the sugar content along the fermentation days. This could be attributed to metabolic activities of the microorganisms during fermentation. For instance the decrease in the starch and increase in sugar contents may be due to breaking down of starch to sugar by some microorganisms containing enzyme amylase. This could further enhance the exploration of its potential in food formulation.

The flour samples from fermented tigernuts contained higher amounts of protein than the unfermented flour. As shown in Table 1, the protein content increased with fermentation period. At 0 h fermentation the protein content of the flour was 6.67% while for 24, 48, and 72 h fermentation the flour contained protein of 7.73, 8.40 and 9.23% respectively. This could be compared 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 decreased with fermentation period from 14.41% to 11.21%. This is contrary to the report of Oladele and Aina (2005) who obtained fat content of 32.13 to 35.43% for flour from different varieties of tigernut. However this is relatively high when compared to pearl millet (7.6%) and quinoa (6.3%) (Oshodi et al., 1999) missing in reference pigeon pea flour (1.80%; Okpala and Mammah, 2001) and wheat flour (3.10%; Akubor and Badifu, 2004) but low compared to some

Table 2. Some Functional properties of Tigernut flour.

Properties	A	B	C	D
Loose bulk density (g/ml)	0.56±0.03a	0.62±0.02a	0.59±0.04a	0.59±0.03a
Packed bulk density (g/ml)	0.83±0.02a	0.91±0.04a	0.83±0.03a	0.91±0.02a
Water absorption capacityg/100 g	141±0.02c	156±0.03b	164±0.03a	123±0.03d
Oil absorption capacityg/100 g	67.6±0.03c	69.8±0.03b	71.3±0.02a	61.2±0.04d
Gelation capacity (%)	21.5±0.03c	23.2±0.02b	24.5±0.03a	19.2±0.01d
Dispersibility (%)	69.2±0.02b	67.3±0.04c	65.4±0.04d	72.5±0.03a
Viscousity(ml/s)	0.132±0.03a	0.126±0.04a	0.121±0.02a	0.143±0.04a

Means followed by different letters within a row are significantly different (p = 0.05)
A - Flour from 24 h fermentation of seed.
B - Flour from 48 h fermentation of seed
C - Flour from 72 h fermentation of seed
D - Control (No fermentation)

commonly consumed oil seeds in Nigeria; *Pentaclethra macrophylla* (46.0%; Achinewhu, 1982), *Telfairia occidentalis* (49.2%; Fagbemi and Oshodi, 1991). The ash content decreased with fermentation time from 2.72% (0 h) to 2.31% (72 h). The ash content is an indication of mineral elements present in the flour. However Oladele and Aina (2007) has reported varieties of tigernuts especially the yellow variety to have high amounts of calcium, sodium and copper potassium, magnesium, manganese and iron. According to Oladele and Aina (2007), 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. The reduction in the ash content may arise as a result of usage of these minerals by inherent microorganisms for metabolic activities which may also be the reason for the reduction in the starch content (21.25 - 15.88%) which has been broken down to sugar thereby causing an increase in the sugar content (6.58 - 9.69%).

Functional properties

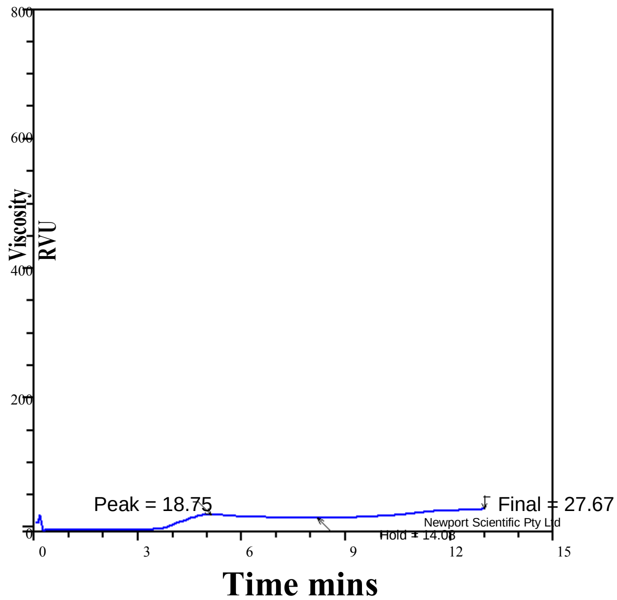
Water absorption capacity describes flour – water association ability under limited water supply .The water absorption capacity was 141,156 and 164 g/100 g for the flour from 24, 48 and 72 h fermentation respectively as shown in Table 2. The water absorption for flour from 0 h fermentation was 123 g/100 g. The water absorption capacity increased with increasing fermentation time. However water absorption capacity of 3.4 ml/g has been reported for raw conophor flour (Odoemelam, 2003 check reference for spelling) and 1.7 ml/g reported for African yam bean (Eke and Akobundu, 1993). This result suggests that tigernut flour may find application in the production of some baked products. The flours were found to have oil absorption capacity of 67.6, 69.8, and 71.3 g/100 g for the 24, 48 and 72 h fermentation respectively. The flour from the unfermented tigernut was found to have oil absorption capacity of 61.2 g/100 g. 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). Bulk density is a measure of heaviness of a flour sample The 72 h fermentation has the highest bulk density of 0.83 g/ml. This is also for packed bulk density as shown in Table 2. The 0.55 g/cm^3 obtained for 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).

Pasting properties

As shown in Figures 1 to 4 the pasting temperature, peak viscosity, breakdown viscosity, final viscosity and setback viscosity of the flours from 24 and 48 h fermentation are lower than 0 h fermentation. Flour from 72 h fermentation has the highest in these parameters. The peak viscosity of 18.75 and 18.17 RVU were recorded for the flours from 24 and 48 h fermentation respectively, while the peak time was 5.13 and 5.07 min respectively. The peak viscousity of flour from 0 h fermentation was 38.17 RVU at peak time of 5.6 min. The setback viscousity and breakdown viscousity were 33.08 and 6.50 RVU. However Oladele and Aina (2007) has recorded the peak viscosity of 9.75 RVU for flour from yellow tigernut and 16.33 RVU for flour from black variety of tigernut and the time to reach peak viscosity at, 6.53 min and 5.33 min respectively and both have low setback and breakdown viscosities. This probably was attributed to the high fat content of the samples.

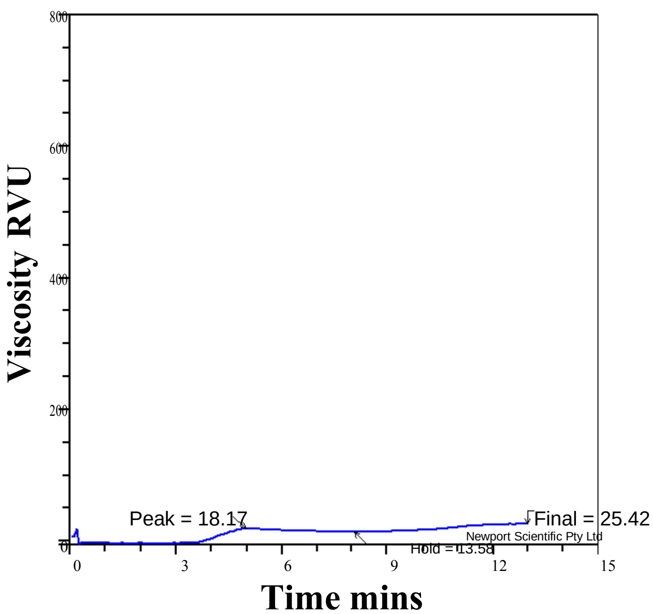
Conclusion

Tigernut flour is a rich source of oil and contains mode-



A

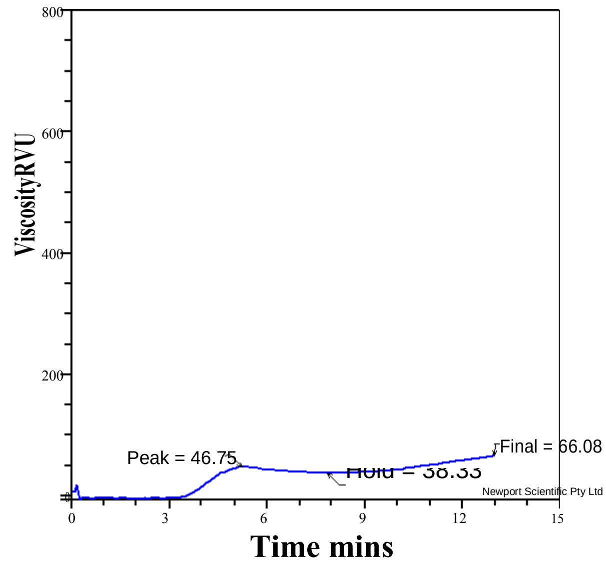
Figure 1. Pasting characteristics of flour from 24 h fermentation of tigernut.



B

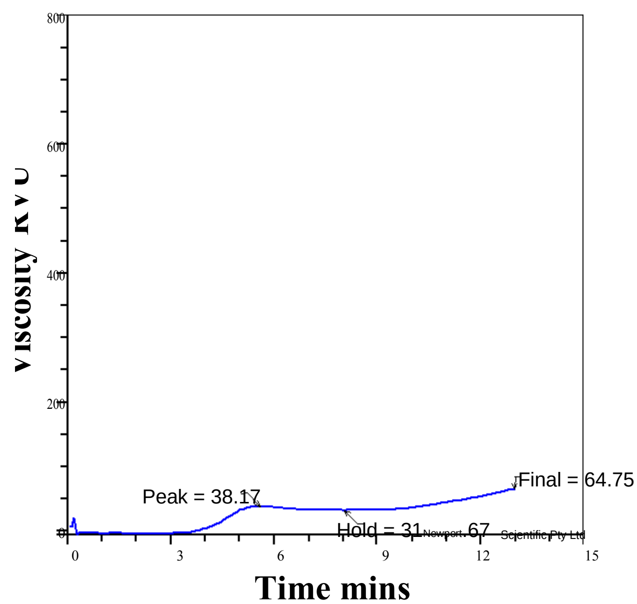
Figure 2. Pasting characteristics of flour from 48 h fermentation of tigernut.

rate amount of protein. Fermentation can also beused to improve the nutritional content of this seed. Further work needs to be carried out on the microorganisms associated with the fermentation and to develop starter culture to ferment this seed and probably see changes on the resultant flour for uses in food formulation.



C

Figure 3. Pasting characteristics of flour from 72 h fermentation of tigernut.



Control

Figure 4. Pasting characteristics of flour from 0 h fermentation of tigernut.

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