Effect of Processing Methods on the Nutrient and Phytochemical Properties of African Oil-Bean Seeds (*Pentaclethra macrophylla*), “Ugba”

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Abstract: The study assessed the effect of different processing methods on the phyto-chemical and nutrient properties of Africa oil-bean seeds *Pentaclethra macrophylla*, commonly known as Ugba. It is a traditional food, consumed by over 20 million people in Nigeria. It is a rich and available source of protein for people, whose staple foods are deficient in protein. Cleaned ugba seeds were subjected to different processing methods, which included: boiling, soaking, drying, and fermentation at different degrees, of 24 h, 48 h and 72 h. The samples were dried and examined on their nutrient, anti-nutrient and phyto-chemical properties. The sensory properties of the samples were determined. The result showed significant difference ($p < 0.05$) in the nutrients, ant-nutrient and organoleptic properties of ugba samples. The protein value of ugba samples, fermented for 72 h was highest (36.13%), in relation to the raw samples (29.49%). According to Ref. [1], fermentation may significantly improve the nutritive value of foods by: increasing the digestibility of protein through hydrolysis of proteins and amino acids. The samples that were boiled, had the highest (32.09%) fat content while the 24 h fermented samples had the least value (30.09%). The crude fiber and carbohydrate values of the raw ugba samples was highest (4.11% and 22.21% respectively). The ugba sample fermented for 72 h, recorded highest for calcium (34.13 mg/100 g), potassium (258.04 mg/100 g) and phosphorous (231.91 mg/100 g) in relation to other samples. This result supports the claim by Ref. [2] that fermentation is associated with microbial activities which stimulate better nutrient availability (particularly protein) and digestibility. The anti-nutrient composition of the samples varied. The 72 h fermented ugba had the least values for tannin (0.01 mg/100 g), phytate (0.01 mg/100 g) and oxalate (0.02 mg/100 g). Furthermore, the low level of phytate observed in this study is desirable because increased phytate level in the body, affects the availability of minerals, solubility functionality and digestibility of protein; Sensory properties of ugba samples showed significant difference ($p < 0.05$) among the samples. The 72 h fermented ugba sample, recorded highest value in: colour (7.85), aroma (6.95), taste (6.95), texture (7.0) and general acceptability (8.20), in relation to samples. The findings of this study had proved that, African oil bean (*Pentaclethra macrophylla*) seeds are rich sources of protein, and appreciable number of some essential minerals especially when processed adequately. Fermentation for 72 h, led to a significant increase in the nutrient availability of the product and a low anti nutritional properties was observed. Ugba seed could be explored to enrich the nutritional quality of some local dishes.

Key words: Oil-bean seed, processing methods, phytochemicals, nutrients.

I. Introduction

Ugba is the Igbo name for the fermented African Oil bean seeds (*Pentaclethra macrophylla*, Benth). It is called Ukana by the Efiks in Southern Nigeria. It is consumed by an estimated 15 million people in Eastern Nigeria, majority of who are Igbos [3]. It is a traditional food generally prepared in homes as a

small family business.

It is recognized by peasant farmers for its soil improvement properties and as a component of an agro forestry system [4] identified *Pentaclethra macrophylla* as a minor food supplement.

The method of production varies from one producer to another resulting in a non-uniform product [5]. The beans that have been fermented for more than three days are taken as a delicacy. Well fermented beans are added to soup as flavouring [6].

It is widely consumed in eastern states of Nigeria

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with tapioca, stock fish and garden eggs and leaves (Fig. 3). It can also be eaten with bitter kola (*Garcinia kola*) or kola nuts (*Cola acuminata* and *C. nitida*) and when prepared with garden egg leaves it is used to eat yam and cocoyam [7, 8].

African oil bean is an important and cheap source of protein for people whose staple foods are deficient in proteins [9]. The quantity of ugba produced annually is not known, since the seeds are collected by individuals and sold in the market to ugba producers.

The fruit is a black, hard and woody pod measuring about 35-36 cm long and 5-10 cm broad, as seen in Fig. 1. When mature it splits open explosively to release about eight flat, glossy brown seeds measuring about 5-7 cm in diameter and weighing between 15-20 g [10]. This is shown in Fig. 2.

The insufficient availability of animal protein sources, and costliness of the few available plant protein sources, has prompted an intense research into harnessing the nutrient potentials of lesser known underutilized legumes and oil seeds.

Legumes go through several primary processes before they are used in different food preparations. Some legumes are processed to detoxify the antinutritional factors, increase palatability and improve bioavailability of the nutrient.

The effect of processing on the nutritional quality of legumes nutritionally, the main effects of processing are detoxification, increasing palatability and bioavailability of nutrients. However, there are still other individual effects caused by specific process [11]. Nutritionally, soaking affects legumes either adversely or beneficially. According to Ref. [12], soaking reduces antinutritional factors such as trypsin inhibitors of legumes; water-soluble minerals, vitamins, amino acids, proteins and sugars are solubilized by the soak water. Long soak also causes enzyme driven changes in proteins, starch and cell wall materials, thereby inducing changes in physico chemical and functional properties of foods [13]. Long soak also increases nitrogen solubility and foaming

ability but decreases jelling and swelling capacity [14].

The oil bean seeds contain 4-17% carbohydrate, 44-47% oil which has been found to be rich in oleic acid [15] and linoleic acid [16].

They also reported that the oil bean seed contains about 75% saturated fatty acid and 25% unsaturated fatty acid.

The major unsaturated fatty acid in the seed is linoleic acid constituting 42.8%. Oleic acid is also present in appreciable amounts (29.0%). However, the sulphur containing amino acid content is much lower than those found in other plant proteins [17]. The high content of other essential amino acids makes the seeds a potential source of protein [18].

Methods for ugba preparation vary from one community to the other.

The fermented ugba deteriorates rapidly and can spoil within two weeks of production [19].

Fermented African oil bean seeds have typical aroma and flavour. These are due to the various volatile compounds produced by the fermenting microorganisms in the course of their metabolism. Not much work has been done in this direction. However, Ref. [20] studied the various flavour and aroma components present in the beans fermented with pure cultures of microorganisms isolated from ugba.

3. Materials and Methods

3.1 Collection of Samples

Fresh African oil bean seeds were purchased from Ahiazu Mbaise main market Imo state, Nigeria. Ahiazu Mbaise is a rural Local Government Area, located in Imo State, southeastern Nigeria.

3.2 Sample Preparation

As described in Fig. 4 (flow chart diagram) above: the seeds were washed in a basin of tap water and freed from dust and other foreign materials. The traditional natural fermentation method practiced in

Fig. 1 Oil Bean pod.

Fig. 2 Oil Bean seed.

Fig. 3 Oil Bean Cotyledon.

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Fig. 4 Flow chart for ugba flour production.

Nigeria was carried out as described by Ref. [21]. The seeds were boiled with water in an aluminum pot with a lid for 3 h and the hard coats were peeled off the cotyledons by hand. The cotyledons were cooled for 10-25 min and then cut into different slices ranging from 2.0 mm for small size, 2.5 mm for medium size and 3.5 mm for large size with, a sterile knife and washed with water. The slices were measured with a basic scientific instrument called caliper and boiled for 2 h, cooled and soaked in distilled water for 10 h.

Thereafter, the slices were drained in a basket lined with banana leaves for 12 h and further wrapped in blanched banana leaves to facilitate fermentation.

The ugba samples were processed as follow:

- Sample A = ugba fermented for 24 h;
- Sample B = ugba fermented for 48 h;
- Sample C = ugba fermented for 72 h;
- Sample D = unfermented ugba.

3.3 Proximate Composition Analysis

This was carried out according to the method of Ref. [22].

3.4 Sensory Evaluation

Color, texture, taste and general acceptability of the products were calculated untrained panelists selected from the department of Nutrition and Dietetics were used for assessing the organoleptic properties/using the untrained panelist including staff and students of the department. A nine-point hedonic scale was used for evaluation with the highest point (9) representing “like extremely”, (5) representing neither liked nor disliked while lowest point (1) representing “disliked extremely”.

3.5 Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) [23]. The mean separation values were determined using a Fischer LSD test. Significant difference was defined at $p < 0.05$.

Table 1 presents the proximate composition of ugba samples. There was significant difference ($p < 0.05$) among the samples. The moisture content varies significantly from 8.48-10.12%. The raw sample has the highest moisture content of 10.12% while soaked

sample has the least value 8.48% of moisture content. The protein ranged from 29.49-36.13%. The 72 h fermented sample has the highest protein value of 36.13% while raw sample has the least value 29.49% of protein content. The fat content ranged between 30.09-32.67% for 24 h fermented sample and boiled samples. The ash content varies for 3.02-3.46%, raw sample has the highest ash content of 3.46%, followed by soaked samples boiled sample units 3.26% and 3.12% respectively while 72 h fermented sample has the least value 3.0% of ash content. The crude fibre varies between 3.56-4.11% raw has the highest value of 4.11% of crude fiber while 72 h has the least value 3.56% of crude fibre content. The carbohydrate content varies significantly from 15.43 value of 22.21% the raw sample has the highest carbohydrate value of 22.21% followed by soaked sample and boiled sample with 21.23% and 19.50% respectively while 72 h fermented sample has the least value 15.43% of carbohydrate content.

The mineral compositions of ugba samples are presented in Table 2. There was significance difference ($p < 0.05$) among the samples. The 72 h fermented sample has the highest value in 34.13 mg/100 g, calcium 258.04 mg/100 g, potassium and 231.91 mg/100 g potassium and 231.91 mg/100 g phosphorous followed by 48 h fermented samples in 33.85 mg/100 g calcium and 231.03 mg/100 g phosphorous. Soaked sample has the least value in calcium 32.19 mg/100 g also raw sample has the least value in potassium 256.10 mg/100 g and 228.48 mg/100 g phosphorous.

The anti-nutrient of ugba sample was presented in Table 3. There was no significant difference ($p < 0.05$) among the samples. Raw samples have the highest value in tannin 2.04 mg/100 g, phylate 1.40 mg/100 g, oxalate 1.48 mg/100 g and saponin 0.46 mg/100 g while 72 h fermented sample has the least value in tannin 0.01 mg/100 g, phytate 0.01 mg/100 g and 0.02 mg/100 g.

Table 1 Proximate composition of ugba samples.

Ugba sample	Moisture %	Protein %	Fat %	Ash %	Crude fiber %	Carbohydrate %
Soaked sample	8.48 ^d +0.02	30.87 ^e +0.01	32.09 ^b +0.02	3.26 ^b +0.01	4.06 ^{ab} +0.01	21.23 ^b +0.01
Boiled sample	9.41 ^c +0.03	31.29 ^d +0.02	32.67 ^a +0.02	3.12 ^c +0.01	3.99 ^{bc} +0.02	19.50 ^c +0.02
24 h fermented sample	9.84 ^b +0.02	34.60 ^c +0.02	30.09 ^f +0.02	3.08 ^c +0.01	3.94 ^c +0.01	18.43 ^d +0.0
48 h fermented sample	10.06 ^a +0.05	35.29 ^b +0.02	31.4 ^d +0.02	3.02 ^d +0.01	3.77 ^d +0.03	16.38 ^e +0.01
72 h fermented sample	9.93 ^b +0.01	36.13 ^a +0.02	31.93 ^c +0.02	3.0 ^d +0.0	3.56 ^e +0.02	15.43 ^f +0.09
Raw sample	10.12 ^a +0.02	29.49 ^f +0.01	30.60 ^e +0.02	3.46 ^a +0.02	4.11 ^a +0.02	22.21 ^a +0.01
LSD ($p = 0.05$)	0.03136	0.02236	0.02255	0.01354	0.01936	0.06048

(+) Standard deviation. Mean scores in the same column with different letter are significantly different ($p = 0.05$).

Table 2 Mineral composition of ugba samples.

Ugba sample	Calcium mg/100g	Potassium mg/100g	Phosphorous mg/100g	Sodium mg/100g
Soaked sample	32.19 ^c +0.02	257.21 ^e +0.01	230.99 ^b +0.02	12.04 ^b +0.02
Boiled sample	32.97 ^e +0.02	256.96 ^d +0.02	229.76 ^c +0.02	11.82 ^c +0.05
24 h fermented sample	33.14 ^c +0.02	257.65 ^c +0.03	230.03 ^c +0.03	11.46 ^d +0.02
48 h fermented sample	33.85 ^b +0.02	257.90 ^b +0.02	231.03 ^b +0.03	10.86 ^e +0.03
72 h fermented sample	34.13 ^a +0.02	258.04 ^a +0.02	231.91 ^a +0.03	10.53 ^f +0.02
Raw sample	32.29 ^d +0.02	256.10 ^f +0.01	228.42 ^d +0.04	12.24 ^a +0.03
LSD ($p = 0.05$)	0.02708	0.02309	0.11026	0.03202

(+) Standard deviation. Mean scores in the same column with different letter are significantly different ($p = 0.05$).

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Table 3 Anti-nutrient composition of ugba samples.

Ugba sample	Tannin mg/100g	Phytate mg/100g	Oxalate mg/100g	Trypsin inhibitor TIU ^A /g	Saponin mg/100g
Soaked sample	1.12 ^b +0.02	0.94 ^b +0.02	0.13 ^b +0.03	0.72 ^a +0.03	0.06 ^b +0.02
Boiled sample	0.93 ^c +0.03	0.29 ^c +0.02	0.10 ^{bc} +0.0	0.09 ^b +0.0	0.03 ^c +0.0
24 h fermented sample	0.04 ^d +0.05	0.02 ^d +0.02	0.06 ^{cd} +0.01	0.06 ^{bc} +0.01	0.02 ^d +0.04
48 h fermented sample	0.03 ^d +0.0	0.02 ^d +0.02	0.03 ^{de} +0.0	0.05 ^{bc} +0.01	0.02 ^d +0.0
72 h fermented sample	0.01 ^d +0.0	0.01 ^d +0.02	0.02 ^e +0.0	BDL	BDL
Raw sample	2.04 ^a +0.02	1.40 ^a +0.02	1.48 ^a +0.0	BDL	0.46 ^a +0.01
LSD ($p = 0.05$)	0.02992	0.01688	0.01120	0.01473	0.00253

BDL = Below detectable limit (+) Standard deviation of duplicate sample. Mean scores in the same column with different letter are significantly different ($p = 0.05$).

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