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Effect of Fermentation on the Nutritional and Antinutritional Composition of *Lagenaria Siceraria* Seeds

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Abstract: *The dehulled seeds of three varieties of Lagenaria siceraria were subjected to control fermentation process. The fermented and unfermented seeds were analysed for their nutritional and anti-nutritional compositions using AOAC 1998. The fermented seeds were found to contain high amount of crude protein (48.12%) and crude fibre (4.11%) compared to 27.42% and 0.67% for unfermented seeds respectively. Similarly, crude lipid content of the seeds decreased by about 75%. The process also results in decrease in phytate, oxalate, tannins and cyanide content with consequent increase in nitrate and Vitamin C. Hence fermenting the seeds is an important way of exposing its protein content and reducing the antinutritional content. The seeds were found to have good potentials for preparation of condiments which are commonly used in the preparation of soup.*

Key words: *Anti-nutritional, fermentation, Lagenaria, seed, nutritional*

I. Introduction

Lagenaria siceraria is an annual climbing or crawling plant that is commonly cultivated in Northern Nigeria. It is called calabash gourd or bottle gourd in English, *Gyandama* in Hausa and *Akeregbe* in Yoruba. Members of this family consist of different varieties such as calabash, bottle gourd and calabash gourd and are widely used for ornamental purposes.

The plant bears fruit of different varieties and shapes as shown in plates 1-3. The numerous variations in shapes of these fruits are as a result of cross pollination of flowers of different species; this yields a different fruit with shape and size different from that of parent flowers [1] . This resulted into a dilemma on assigning scientific names to each variety; hence some of the varieties were called using local names of the geographical location of their origin. Its seeds are brown in colour, rectangular in shape and of variable size depending on the variety. They seed coat texture ranges from smooth in some varieties to those with marginal ridges [1,2].

Although researches have shown that many seeds such as those of *Parkia biglobosa*, *Rhizopus oligosporus*, *Parkia roxburghii* were fermented before being used in condiment preparation [3,4,5], *L. siceraria* seeds has not been documented for its use in fermentation.

Plate 1.**Calabash Gourd (Sterile neck) or*Luddai* in Hausa language**

Plate 2. Bottle Gourd(Seeded neck) or *Gyandama* in Hausa language

Plate 3. Elongated Calabash Gourd or *Zungurum* in Hausa language

The current work aimed at studying the effect of fermentation on the nutritional and antinutritional composition of raw and processed *L. siceraria* seeds.

II. Materials and Method

2.1 Sample collection and treatment

Lagenaria siceraria fruits were obtained from a farm land in Bukkuyum Local Government Area, Zamfara State, Nigeria. The fruits were identified at the Botany Unit, Department of Biological Sciences of Usmanu Danfodiyo University, Sokoto. The seeds were removed from the spongy pulp of the fruit, dried and dehulled manually. The dehulled seeds were kept pending the time for analysis.

2.2 Fermentation process

The seeds (100g) were cooked for six hours (to softness) at 100^0C, covered in an airtight condition inside a pot for 24 hours, after which it was pounded, mixed with a solution of potash(1g/kg of sample) to form a paste and fermented in an airtight condition at 31^0C for 109 hours. The paste was air dried to a constant weight (this was to terminate the fermentation) and stored in a dark polythene bag prior to analysis.

The fermented and unfermented seeds were analysed for their residual moisture, ash, crude lipid, crude protein, crude fibre, and available carbohydrate contents [6]. Their phytate content was estimated using the method of Young and Greaves, [7], oxalate by Day and Underwood, [8] tannins by Allen et al.,[9], hydrocyanic acid by AOAC, [6].The nitrate and ascorbic acids were determined using IITA, [10] and AOAC, [6] respectively. The results obtained in each case were subjected to t-test using SPSS package.

III. Result and Discussion

Fig. 1-3 summerises the effect of fermentation on some nutrient composition of *L. siceraria* seeds. As seen in the charts, there was significant decrease in ash, lipid and available carbohydrate contents with consequent increase in residual moisture, crude protein and crude fibre contents of all the varieties.

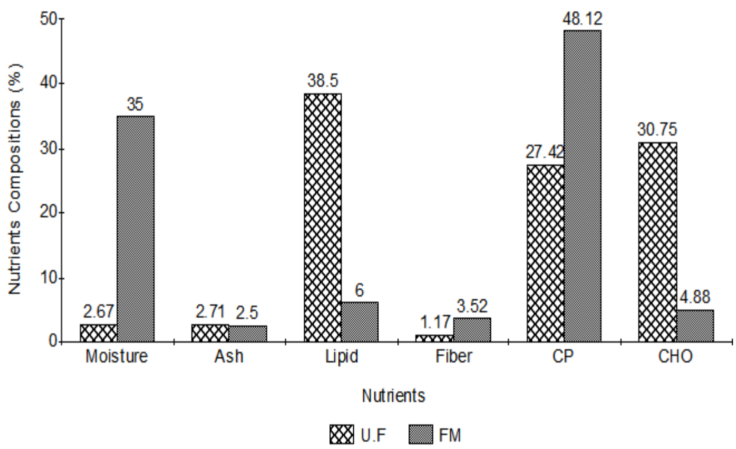

Figure 1: The Effect of Fermentation on the Proximate Composition of *Luddai* seed

Key: U.F- Unfermented seed while F.M- fermented seed.

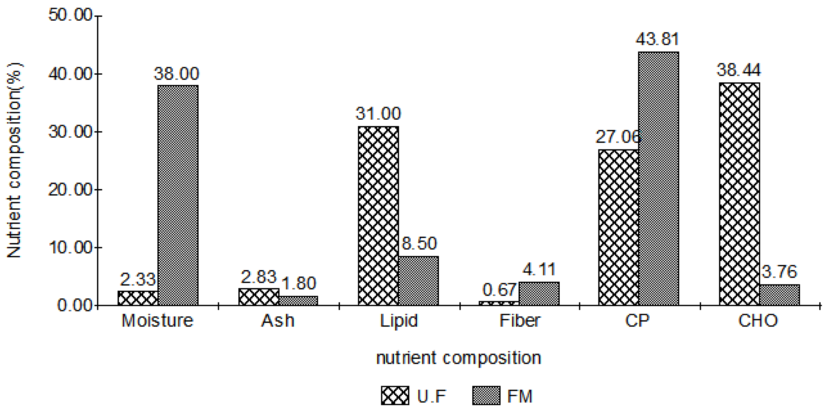

Figure 2: The Effect of Fermentation on the Proximate Composition of *Gyandama* seed
U.F stands for the unfermented seed while F.M represents fermented seed

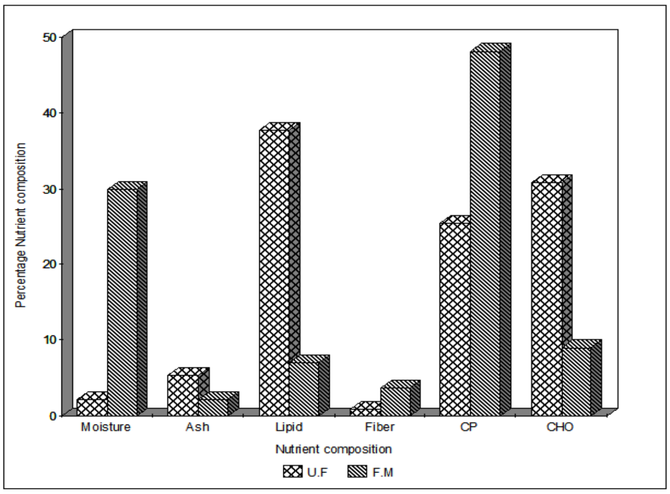

Figure 3: The Effect of Fermentation on the Proximate Composition of *Zungurum* seed
U.F stands for the unfermented seed while F.M represents fermented seed.

Fig. 4-6 shows some antinutrient and antioxidant profile of *L. siceraria* seed. Phythate ranged between (9.88-11.11mg/g; 19.53-20.84mg/g), oxalate (5.85-6.01mg/g; 6.45-7.05 mg/g), Tannins (4.81-5.52 mg/g;19.85-22.92 mg/g), cyanide ($7.53x10^{-5}$ -9.73 $x10^{-5}$ mg/g; $1.33x10^{-4}$ – $1.43x10^{-4}$ mg/g), Nitrate (400-412 mg/g; 211-220 mg/g) and Ascorbic acid (11.59-13 mg/g; 5.17-6.05 mg/g) for fermented and non fermented seeds respectively.

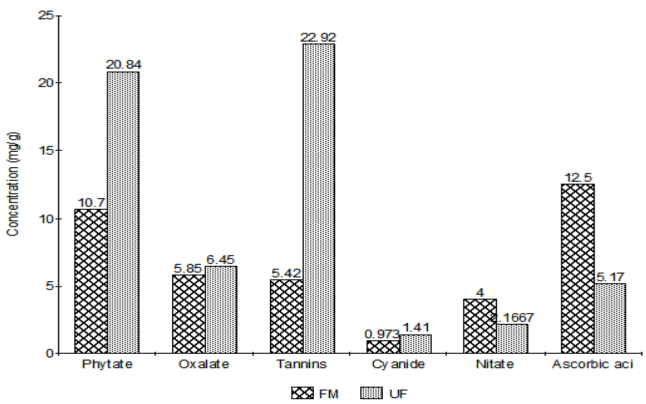

Figure 4: Some anti-nutrient and antioxidant contents of fermented and non-fermented *Luddai* seeds
Note: Ascorbic acid and nitrate content are x 10^{-5} and 10^{2} respectively**.**

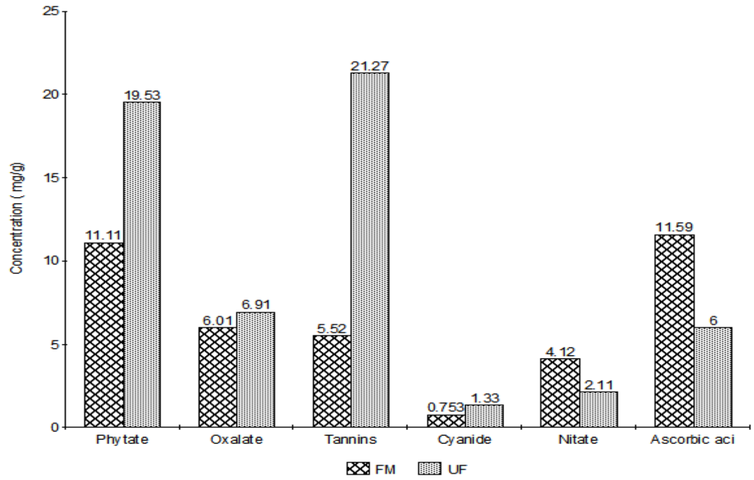

Figure 5 : Some anti-nutrient and antioxidant contents of fermented and non-fermented *Gyandama* seeds
Note: Ascorbic acid and nitrate content are x 10^{-5} and 10^{2} respectively.

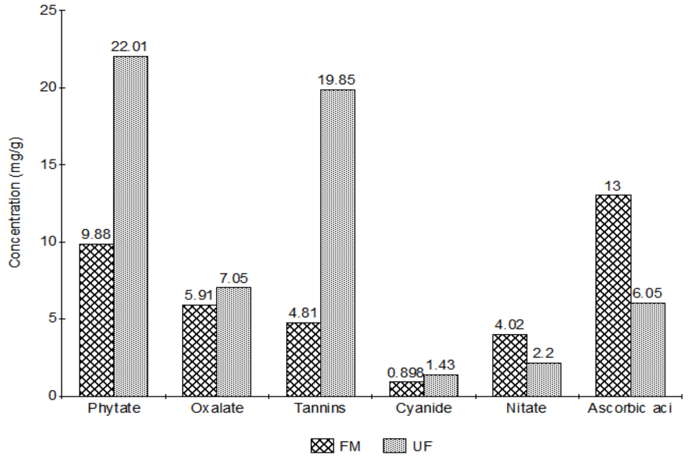

Figure 6: Some anti-nutrient and antioxidant contents of fermented and non-fermented *Zungurum* seeds
Note: Ascorbic acid and nitrate content are x 10^{-5} and 10^{2} respectively.

IV. Discussion

Moisture content of the fermented dehulled seeds are in the order *Gyandama>Ludddai> Zungurum* with values 38, 35 and 30 respectively. The values are significantly high when compared with the residual moisture content of unfermented dehulled seeds 2.6, 2.3 and 2.17%. The increase in the residual moisture content of the seed is due to boiling processes done during fermentation. This reduces the storage quality of seed when compared with the unfermented. High moisture content was also reported in fermented Banbra nut and African oil Bean[4,11].

The fermentation process has also shown significant impact on the ash content of the seed as seen in Fig. 1-3. Decrease in the ash content of fermented seed was in accordance with the observations of Fadahunsi and Sani [4]. This could be attributed to the drastic increase in protein and residual moisture content of the fermented seed which consequently lead to proportionate decrease in ash content. However, reduction in ash content of the seed contradicts the findings of Odebunmi et al, [5] on fermented locust bean seed.

Achinewu, 1986 observed no significant change in lipid content between fermented and unfermented African oil bean but only transformation of the saturated fatty acids to unsaturated ones. Similarly, Odebunmi et al., 2010 reported a significant increase in crude lipid content of pakia biglobosa seed from 19.30 to 35.27%. However, in this research, there was a drastic reduction in the seed's crude lipid from <40% to 6.0-8.5%. This indicates that the organism used for the fermentation has in addition to sugar, utilized fatty acid as its source of energy. The result concurs with the findings of Fadahunsi and Sanni [4] on fermented Bambara nut seed.

The Protein content of the seed was found to almost doubled that of the unfermented seed. This could be attributed to the increase in microbial activity and protein hydrolysis [4]. This pre-digestion of protein is highly favourable as protein quality depends on both amino acid composition and availability[11,4]. In comparison with some food condiments such as locust bean (35.73%), ginger (8.75%) and garlic (7.87%), it is apparent that, fermented *L. siceraria* seed is a better protein source for condiment preparation [5].

Carbohydrate and fibre content of the fermented seeds decreased sharply when compared with the unfermented seeds as seen in Fig. 4-6. This could be as the result of hydrolysis and subsequent utilization of sugar from the carbohydrate. The observed decrease is in agreement with the findings of Achinewu [11}, Fadahunsi and Sanni [4] and Odebunmi et al., [5] who observed decrease of 27.7% and 27.8% for crude fibre and reducing sugar respectively. Hence, fermenting the seed would be a good way of reducing their carbohydrate content thus, making it relative safe for people requiring less sugar food.

There were significant difference in the results of the anti-nutrient components figure 4-6 of the fermented and non-fermented *L. siceraria* seeds respectively; phytate (10.70±0.32 and 20.84±0.72)mg/g, oxalate (5.85±0.45 and 6.45±0.26)mg/g, tannins (5.41±0.14 and 22.92±2.13)mg/g and cyanide ($9.73x10^{-5}$±0.00 and $1.41x10^{-4}$ ±0.00)mg/g.

Phytate content (mg/g) of fermented *L. siceraria* seed (10.70±0.32) was significantly ($p<0.05$) lower than unfermented seed (20.84±0.72) indicating 49% decrease due to fermentation. In comparison with phytate content of both fermented and unfermented *J. curcas* seed, *L. siceraria* has lower phytate content [12]. However, the percentage decrease in phytate content (49%) is comparable to (50%) obtained in the fermentation process of *J. curcas* seed. These observations are however contrary to the observations of Oladele and Oshodi [13] who observed an increase in the phytate and tannin content as a result of fermentation; but in consonance with what earlier obtained for reduced phytate by Oseni and Ekperigin [14] when pure strains of Aspergillus niger were used to ferment maize cobs, it is however possible that the mode of fermentation and the species of organisms involved play crucial roles in the fermentation processes. Decrease in phytate content due to fermentation will help in ensuring the bioavailability of minerals such as Ca, Mg, Fe, and Zn [15].

The difference between the Oxalate content (mg/g) of fermented (5.85±0.45) and non-fermented (6.45±0.26) seeds is not significant ($p<0.05$). Oxalate content of both samples is quite low when compared with 10.31±1.00% reported for baobab seed [16]. On the other hand, the values obtained in this work are higher than 0.23, 0.31, 0.46 and 0.56mg/g reported for Artocarpus heterophyllus, Strychnos innocua, Bombax glabra, and Cola millenii seeds respectively [17]. Oxalate, when present in large quantity, chelates with some metal ions in the body, rendering them insoluble. Hence, cannot be absorbed in the intestine [18]. Thus, fermenting the seed would go a long way in solving the problem of nutrients mal-absorption.

Unfermented seeds are four times higher in tannin than fermented ones, indicating significant reduction in tanning content due to fermentation. The tannin content was higher than the range of 1.08-1.27mg/g reported for some lesser known Nigerian seeds [17]. Conversely, the tannin content of the samples was lower than that of Baobab seeds with the values 2.84±0.30%[16].

Cyanide compositions (mg/g) of the samples were 9.73×10^{-5}±0.0 and 1.41×10^{-4}±0.0 for fermented and unfermented *L. siceraria* seeds respectively. The cyanide content in mg/g of the non-fermented *L. siceraria* seed (1.41×10^{-4}) was very low compared to 5.1mg/g obtained by Onweluzo and Nwabugwu [19] in their work on the fermentation of Millet (Pennisetum americanum) seeds for flour production. However, the effect of their fermentation is in agreement following the reduction in the cyanide content in both (9.73×10^{-5} in *L. siceraria* and 4.9 in Millet) by 31% and 4% respectively.

Generally, it has been established that fermentation results in decrease of phytate, tannin and oxalate contents of *L. siceraria*, *J. curcas* and *P. americanum*. Similarly, processing by fermentation, moist heating or any other heat treatment has also been reported to reduce anti-nutrients constituents of plant foods,[20]

Fig. 4-6 showed considerable difference in the nitrate content as a result of fermentation; 212.50±31.82 and 400.00 ± 318.20mg/g, for the non-fermented and fermented seed respectively (an increase of about 47%).As a rule, 5mg/g NO_3 on a dry matter basis is safe. Concentration of 5 to 10 mg/g NO_3 is considered potentially toxic. However, concentration above 10mg/g NO_3 is considered dangerous [21]. This shows that the nitrate content of *L. siceraria* is too high but this could be as a result of accumulation of the nitrate which is usually triggered by some environmental stress, where plant growth is restricted but absorption of nitrate from the soil continues.

The result also showed that the seed contained 5.17± 0.58 mg/g ascorbic acid. Although the quantity is appreciably large, fermentation almost tripled it to 12.50 ± 3.37 mg/g (an increase of about 60%). Ascorbic acid is needed for the growth and repair of tissues in all parts of our body. An average of 45, 28, 70, 82.5 mg/day ascorbic acid is recommended for infants (0-12 months), children (1-13 years), adolescents (14-18 years) and adults (19 years and above) respectively [22].

V. Conclusion

In conclusion, the fermentation of *L. siceraria* seeds showed a significant increase in the crude protein, crude fibre and residual moisture suggesting it to have good potentials as protein source. Furthermore, fermentation also resulted in the significant reduction in the phytate, oxalate, tannins, and cyanide content with consequent increase in the nitrate and ascorbic acid contents. Hence, fermenting the seed could be a viable approach to reduction of the antinutritional content of the seed and also a method for the production of protein concentrate.

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