Graded Fermentation Effects on Nutrient Content of Oil Bean Seed (*pentaclethra macrophylla*) Consumed in Umuayom Village, Awka

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Abstract
Graded fermentation was adopted to study its effect on nutrient composition of oil bean seed (*Pentaclethra macrophylla*). The unshelled oil seed was purchased and processed by hand picking the dirt, washed, cooked, dehulled, sliced and cooked again, allowed to ferment for 72, 96, 120 and 144 hours at about 35±2°C by the microflora inherent in the seed. The fermented products were milled. The fermentation periods brought about slight increases in protein, ash and carbohydrate content values and decreases in the fat content of seeds on wet weight bases. At 72hrs fermented sample had the highest (26.32±0.98mg/100g) iodine value, zinc (2.4±0.14mg/100g) and iron (2.97±0.14mg/100g).

Introduction
African oil bean seeds (*Pentaclethra macrophylla*) belong to leguminous family mimosa cease. It is frequently cultivated in forest areas. The pods explode at maturity and disperse the seeds. The number of the seeds depends on the length and size of the pod. The raw seed is a potential source of edible protein, energy and fatty acids (Enujiugha and Agbede, 2000; Enujiugha, 2003).

The oil bean seed is a family food. It has received most attention as fortifiers or ingredients for cheap nutritious and high nutrient quality formulated foods. Oil bean seed is among the oil seeds that store energy in form of oil. The quality of oil seed protein is not as high as that of animal (Enujiugha, 2003). However, it has considerably higher protein than that of cereals. Enujiugha (2006) stated from his study, rats given fermented seeds consumed more food than rats given heat-treated seeds which, in turn, consumed more food than rats given the raw seeds. Hence...
fermentation and heat treatment improved apparent digestibility, feed conversion efficiency (FCE) and protein efficiency ratio (PER). In general, rats given the various forms of the oil seed, lost weight, resulting in a negative protein efficiency ratio (PER) and feed conversion efficiency (FCE) (Enujiugha, 2003). The fermented seed product (ugba) is traditionally prepared in various steps. Boiling the oil bean seed overnight is the first step to soften it, followed by dehulling, slicing the cotyledons and cooking it a second time to soften and reduce bitterness by washing in fresh clean water for four to five times. The sliced cotyledons are fermented for a period of three days (Enujiugha, 2000; Enujiugha, 2003). After 3-day fermentation, it is known as ‘ugba’ which will now be ready to be consumed as snack or used as condiment in soup mixes, local salad and porridges. Previous works reported that fermentation improved the nutritional quality as compared with the unfermented seeds (Achinewhu, 1986).

The reliance on starchy roots like tubers and protein deficient cereals as main staples precipitates consumption of starchy and monotonous less nutritious diets. In Nigeria, especially infant and pre-school are malnourished mostly from protein-energy (Abidoye and Sikabofori, 2000). There is evidence that cheap and locally available food crops are abundant in Nigeria. Some legumes (oil seed) though might be toxic and contain anti nutrients, but require to be properly processed prior to use in order to destroy the toxicants and anti-nutrients (Isu and Njoku, 1997; Enujiugha, 2003).

Therefore the present study intended to investigate these neglected areas during the fermentation processes of the oil bean seed. Recent studies showed that apart from fermentation, roasting could serve as an alternative food processing technique yielding nutritious product (Enujiagha, 2000). However, roasting as a supplementary process had no significant effect on nutrient composition of the fermented product. Furthermore, both approaches altered the use of the product as a cherished condiment. These approaches caused some undesirable changes in normal quality attributes. Enujiugba and Akanbi (2008) suggested strongly that thermal processing is the most appropriate processing method for maintenance of preferred form and quality of ugba as well as ensuring its shelf life elongation.

Ugba is low acid food and product of alkaline fermentation. The application of heat to maintain commercial sterility could increase its nutritional quality and reduce its anti-nutrient and improve also the functional characteristics of the product. The thrust of the study was to determine the effects of processing, heat and different levels of fermentation on chemical composition
of treated ugba to increase and preserve its nutrient potential.

**Objective**

General objective of the study is to determine the effects of graded levels of fermentation on the nutrient contents of oil bean seeds as consumed in Umuayom, village, Awka. While the specific objectives are to determine the optimum fermentation period for production of ugba that contain the most desirable organoleptic attributes of the product; to determine the domestic food processing method that is much more effective to improve its nutritional and functional qualities and to determine the local use of the product.

**Materials and Methods**

The oil bean seeds were purchased from Nsukka local market in Enugu state, Nigeria. The seeds were cleaned by hand picking dirt, washed and cooked in a pressure cooker over a gas cooker marked 4 for 6 hours, and the hard seed coats were removed manually. The cotyledons were sliced to about 3.00-5.00cm long x1.00cm thick, steamed in a pressure cooker for 5 hours over a gas cooker marked 3 and soaked in 5% brine at 40°C for 2 hours. The slices were drained and weighed, 2 kg each was fermented using the traditional method in which green leaves called “uma” in eastern Nigeria was used to wrap the sliced cooked oil bean seed. This was subsequently put into a cellophane paper at a temperature 35°C for different fermenting periods: 72 hours, 96 hours, 120 hours and 144 hours. The fermented samples were ground in an electric grinder and passed through a 40-mesh sieve (aperture size 0.42mm) and kept at 20°C in sealed cellophane containers until analyzed for various nutrients.

**Proximate Chemical Analysis**

The proximate chemical composition of the samples was determined using the standard procedures method for sample treatment and analysis for moisture, crude fibre, ash and protein using the standard procedures recommended by Association of Official Analytical Chemist (AOAC, 1995) method. Microkjeldahl method was used to determine the nitrogen, which was converted to crude protein by multiplying with 6.25 (N x 6.25). Fat was extracted using the soxhlet apparatus. Ash was determined in a muffle furnace as by AOAC (1990). The carbohydrate content was obtained by difference. Energy value was calculated using the Atwater's conversion factors (www.nutribase.com/449.shtml).

**Mineral determination**

The mineral elements were determined using the analytical method of determining mineral constituents of food product (Hack, 2000). Samples obtained through ashing were used for this procedure which was the white fluffy mass. Five
milliliter of concentrated hydrochloric acid was used to digest ash content in glass petridish. The mixture was transferred to 50ml chemical flask using distilled water. Particles which cannot dissolve and would cause contamination were filtered off using Whatmann’s no. 1 filter paper in a funnel. The new filtrate was made up to mark in readiness for mineral nutrient determination. The elements determined include zinc, iron and calcium. The determination was made using method described by Hack (2000), standard reagents for the various elements to be determined were prepared. The series spectrophotometer was first warmed for 30min. Then, the standard reagent of the elements to be determined and distilled water was used to standardize the equipment. The samples contained in 10ml cuvette were then introduced into the sample chamber where the samples were read and recorded.

The extracted seed meals were thoroughly air-dried to remove traces of solvent. The extracted seed oils were immediately analyzed for iodine value using standard method (AOAC, 1990).

**Statistical Analysis**
The data generated were statistically analyzed using percentage, means and standard deviation by Steel and Torrie (1997).

### Results

Table 1: Proximate composition of oil bean fermented for 72, 96, 120 and 144 hours (%) (Wet weight bases)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture</th>
<th>Protein</th>
<th>Ash</th>
<th>Fat</th>
<th>Fibre</th>
<th>Carbohydrate</th>
<th>Energy kcal</th>
</tr>
</thead>
<tbody>
<tr>
<td>72hrs</td>
<td>44.66±4.30</td>
<td>14.02±0.45</td>
<td>2.18±0.07</td>
<td>8.44±2.04</td>
<td>15.10±0.35</td>
<td>14.09±0.24</td>
<td>188.40±0.89</td>
</tr>
<tr>
<td>96hrs</td>
<td>50.90±1.30</td>
<td>14.36±0.22</td>
<td>2.39±0.07</td>
<td>7.78±0.87</td>
<td>15.00±0.19</td>
<td>15.47±0.28</td>
<td>189.34±0.67</td>
</tr>
<tr>
<td>120hrs</td>
<td>44.47±4.09</td>
<td>14.42±0.19</td>
<td>2.96±0.21</td>
<td>7.65±1.04</td>
<td>14.66±0.39</td>
<td>16.66±0.24</td>
<td>193.17±0.79</td>
</tr>
<tr>
<td>144hrs</td>
<td>52.32±2.53</td>
<td>14.43±0.22</td>
<td>3.12±0.44</td>
<td>7.42±0.62</td>
<td>15.62±0.39</td>
<td>17.81±0.29</td>
<td>195.74±0.29</td>
</tr>
</tbody>
</table>

Mean ±SD of three determinations

Table 1 presents proximate composition of oil bean fermented for 72, 96, 120 and 144hrs respectively. The 72 and 120hrs fermented samples had the lowest moisture content and comparable values (44.66 and 44.47%) respectively. On the other hand, the 96 and 144hrs samples had slight variation (50.90 and 52.32%) respectively.

**Protein values varied.** There were slight increase in the protein value with increased hours of fermentation (14.02 – 14.43%). At 144hrs the protein value was highest 14.43±0.22%, followed by 14.42±0.19% at 120hrs then 14.36±0.22% at 96hrs and at 72hrs
its value was 14.02±0.45%.

Ash - Ash value also followed the same trend as protein value, as it increased with increasing fermentation period. It ranged from 2.18±0.07 to 3.12±0.94 respectively.

Fat value - The fat value decreased as the hours of fermentation appreciated (8.44-7.42%). At 72hrs the fat value was 8.44±0.07%, at 96hrs it came down to 7.78±0.87%, 7.65±1.04% at 120hrs and 7.42±0.62% at 144hrs.

Fibre - Fibre values experienced fluctuations from 72 to 144hrs fermentation periods (15.10, 15.00, 14.66 and 15.62%) respectively. After dropping (14.66±0.38%) at 120hrs period, it picked up (15.62±0.39%) at 144hrs.

Carbohydrate - The carbohydrate content of the sample appreciated with fermentation periods increasing (14.09±0.29 - 17.81±0.24%). The highest value 17.81±0.29% was observed at 144hrs while the lowest 14.09±0.24% was at 72hrs.

Energy value - Energy value was highest (195.74±0.29kcal) at 144hr fermentation period. As the fermentation period increased the energy values appreciated also.

Table 2: Mineral composition of 72, 96,120 and 144hrs fermented oil bean (mg/100g).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Calcium</th>
<th>Iodine</th>
<th>Zinc</th>
<th>Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>72hrs</td>
<td>0.16±0.05</td>
<td>26.32±0.98</td>
<td>2.44±0.24</td>
<td>2.97±0.14</td>
</tr>
<tr>
<td>96hrs</td>
<td>0.17±0.07</td>
<td>19.32±0.22</td>
<td>2.06±0.07</td>
<td>2.15±0.24</td>
</tr>
<tr>
<td>120hrs</td>
<td>0.15±0.00</td>
<td>11.01±0.98</td>
<td>1.86±0.13</td>
<td>2.68±0.18</td>
</tr>
<tr>
<td>144hrs</td>
<td>0.39±0.35</td>
<td>25.65±0.39</td>
<td>1.57±0.22</td>
<td>2.72±0.24</td>
</tr>
</tbody>
</table>

Mean±SD of three determinations

Table 2 presents mineral content of 72, 96, 120 and 144hrs fermented African oil bean seed samples. Calcium values were less than 0.5mg/100g. The 144hrs treated sample had the highest calcium value of (0.39±0.35mg/100g). The 120hrs treated sample had the least value of (0.15±0.00mg/100g) while the 72 and 96hrs treated samples had the least value of (0.16±0.05 and 0.17±0.07mg/100g) respectively.

Iodine values revealed that at 72hr treatment the sample had the highest iodine value of (29.32±0.98mg/100g). The value decreased at 96 and 120hr treatments, with values (19.32±0.22 and 11.01±0.98mg/100g) respectively. However there was a dramatic increase rate of 25.65±0.9mg/100g at the 144hr treatment.

Zinc value was highest at 72hr treatment (2.44±0.24mg/100g) and decreased as the hours of treatment increased. That is 96hr to 144hr (1.57±0.22 to 2.06±0.07mg/100g).

Iron values show the highest with (2.97±0.14mg/100g) at 72hr
fermentation, (2.15±0.24mg/100g) at 96hr treatment and then an acceleration from 120 to 144hr (2.68±0.18 to 2.72±0.24mg/100g) respectively.

Discussion
The results have shown that African oil bean seeds in the fermented forms have enough protein nutrients to satisfy protein requirements of populations in developing countries that rely much on starchy staples. Enujiugha (2003) reported lower (9.31%) crude protein in cooked unfermented oil bean seeds. According to Fogarty and Griffin (1973) they established that Bacillus species implicated in oil bean seed fermentation are important producers of proteases. These intracellular proteases easily hydrolyze complex plant proteins to amino acids and short chain peptides, thereby causing an increase in total nitrogen content.

The ash value observed was comparable to Enujiugha (2003), but decreased as fermentation period increased. This decrease was contrary to Enujiugha’s (2003) findings, although it could be explained by the fact that the fermentation periods in this study exceeded that of his study. The highest ash value (3.12±0.44) for the 144hr sample appears to suggest that 144hr was the optimum period to obtain ash from oil bean seed.

According to Mohamadou et al. (2008) the increase of ash content in the fermented product could be attributed to the increased metabolic activities of the fermenting microorganisms. Some of the biosynthetic mechanisms, especially those involving Bacillus species, are capable of synthesizing divalent metals.

Fermentation at 72hrs had the highest (8.44%) fat value, but decreased as fermentation period increased. Akubor and Chukwu (2008) reported that fermentation significantly decrease oil content of African oil bean seed flour in their study. The decrease in the oil content of samples could be attributed to glycerol, one of the hydrolytic products of lipids, not being fat-soluble (Landers and Rathmann, 1981).

Crude fibre had varied values at different fermentation temperature, which may or may not be attributed to fermentation processes. This agreed with Landers and Rathmann (1981) who reported that crude fibre content is not affected by fermentation, which could be due to the inability of the microbial agents to synthesize cellulose and hemicelluloses for the hydrolysis of complex polysaccharides in the seeds. It is also known that the higher fibre content of a given food, the higher is its quality with regards to human beings’ consumption.

The carbohydrate content of the four samples values (14.09±0.29 to 17.81±0.24) respectively were not a surprise, because according to Achinewhu (1986) during fermentation the carbohydrate extract
increased slightly but steadily throughout the end of fermentation period, with a difference of more than 15%. This increase could be attributed to the hydrolysis of complex oligosaccharides in the seed. Akubor and Chukwu (2008) reported that there was significant decrease ($p<0.05$) in the carbohydrate contents of the fermented African oil bean flour compared to the cooked samples they worked on.

Energy calculated at 144hr fermentation revealed that the more the hour of fermentation the energy appreciated. It is known that oil bean seeds store fat as a source of energy and not carbohydrate.

At 144hr of fermentation calcium value was highest (0.39±0.35) the optimum value for calcium extraction from oil bean. The comparable values of (0.16, 0.17 and 0.15mg/100g) respectively for other three samples have the capability of furnishing the same nutrient.

The first and second highest iodine values of (29.32 and 25.65mg/100g) at 72 and 144hr respectively strongly suggest that these two periods were optimum for the releases of the nutrient from oil bean seed. The lower zinc value except for 72hr sample value of 2.44 mg/100g and fermentation beyond 72hr seriously affected zinc levels as well as iron value.

**Conclusion**

As shown in the result, increased fermentation periods slightly increased protein and ash values more than the other: (moisture, fat, crude fibre and carbohydrate) values. Fermentation at 144hrs increased calcium, while at 72hr period iodine, zinc and iron values were more adequate.

**Recommendation**

A much more detailed work is imperative to study the functional properties of oil bean seed and its uses for various traditional dishes. Dietitians should be encouraged to incorporate oil bean seed into infants’ feeds as to bust their protein content.

Efforts should be focused on the shelf-life of processed African oil bean seed, so as to export same to other countries. Industries can process oil bean seed for exportation.

**References**


