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Effect of varying fermentation periods on the proximate and vitamin composition of Mahogany Bean (*Afzelia africana*) seed flour

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ABSTRACT

Mohagany bean seed (*Afzelia africana*) locally known as "akparata" in Nigeria among the Igbos is a food thickening agent with some nutritional values. However, the availability of these nutrients is dependent on the processing method used on the seeds. Fermentation as one of the methods of processing was used in the processing of *Afzelia africana* seeds. The seeds were bought, sorted and roasted for 20 – 25 minutes on gas cooker at 145°C. Then dehulled, cracked into smaller pieces and divided into four portions. One portion was not soaked while three others were fermented for 24hrs, 48hrs and 72hrs. The fermented cotyledons were dried in the oven at 60°C for 24hrs separately. All the (four samples) seeds processed were ground into flour separately using hammer mill machine and sieved using cheese cloth (0.4mm diameter) to obtain fine flour. The proximate and mineral compositions of the samples were determined using standard methods. The results showed the following ranges: moisture content (4.36% - 4.46%), ash (3.41% – 6.05%), crude fibre (1.87% – 2.29%), fat (10.21% – 22.47%), protein (14.88% – 22.33%) and carbohydrate (45.56%–62.11%). The moisture, crude fibre, ash and carbohydrate content of fermented *Afzelia africana* increased as fermentation period increased. The fat and protein contents of fermented *Afzelia africana* decreased as fermentation period increased. Fermentation does not necessarily increase protein quantity but quality due to increase in micro organisms that use protein for metabolism. The pro-vitamin A content of unfermented and fermented *Afzelia africana* varied from 14.88iu – 22.36iu, ascorbic acid (7.76iu – 39.48iu) and vitamin E (6.57iu– 10.66iu). The results showed that fermentation for 24hrs yielded the highest pro-vitamin A and vitamin E content. This shows that fermentation increases the quantity of the ash, crude fibre, vitamin A and E of the seeds.
Keywords: Fermentation, proximate, vitamin composition, of Mahogany Bean, *Afzelia Africana* and seed flour

INTRODUCTION

Legumes are plants in the botanical family leguminosae (fabaceae). Various types of legumes are consumed either as staple foods, additives, or thickeners due to their nutritional values. In support of this [1], stated that the nutritional value of legumes is gaining considerable interest in developed countries because of the demand for healthy foods. Again legumes are excellent source of many essential nutrients, including vitamins, minerals, fibers, antioxidants, and other bioactive compounds, as well as being associated with health promoting benefits, such as reducing risk for CVD [2]. [3] also stated that legumes are high in proteins, carbohydrates and dietary fibres and a rich source of other nutritional components. Specifically, [4] noted that *Afzelia* protein content ranges from 21.88-26.38%; moisture 4.65-5.67%; fat 23.38-32.53%; crude fibre 19.07-20.38% and carbohydrate 25.20-9.87%. [5] also stated that legume produce primary and secondary metabolites and other phytochemicals. *Afzelia africana* and *Brachystegia eurycoma* are used as thickening agents. Apart from the thickening properties, these seeds also impact the tastes of foods and flavor. Thus, these properties widened the usage especially in the Southern part of the country. Thickening agents are substances which are added to a mixture to increase its viscosity without substantially modifying other properties such as taste and aroma [6]. The seed flour from these thickening agents has gelatin properties and gives viscous texture when used in soups [7]. They are used as emulsifiers and flavouring agents in traditional soups. Apart from this culinary use, it is possible for these flours when used as additives in other foods to impact desirable textural and functional properties to the finished food product particularly the "convenience foods" [2]. *Afzelia africana* has medicinal purposes and is used in traditional medicine as laxative, analgesic, antihaemorrhagic, febrifuge, aphrodisiac, emmenagogue and emetic. It is also used in local medicine for treating digestive problems and for general pain relief. Its bark is used as a fish poison. However through the process of decoction and infusion, it can be used for treating malaria, rheumatism, paralysis and constipation [8]. [3], also observe that thickening agents can also be used when medical conditions such as dysphagia cause individuals difficulty when swallowing.

The use of legumes as food had some problems due to their hard-to-cook phenomenon, low digestibility and bioavailability of nutrients, flatulence effect and beany flavour as a result of antinutrients such as tannins, phytates, trypsin inhibitors, haemaglutinnins, cyanide, oxalate and among others [9]. Fermentation overcomes the disadvantage of a long cooking time, leading to an easily digestible product and reducing some toxic components [10]. Legumes like *Afzelia africana* are used as soup thickeners in Nigeria among the lgbos using different processing methods. Some of these methods help to reduce/eliminate some toxins from these legumes. However, the people are mostly ignorant of the importance of some of the processing methods used. The research done by [11] supported that antinutrients can be reduced or eliminated by processing such as soaking, dehulling, extraction, fermentation, germination/sprouting and heat treatment. Fermentation generally decreased the antinutrients content of the seeds. The longer the fermentation period the lower the antinutrients content of the seeds and more available the nutrients are in the body.

In view of all these effects of fermentation on food, this research focused on the identification of the chemical composition of *Afzelia africana* and the effects of their varying fermentation periods on the nutritive value of the seed flour.

MATERIALS AND METHODS

Four kilogrammes (4kg) of *Afzelia africana* were purchased from Ogige market in Nsukka, Enugu State, Nigeria. The seeds were identified and characterized at the Department of Plant Science, University of Nigeria, Nsukka. The seeds were roasted in sand bath with continuous stirring as is traditionally done using gas cooker at 145°C. The roasting lasted for 20- 25min. After roasting, the seeds were dehulled and cracked into small pieces. The dehulled seeds were divided into four equal portions; one portion was not fermented and three portions were fermented separately for 24hrs, 48hrs and 72hrs and oven dried at 60°C for 24hrs. The unfermented *Afzelia africana* was not soaked nor dried in the oven. The samples were ground with hammer mill and sieved separately using cheese cloth (0.4mm diameter) to obtain fine flour. The flour was stored in an air tight container and put in the refrigerator at 4°C until used for analysis and experiment as shown in figures 1and 2.

Traditional method of processing (unfermented)

Afzelia africana seeds
↓
Seeds sorted
↓
Roasted (20-25mins at 145°C)
↓
Dehulled
↓
Cracked (smaller pieces)
↓
Ground (fine flour)
↓
Stored (air tight container in refrigerator at 4°C)

Fig 1: Flow chart for the traditional processing method of *Afzelia africana* flour.

Fermentation method of processing *Afzelia africana* flour

Afzelia africana seeds

↓

Seeds sorted

↓

Roasted (20-25mins at 145^oC)

↓

Dehulled

↓

Cracked (smaller pieces)

↓

Fermented (for 24hrs, 48hrs and 72hrs)

↓

Oven dried (60^oC for 48hrs).

↓

Ground (fine flour)

↓

Stored (air tight container in refrigerator at 4^oC)

Fig 2: Flow chart of production of fermented *Afzelia africana* flour

Chemical analysis of samples

Proximate composition

Samples of unfermented and fermented *Afzelia africana* flour were analyzed for the following: protein, fat, crude fibre, moisture and ash using the methods of the Association of Official Analytical Chemists (2012)[12]. The carbohydrate content was determined by difference between 100 and total sum of the percentage of protein, fat, crude fibre, moisture and ash.

Vitamin determination.

The Vitamins C and E contents of the unfermented and fermented *Afzelia africana* flour were determined using A.O.A.C (2012) [12]. Pro-vitamin A was determined using the spectrophotometric method described by [13]. Statistical analysis of data was performed using the statistical product and service solution (SPSS) version 21.0 for the descriptive analysis such as means and standard deviation.

RESULTS

Table 1: Percentage proximate composition of unfermented and fermented *Afzelia africana*

Sample Description	Moisture	Ash	Crude fiber	Fat	Protein	Carbohydrate
UnFAa	4.36±0.03	3.41±0.03	1.87±0.02	22.47±0.02	22.33±0.02	45.56±0.02
FAa24hrs	4.44±0.02	4.63±0.04	1.94±0.03	20.61±0.02	21.90±0.02	46.48±0.02
FAa48hrs	4.45±0.02	4.85±0.03	2.21±0.06	15.84±0.04	20.14±0.02	52.51±0.02
FAa72hrs	4.46±0.03	6.05±0.02	2.24± 0.07	10.21±0.03	14.88±0.02	62.11±0.03

Values are expressed as Mean ±SD

Key:

UnFAa -Unfermented *Afzelia africana*

FAa24hrs - Fermented *Afzelia africana* for 24hours

FAa48hrs - Fermented *Afzelia africana* for 48hours

FAa72hrs - Fermented *Afzelia africana* for 72hours

Table 2: Vitamin composition of unfermented and fermented *Afzelia africana* flour (dry weight)

Samples	Pro-vitamin A (IU)	Vitamin C (mg)	Vitamin E (mg)
UnFAa	18.11±0.03	39.48±0.02	8.27±0.21
FAa24 hrs	22.36±0.02	35.88±0.02	10.66±0.01
FAa48 hrs	20.96±0.03	20.34±0.01	10.22±0.03
FAa72 hrs	14.83±0.03	7.76±0.02	6.57±0.02

Values are expressed as Mean ± SD

Key:
UnFAa - Unfermented *Afzelia africana*
FAa24hrs -Fermented *Afzelia africana* for 24hours
FAa48hrs - Fermented *Afzelia africana* for 48hours
FAa72hrs - Fermented *Afzelia africana* for 72hours

DISCUSSION

The results in table 1 show that *Afzelia africana* (*Aa*), has moisture content of the unfermented flour as 4.36% while that of fermented flour for 24hrs, 48hrs and 72hrs were 4.44%, 4.45% and 4.46% respectively. The moisture content of the fermented flour increased as the period of fermentation increased from 24hrs to 72hrs. The increase in the moisture content after fermentation could be attributed to hydrolytic decomposition of the flour during fermentation. This is in line with the work done by [4] who found out increase in moisture content on fermentation of *Afzelia africana (Aa)*. The ash content of unfermented flour was 3.41% while that of fermented flour for 24hrs, 48hrs and 72hrs were 4.63%, 4.85% and 6.05% respectively. The ash content increased as fermentation period increased. This observed increase in ash content of the flour is similar to the observation by [14] who stated that total ash increase with fermentation period of castor oil seed. The high ash content of fermented *Afzelia africana* compared with the unfermented *(Aa)* could be due to loss of dry matter caused by the activities of enzymes and microorganism during fermentation [15]. However, this is contrary to the result reported by [4] on the effect of fermentation on the proximate composition and functional properties of *Afzelia africana* flour which resulted to decrease in ash content. The crude fiber content of unfermented *Aa* was 1.87% while fermented *Aa* for 24hrs, 48hrs and 72hrs were 1.94%, 2.21% and 2.24% respectively. The crude fibre contents of *Aa* increased as fermentation period increased. However, the crude fiber obtained in this study was lower than the values reported by [4] for *Afzelia africana* seeds. The fat content of unfermented *Aa* was 22.47% and fermented samples had 20.61%, 15.84% and 10.21% for 24hrs, 48hrs and 72hrs respectively. The fat content of the fermented samples were found to decrease as fermentation time increased and this might be attributed to the increased activities of the lipolytic enzymes during fermentation which hydrolyses fat components (triacylglycerol) into fatty acid and glycerol. This result agreed with the report of [16] who observed a decrease in crude fat as fermentation period increased on pigeon pea. The high fat content of unfermented *Aa* makes this plant a potential source of vegetable oil and is comparable to the fat contents of dehulled soya bean seed (20.40%) and cotton seed (20.00% - 26.20%) [8].The decrease in fat found as fermentation time increased may be as a result of some micro-organisms such as moulds. The result of this study showed that the unfermented *Aa* has high protein content of 22.33%. This was within the range reported by [4] who stated the crude protein value of unfermented *Aa* as 21.88%. The fermented *Aa* showed a gradual decrease in protein content as fermentation period increase as follows 21.90%, 20.14%, 14.88% at different hours (24hrs, 48hrs, 72hrs) of fermentation respectively. This result was supported by results of [17] on pigeon pea who reported a decrease in crude protein during 24hrs and 48hrs but an increase at 72hrs fermentation period. The decrease in the protein during fermentation may be attributed to a possible increase in the number of microorganisms that utilize protein for metabolism. Table 2 shows that the Pro-vitamin A content of unfermented *Aa* was 18.11iu while the values of fermented *Aa* decreased with increase in fermentation period. Specifically, the values of 24hrs, 48hrs and 72hrs fermented *Aa* were 22.36iu, 20.96iu and 14.83iu respectively. The result of this finding agreed to the findings of [2] who reported decrease in Pro-vitamin A content of fermented Mung bean flour. The reduction of Pro-vitamin A in 72hrs fermentation reported in this work could be attributed to nutrient loss as a result of leaching. This could also be due to the combined effect of β-carotene and improved moisture loss resulting from fermentation. The vitamin C content of unfermented *Aa* was 39.48mg. The ascorbic acid content values reported in this work were higher than the value reported by [18] for underutilized unfermented legumes 0.5-0.9mg/100g. Vitamin C content of fermented *Aa* was 35.88mg, 20.34mg and 7.76mg respectively for 24hrs, 48hrs and 72hrs of fermentation period. The vitamin C content of the samples was found to decrease as fermentation time increased. This agreed with the report of [19] who found reduction of ascorbic acid in lupin seeds and soymilk. This may be as a result of degradation or biosynthesis of ascorbic acid by microbes in the fermentation process. The vitamin E content of unfermented *Aa* was 8.27mg while that of fermented *Aa* ranged from 6.57-10.66mg. The vitamin E content increased at 24hrs fermentation *Aa* (10.66mg) and gradually reduced at 72hrs fermentation *Aa* (6.57mg). The increased in vitamin E content found in this study agreed with finding of [20] who reported that fermentation increased the vitamin E content of soy bean. These results suggest that some microbes may biosynthesize tocopherol during the fermentation process.

CONCLUSION

It was evident from the study that fermenting *Afzelia africana* seed flour (*Aa)* decreased crude protein, fat and vitamin C. Fermentation increased moisture, ash and crude fibre, vitamin A and E contents of the seeds. In view of this, fermentation improves the nutrient quality, reduces the anti-nutritional factors to safe levels, and increases its digestibility, thereby changes inedible foods to edible. Therefore, fermentation should be encouraged as a natural means of improving nutritional quality of legumes.

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