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Proximate, Functional and Anti-Nutritional Properties of Boiled Ukpo Seed *(Mucuna flagellipes)* Flour

Onuegbu, N.C., Nworah, K.O., Essien, P.E., Nwosu, J.N. and Ojukwu, M.[1]

ABSTRACT

"Ukpo" (*Mucuna flagellipes*) seed flour is one of the soup thickeners used in most rural Igbo-speaking communities of Southern Nigeria. Its preparation is usually associated with long cooking time which is required to soften the cotyledon before grinding as well as reduce the anti-nutritional components of the seed. This work was therefore aimed at determining the effect of boiling time on some functional properties and antinutritional properties of the ukpo seed flour. The result obtained showed that there were slight reductions in the protein, fat and ash content as boiling time increased probably due to leaching. All the functional properties analysed increased significantly ($p \leq 0.05$) with increasing boiling time. The water absorption, oil absorption and emulsion capacities increased from values of 1.60 ml/g, 1.23 ml/g and 9.3 ml/g respectively at 0 minutes to 3.2 ml/g, 2.8 ml/g and 17.66 ml/g respectively at 60 minutes. The bulk density and swelling index also increased from 0.72 g/ml to 1.17cm^3/cm^3 and from 1.02 g/ml to 1.36 cm^3/cm^3 respectively. The oxalate, tannin, saponin, phenol and phytate contents decreased significantly ($p \leq 0.05$) with increasing boiling time. The values at 60 minutes boiling time were 0.14%, 0.182%, 0.434%, 0.146% and 0.719% respectively. These results suggest that heat treatment improves the performance of the Ukpo flour in soup thickening while reducing to a large extent the anti-nutritional properties.

Keywords: Thickners, anti-nutritional, functional properties.

Introduction

Mucuna flagellipes which is popularly known as "ukpo" by the Igbo-speaking people of South-eastern Nigeria is a legume belonging to the sub-family papilonacea. It comprises pods covered with brownish dense whisker – like hairs called trichomes that are irritating when they come in contact with the skin or eyes. Each pod may contain 1 to 3 seeds with a hard coating which is white when immature and turns black when mature and dry. (Enwere, 1998).

Mucuna species generally have high protein content of 24% to 1.44%, lipids ranging from 2.86% to 9.8%, crude fibre (5.3 – 11.5%), ash (2.9 – 5.5%), and carbohydrate ranging from 59.2% to 64.88% (Arianthan *et al.*, 2003, Vadivel and Janardhanan 2000; Adebowale *et al.*, 2005; Ezeagu *et al.,* 2003).

The anti-nutritional factors found in Mucuna species include L-dopa, phenolics, tamin, haemagglutinins, trypsin and chymotrypsin inhibitors, phytic acid, saponins and cyanogenic compounds. (Vadivel and Janardhanan, 2000). However, most of these anti-nutritional factors are eliminated to low levels during processing. Ukachukwu and Obioha(1997) reported detoxification by cooking for 90 min or toasting for 60 min.

In Eastern Nigeria, *mucuna flagellipes* is used as a soup thickener in traditional soups preparation. Here the seeds are cracked, boiled, dehulled, ground to powder and added to the soup. In some localities, it is prepared as a choice dish. In this case the *mucuna*

[1] Department of Food Science and Technology, Federal University of Technology Owerri
* corresponding author: tobuz2000@yahoo.com

flagellipes is cracked, boiled overnight and dehulled. The cotyledons are spiced to taste and served as a delicacy. (Ezueh 1997, Anumnu 1991, Eneobong 1992).

The functional properties as well as the anti-nutritional properties of *mucuna flagellipes* have been studied by some authors (Ukachukwu and Obioha 1997, Vadivel and Janardhanan 2000). This research therefore was aimed at finding out the actual cooking time that may be applied in ukpo processing for maximum detoxification as well as maintain the necessary functional properties.

Materials and Methods

Preparation of samples

Mature, dry ukpo seeds were purchased from Owerri main market in Imo State, Nigeria. The seeds were cleared and sorted to remove spoilt seeds. Two grams of seeds were cracked and boiled for 0, 10, 20, 30, 40, 50, 60 min respectively. The seeds were cooled, dehulled and the cotyledons were milled to powder dried and kept in airtight containers prior to subsequent analysis.

Determination of Proximate Composition and anti-nutritional factors in ukpo seed flour samples

The proximate composition of the ukpo seed flour samples were analyzed using methods described by AOAC (1990). The tannin, phenol, phytate and oxalate contents were also determined using AOAC (1990) methods.

Determination of functional properties of ukpo seed flour samples

Determination of water absorption capacity

Water absorption capacity was determined by the method described by Abbey and Ibeh (1988). Flour samples (1 gdb) of each treatment was weighed separately and placed into clean centrifuge tubes of known weights. Distilled water was mixed with the flour to make up to 10 ml dispersion. The tubes were then centrifuged at 3500 rpm for 15 min. The supernatant was decanted and each tube together with its content was rew252eighed. The gain in mass is the water absorption capacity of the flour sample

Determination of oil absorption capacity

The method described by Abbey and Ibeh (1988) was adopted. Each flour sample (1 g) was weighed separately and introduced into clean centrifuge tubes of known weights. Groundnut oil was mixed with the flour in each tube to make up to 10 ml dispersion. The tubes were centrifuged at 3500 rpm for 15 min. The supernatant was discarded and the tubes reweighed. The gain in mass is the oil absorption capacity.

Determination of emulsion capacity

The procedure of Nwosu *et al.* (2010) was adopted. Flour sample of 2 g was mixed with 10 ml of distilled water for 30 sec in a mixer and magnetically stirred. After complete dispersion, deodorized vegetable oil (Devons Kings oil) was added continuously through a burette until emulsion breakpoint when separation into 2 layers was reached. The emulsion capacity in ml of emulsified oil per g was recorded.

Determination of bulk density

Method as described by Onwuka (2005) was adopted. A graduated cylinder 10ml was weighed dry and gently filled with the flour sample. The bottom of the cylinder was then tapped gently on a laboratory bench several times. This continues until no further diminution of the test flour in the cylinder after filling to mark, was observed. Weight of cylinder plus flour was measured and recorded. Bulk density (g/ml) = {weight of sample(g)}/ Volume of sample(ml)

Determination of swelling index

The swelling index was determined according to the method described by Ukpabi and Ndimele (1990). Three gram portions of the flour were transferred into clean dry graduated (50 ml) cylinders. The flour samples were gently filled and the volumes noted. Distilled water (30 ml) was added to each sample. The swirled cylinder was allowed to stand for 60 min, while the change in volume recorded every 15 min. The swelling index of each flour sample was calculated as multiple of the original volume as done by Ukpabi and Ndimele(1990).

Results and Discussions

Effect of boiling time on proximate composition

The proximate composition of the processed ukpo seed flour is shown on Table 1. The values indicate that significant difference ($p < 0.05$) exists among the processed samples. The ash, fat and crude protein content decreased from 4.41%, 3.87% and 27.69% respectively in the raw sample to values of 4.08%, 3.62% and 26.59% respectively at 60 min boiling time. These decreases in ash, fat and crude protein content can be attributed to losses due to leaching of soluble components into the boiling water. Crude fibre also decreased from 8.98% in the raw sample to 8.84% at 60 min of boiling. This is possibly due to thermal hydrolysis of large molecules into smaller ones and subsequent leaching of such compounds into the boiling water.

The moisture content of the ukpo seed flours increased from 12.14% in the raw sample to 12.61% at 60 min boiling time. This may be attributed to high cell damage due to long boiling time that resulted in high moisture retention (Uzoma and Osuji, 2004).

Effect of boiling on anti-nutrients

The values for the various anti-nutritional factors showed a significantly ($p < 0.05$) steady increase as the boiling time increased (Table 2). The oxalate tannins, saponins, phenols and phytates reduced from values of 0.838%, 0.314%, 0.539%, 0.152% and 1.327% respectively in the raw sample to low values of 0.140%, 0.812%, 0.434%, 0.148% and 0.719% respectively after 60 min boiling. This is as a result of thermal breakdown of these compounds and subsequent leaching of soluble components into the boiling medium. This reduces the levels of these anti-nutrients to safer levels.

The results also showed that the values of the tanins and phenols did not decrease significantly ($p < 0.05$) after 40 min. This suggests that these compounds have been reduced to minimal levels in the ukpo seed flour. Therefore, for economical reasons, it may be advisable to terminate the boiling after 40 min since further cooking does not reduce these substances further.

The reduction in these anti-nutritional factors will enhance the availability of nutrients especially minerals and also increase the safety of the products (Akpatta and Nelligaswatta, 2005).

Effect of boiling on functional properties

The results of the analysis of the functional properties of the raw and processed ukpo are shown on Table 3. A significant increase was observed among the values. The water and oil absorption capacities of the raw sample were 1.60 and 1.23 mg/g respectively. The values increased steadily to 3.2 and 2.8 mg/g respectively after boiling for 60 min. This suggests an increase in cellular water uptake with increased boiling time. Some previous authors have also reported better water absorption as well as oil absorption capacities of mucuna seed flours as against raw flours (Ahenkora *et al.*, 1999). The water absorption capacity of flour is useful in determining the suitability of the material in baked flours (Natt and Narasinga, 1981) while the increase in oil absorption capacity of the flour may help to maintain and improve mouthfeel, if such flours are used as meat extenders, etc. The oil capacity increased from 9.3 at 0 min to 17.66 at 60 min of boiling.

Also, increase in boiling brought about an increase in emulsion capacity of the ukpo flour from 9.3% in the raw sample to 17.66% after boiling for 60 min. The ability to form emulsions is an important characteristic of soup thickeners in southern Nigeria since the oil and water phase in the soup must not be separated. Soup thickeners with high emulsion capacity are very highly recommended.

The bulk density also increased gradually and significantly from the value of 0.72 g/ml at 0 min to the value 1.77 g/ml at 60 min. This indicates that the processed ukpo flour particles are better aligned and easily packed together. This is an advantage during transportation and distribution since a large amount of material may be accommodated in a smaller volume.

The swelling index increased from 1.02 at 0 min to 1.36 after 30 min boiling. This increase suggests that there was a partial breakdown of the starch thus making it possible for the starch to absorb more water and thereby swell. Boiling beyond 30 min did not result in an increase in this parameter. This trend was also observed in the water absorption capacity which also did not increase significantly after 30 min. The ability of flours to absorb water and swell is an important factor in the choice of soup thickeners.

Conclusion

The results showed that the boiling affected the various properties of the ukpo seed flour. The proximate composition showed slight reductions due to leaching. The anti-nutrients reduced significantly, suggesting that boiling is an effective means of detoxifying the seed. Boiling improved the functional properties of the ukpo seed flour. The bulk density, swelling index and water absorption and oil absorption capacities that are desirable properties in soup thickening improved after 40 min

Table 1: Mean value of the results of the proximate composition of *ukpo* flour

Sample boiling time (min)	Moisture content (%)	Ash (%)	Crude fat (%)	Fat (%)	Crude protein (%)	Carbohydrate (%)
0	12.14^{f}	4.40^{a}	8.98^{a}	3.87^{a}	27.69^{b}	42.96^{f}
10	12.20^{f}	4.41^{a}	8.97^{a}	3.80^{b}	27.64^{b}	43.04^{e}
20	12.30^{e}	4.34^{b}	8.95^{ab}	3.79^{b}	27.60^{b}	43.10^{e}
30	12.46^{d}	4.32^{b}	8.96^{a}	3.77^{bc}	26.27^{c}	43.25^{d}
40	12.61^{c}	4.19^{c}	8.92^{bc}	3.74^{c}	26.99^{d}	43.58^{c}
50	12.93^{b}	4.18^{c}	8.90^{c}	3.63^{d}	26.74^{e}	43.67^{b}
60	12.61^{a}	4.00^{d}	8.84^{d}	3.62^{d}	26.59^{a}	43.94^{a}

Mean value in the same column followed by the different superscript are significantly ($p \leq 0.05$)

Table 2: Mean value of the results of the anti-nutritional properties of ukpo flour

Sample boiling time (min)	Oxalate (%)	Tannin (%)	Saponin (%)	Phenol (%)	Phytate (%)
0	0.838^{a}	0.314^{a}	0.539^{a}	0.152^{a}	1.327^{a}
10	0.624^{b}	0.310^{a}	0.527^{b}	0.154^{b}	1.214^{b}
20	0.243^{e}	0.237^{b}	0.511^{c}	0.153^{b}	1.019^{c}
30	0.419^{c}	0.214^{c}	0.509^{c}	0.153^{b}	0.983^{d}
40	0.377^{d}	0.185^{d}	0.499^{d}	0.147^{c}	0.982^{d}
50	0.227^{e}	0.183^{d}	0.479^{e}	0.146^{c}	0.725^{e}
60	0.140^{f}	0.182^{d}	0.434^{f}	0.146^{c}	0.719^{f}

Table 3: Mean values for functional properties of ukpo at different boiling times

Samples boiling time (min)	WAC capacity %	OAC density	Emulsion	Bulk	Swelling index (cm^3/cm^3)
0	1.60^b	1.23^c	9.30^c	0.76^{ba}	1.02^b
10	1.70^b	1.33^c	11.10^d	0.68^{bc}	1.02^b
20	1.66^b	1.36^c	12.20^c	0.55^a	1.03^b
30	2.60^a	1.40^c	14.16^b	1.11^b	1.26^a
40	2.56^a	1.33^c	11.30^d	1.14^{ab}	1.30^a
50	2.70^a	2.06^b	12.70^c	1.14^{ab}	1.33^a
60	3.20^a	2.80^a	17.66^a	1.17^a	1.36^a

of boiling.

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