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Effect of Varying Fermentation Temperature on Proximate Composition and Mineral Content of African Oil Bean Seeds (Pentaclethra Macrophylla- Benth)

Okechukwu E. C.[1] Itah A.Y.[2] Aguora S. O.[3]

[1,2] Department of Microbiology, Faculty of Natural and Applied Sciences, University of Uyo, Akwa Ibom State, Nigeria.

[3]Department of Pharmacology and Therapeutics, College of Health Sciences, Nnamdi Azikiwe University Nnewi Campus, Anambra State, Nigeria.

Corresponding author: Okechukwu Edith Chinenye (ecokechukwu@gmail.com)

Abstract: *Proximate composition and mineral content analysis were carried out on the African Oil Bean Seeds (Pentaclethra macrophylla -Benth) fermented under three temperature regimes 8^0C, 26^0C and 33^0C subjected to 0-144 hours fermentation period. The laboratory samples of African Oil Bean Seeds and market samples were evaluated for their proximate composition and mineral content. The result revealed that the Oil Bean Seeds samples under room temperature (26^0C) had the highest nutritional content of crude protein of 18.58 % amongst other Oil Bean Seeds samples under the cold and hot temperatures. The Oil Bean Seeds samples under room temperature (26^0C) had the highest value of the most abundant mineral content of potassium (K) 0.77%%. The most abundant mineral found in the fermented Oil Bean Seeds was potassium (K) with values ranging from 0.32% to 0.77%. Sodium (Na) was the least abundant in the Oil Bean Seeds samples, values 0.005% to 0.020%. The mineral content of the Oil Bean Seeds sample therefore followed this sequence K>P>Mg>Ca>Na. The results have shown that the fermentation process under standard hygienic conditions at room temperature remains adequate to enhance the flavour, taste, colour and nutritive value of African Oil Bean Seeds.*

Keywords: *African Oil Bean Seeds, proximate composition and mineral content, physicochemical analysis, fermentation temperature and nutritive value.*

I. Introduction

Fermentation is a form of food preservation technology that has been used from ancient times. Over the years it became part of the cultural and traditional norm among the indigenous communities in most developing countries especially in Africa. The rural folk have come to prefer fermented over unfermented foods because of their pleasant taste, texture and colour. This popularity has made fermented foods one of the main dietary components of the developing world (Nout *et al*., 1999; Aderiye *et al*., 2003). Thus, fermentation is unique in that it modifies the unfermented food in diverse ways, resulting in new sensory properties in the fermented product (Leroy *et al*., 2004).

The African Oil Bean tree (Pentaclethra macrophylla-Benth) is a large leguminous woody plant that belongs to the sub-family Mimosoidae (Keay, 1989). It is frequently cultivated in forest areas, with about eight (8) flat glossy brown edible seeds per pod. The plant grows both as wild and cultivated types. The raw seed is a potential source of edible protein and calories, containing the twenty (20) essential amino acids and essential fatty acids that make up more than 80% of the fatty acids in the oil (Ikediobi, 1981; Enujiugha and Agbede, 2000).

Fermented legumes occupy significant position in the dietary needs of the world population (Steinkraus *et al*., 1983). In recent times, there has been an increasing need for protein that is required for healthy growth and repair of worn out tissues in the body. But the reach for these protein-containing foods such as fish, beans, meat and eggs by the common man has not been easy as a result of the cost. Therefore there is a tendency for the teaming population to resort to cheap sources of protein of which edible fermented Oil Bean Seeds form a part.

Reports on the production of fermented condiments from African locust bean 'iru' (Eka, 1980), melon seed, fermented Ogi (Odunfa, 1981, 1986; Barber and Achinewhu, 1992) and soybean 'Daddawa' (Omafuvbe *et al*., 2000). The proximate composition indicates these condiments could contribute to the daily intake of proteins, lipids and minerals when used liberally, as practiced in several homes, where expensive animal products are a luxury (Omafuvbe *et al*., 2000, 2002). Seeds of legumes may account for 80% of dietary protein and may be the only source of protein for some groups.

Fermentation of the African oil bean seeds does not have any significant effect on the lipid composition of the product; a lot of protein may be lost in the process of the traditionally fermented oil bean seeds even though it may still maintain at least 55% of its nutritional value (Achinewhu, 1983). Therefore there is need to evolve new methods of producing high grade of edible fermented oil beans seeds through laboratory or industrial means to minimize the loss of protein and other nutrients. The purpose of this study is to investigate the effect of varying fermentation temperature on the proximate composition of African oil bean tree (Pentaclethra macrophylla Benth).

II. Materials and Methods

2.1. Source/Collection of Samples

The African Oil Bean Seeds used in the study were purchased locally from Nwafor Market in Nnewichi in Nnewi North Local Government Area of Anambra state, Nigeria. The purchased samples were collected in sterile polyethylene bags and were sent immediately to the laboratory. The traditional technique in the fermentation was followed in the laboratory preparation.

2.2. Processing of Samples for Analysis

The traditional method of preparing 'Ugba' was employed in the laboratory to ferment the product. The processing of the large brown glossy seeds of the African Oil Bean to obtain 'Ugba' involved the following; the Oil Bean Seeds were boiled in an autoclave at a temperature of 121^0C and a pressure of 15 pounds per square inch (psi) for 1 hour to soften the hard brown testa (shell). The shells were removed and the kernels washed, drained and rewashed with cold water several times. The washed cotyledons were cut into long thin slices. These slices were mixed with salt, wrapped in small packets with leaves and lightly tied. These small packets were placed in a basket to ferment at room temperature for 3 days to yield 'Ugba'.

2.3 0rganoleptic Analysis

The physical properties of the samples were analysed. The samples were felt for sliminess, odour was perceived and colour observed throughout the fermentation process. Ten students who felt and reported same giving scores were used for the assessment.

2.4 Proximate Analysis of the Samples

The proximate and chemical composition of the samples was determined using the standard procedures of AOAC (1990). The crude protein content was calculated by multiplying the total nitrogen by the factor 6.25. The carbohydrate content was estimated by difference and expressed as the nitrogen free extracts (NFE). Other parameters determined were moisture content, ash content, crude protein, crude fat, crude fibre and carbohydrate content. These parameters were determined according to methods of AOAC (1990).

2.5 Determination of Mineral Content

The following minerals such as Sodium (NA), Potassium (K), Calcium (Ca) and Magnesium (Mg) were determined from the fermenting African Oil Bean samples according to the AOAC (1990) procedures.

2.6 Physicochemical Analysis

There are several physicochemical parameters in the environment which influence the presence, growth, diversities and abundance of microorganisms in 'Ugba' samples. pH and titrable acidity were determined as described by Aderibigbe *et al.,* (2006).

2.6.1 pH Determination

For the determination of pH of 'Ugba' samples, 1 gram was grounded using an electric blender and thereafter dissolved in 9ml of deionized water contained in test tubes. This was measured using Pye, Unicam pH meter, model 291 equipped with glass electrode. The pH value displayed by the pH meter before taking the actual reading was noted, the meniscus of the pH meter was then allowed to stabilize. The reading was done immediately the 'Ugba' sample arrived to the laboratory.

2.6.2 Temperature Determination

This was done using calibrated mercury in glass thermometer. A hole was bored through the wrapped samples and the temperature readings were taken at 12 hours intervals.

2.6.3. Measurement of Titratable Acidity (%)

The titratable acidity expressed in percent (%) acid produced was determined by the titration of 10ml of fermenting ‘Ugba’ sample dissolved in deionized water with 0.1N NaOH using phenolphthalein as an indicator until the end point (pink colour) is achieved (Achi *et al* ., 2000). The percentage total titratable acidity (%TTA) was calculated

III. Results

Table 1 shows the ph value and proximate composition of the Oil Bean Seeds at the three varying temperatures (8^{0}C, 26^{0}C and 33^{0}C) including the already prepared market sample of the Oil Bean Seeds ranging from 0 hour to 144 hours. The pH values increased from 6.14 at 24 hours at 8^{0}C to 8.10 at 144 hours at 26^{0}C. The crude protein content value was 15.31% for market sample (control) and 16.63% at 48 hours under 33^{0}C, 18.58% at 120 hours at 26^{0}C. The moisture content ranged between 33.71% at 0 hour at 8^{0}C to 56.40% at 144 hours at 8^{0}C and the market sample value was 51.31%.

The crude fat ranged from 46.60% at 48 hours at 8^{0}C to 58.61% at 144 hours at 33^{0}C, and 33.00% for market samples. The crude fibre ranged between 1.48% at 144 hours at 8^{0}C to 2.00% at 48 hours at 33^{0}C and market sample (1.70 %). The ash content ranged between 4.58% at 144 hours at 8^{0}C to 6.00% at 48 hours at 33^{0}C market sample (5.12%). The carbohydrate value ranged between 12.38% at 96 hours at 8^{0}C to 29.37% at 48 hours at 8^{0}C and 44.87% of the market sample.

Table 2 shows the mineral content of the fermenting Oil Bean Seeds at the varying temperatures (8^{0}C, 26^{0}C and 33^{0}C) including the already prepared market samples of the Oil Bean Seeds ranging from 0 hour to 144 hours. The most abundant mineral in the fermented Oil Bean Seed was Potassium (K) with values ranging from 0.32% at 144 hours at 8^{0}C to 0.77% at 48 hours at ambient temperature (26^{0}C). Sodium (Na) seem to be the least abundant in the food sample, values ranging between 0.005% at 48 hours at 8^{0}C to 0.020% at 96 hours at 33^{0}C. The second most abundant mineral is Phosphorus (P) with values ranging from 0.11% at 0 hour at 8^{0}C to 0.75% at 120 hours at 8^{0}C. The third is Magnesium (Mg) 0.021% at 144 hours at 8^{0}C and 33^{0}C to 0.044% at 0 hour across the three temperature regimes. Calcium (Ca) is penultimate to the least available mineral 0.014% at 48 hours at 8^{0}C to 0.036% at 0 hour across the three temperature regimes.

Table 1: Proximate Composition of the Fermented Oil Bean Seeds.

Time	Sample	pH	Moisture (%)	Crude Protein (%)	Crude Fat (%)	Crude Fibre (%)	Ash (%)	Carbohydrate (%)
	Market	6.70	51.31	15.31	33.00	1.70	5.12	44.87
0hr	8^{0}c	6.43	33.71	17.80	54.66	1.60	4.80	21.14
	26^{0}c	7.40	36.44	18.20	55.50	1.72	5.20	18.17
	33^{0}c	7.33	35.80	17.70	55.62	1.81	5.35	25.65
24hrs	8^{0}c	6.14	35.75	17.85	50.71	1.64	4.88	27.80
	26^{0}c	7.41	36.54	18.13	55.55	1.75	5.30	18.19
	33^{0}c	7.35	35.83	17.74	55.60	1.91	5.60	25.75
48hrs	8^{0}c	6.17	38.43	17.93	46.60	1.70	5.00	29.37
	26^{0}c	7.69	40.65	18.38	56.66	1.83	5.50	17.63
	33^{0}c	7.52	38.56	16.63	56.31	2.00	6.00	26.06
72hrs	8^{0}c	6.21	45.63	17.67	52.11	1.59	4.70	22.17
	26^{0}c	7.70	43.20	18.24	55.58	1.76	5.35	19.15
	33^{0}c	7.55	39.11	18.23	56.76	1.88	5.40	26.88
96hrs	8^{0}C	6.76	54.56	17.07	54.38	1.54	4.63	12.38
	26^{0}C	7.75	44.10	18.11	55.40	1.73	5.20	19.56
	33^{0}C	7.57	41.08	18.38	57.66	1.69	5.08	18.19
120hrs	8^{0}C	6.49	55.74	17.05	55.71	1.54	4.61	21.59
	26^{0}C	7.78	45.31	18.58	56.19	1.70	5.30	18.90
	33^{0}C	7.63	42.44	18.45	58.32	1.81	5.40	25.00
144hrs	8^{0}C	6.52	56.40	17.01	56.18	1.48	4.58	21.10
	26^{0}C	8.10	47.55	18.03	56.85	1.77	5.20	24.40
	33^{0}C	7.68	43.09	18.51	58.61	1.67	5.10	17.17

Table 2: Mineral Content of the Fermented Oil Bean Seeds.

Time	Sample	Calcium (%)	Magnesium (%)	Potassium (%)	Sodium (%)	Phosphorus (%)
	Market	0.028	0.036	0. 42	0.04	0.122
0hr		0.036	0.044	0.49	0.008	0.11
24hrs	8^0c	0.028	0.032	0.54	0.006	0.12
	26^0c	0.030	0.038	0.65	0.010	0.15
	33^0c	0.025	0.035	0.51	0.008	0.12
48hrs	8^0c	0.014	0.024	0.56	0.005	0.12
	26^0c	0.024	0.036	0.77	0.014	0.17
	33^0c	0.022	0.031	0.53	0.009	0.13
72hrs	8^0c	0.016	0.025	0.45	0.010	0.16
	26^0c	0.021	0.039	0.50	0.012	0.19
	33^0c	0.022	0.030	0.52	0.015	0.22
96hrs	8^0C	0.018	0.026	0.39	0.013	0.19
	26^0C	0.020	0.040	0.39	0.013	0.20
	33^0C	0.022	0.030	0.53	0.020	0.24
120hrs	8^0C	0.015	0.023	0.35	0.009	0.75
	26^0C	0.020	0.037	0.50	0.010	0.18
	33^0C	0.021	0.029	0.37	0.013	0.21
144hrs	8^0C	0.014	0.021	0.32	0.007	0.15
	26^0C	0.019	0.036	0.47	0.008	0.18
	33^0C	0.020	0.021	0.34	0.011	0.19

IV. Discussion

Proximate composition is the true representation of the nutritive value of any food. Any food that contains these nutrients such as protein, carbohydrate, fat is defined as food with high nutritive value. The proximate composition of the fermenting Oil Bean Seeds at varying fermentation temperature and time was evaluated as shown in Table 1: protein, fat, fibre, ash and carbohydrate composition respectively. The results are in agreement with the works of (Okorie and Olasupo 2013; Eze *et al*., 2014).

The results have shown that the fermented African Oil Bean Seeds especially the Oil Bean Seeds fermented at room temperature produced substantial amount of nutrients that could meet the protein demand of the population that may not be able to afford protein from other expensive sources. This is consistent with the reports of (Enujiugha, 2003; Eze *et al*., 2014) carried out on the seeds of African Oil Bean Seeds. The relative increase in the crude protein content present in the Oil Bean Seeds may be as a result of the enzymatic actions produced by the mesophilic microorganisms responsible for the Oil Bean Seeds fermentation. The increase in protein content could also be attributed to the increase in the microbial population during the fermentation leading to the hydrolysis of protein molecules into amino acids and simple peptides. The values of the percentage of protein content (16.63- 18.51%) revealed in this research is comparable to the values (16.45%) of the work by Eze *et al*., (2014) on the same seeds. On the contrary, the value in this work is lower than the value in the report of (Enujiugha, 2003). These variations may be ascribed to the diverse species of the African Oil Bean Seeds, the climatic and the environmental conditions under which this plants grow. The increase in the moisture level as the fermentation time increased though at cold temperature may probably be due to the absorbent nature of the sliced seeds and condensation of water during the chilling period.

The reduction in the ash content could be as a result of boiling and leaching of the soluble inorganic salts during fermentation. Isichei and Achinewhu (1998) reported similar findings on African Oil Bean Seeds. The reduction in the fibre content may be due to the dissolution effect on the fibre as well as enzymatic degradation of the fibrous material fermentation. The fat content showed increase with respect to fermentation time and temperature. The result agrees with the report of Igbabul *et al.*, (2014). This could be attributed to the fermenting microbes that could not utilize the fats as their major source of energy and may be as the result of breakdown of large fat molecules into smaller fatty acids component by the actions of lipolytic enzymes. The carbohydrate content decreased as the fermentation time increased with respect to the temperature (cold). This could be attributed to the increase in the moisture content.

African Oil Bean Seeds contained the minerals in trace amounts. Potassium (K) was the most abundant but decreased as the fermentation time increased. The highest value of the mineral was at the room temperature at 48 hours and decreased significantly as the fermentation progressed at 144 hours. This could mean that there will be loss of essentials minerals as the fermentation time increases. This is ascribed to the washing off of the soluble mineral element into the fermenting medium. The result agrees with report by Igbabul *et al.*, (2014). It is evident that the seed is a source of some of the essential mineral that the body require.

The organoleptic properties results showed that the samples fermented under the cold temperature (8^0C) were slow to enhance the flavour, taste and colour. With the samples under room temperature the enhancement was adequate, but the samples under hot temperature (33^0C) biodegraded drastically before the end of the normal fermentation time.

V. Conclusion

The fermentation of African Oil Bean Seeds at the appropriate temperature and time has exhibited its nutrient availability and digestibility. Fermentation as a way of food processing improves nutritional quality, shelf life of food and enhances sensory qualities of food. Fermented foods have continued to be widely accepted as they are valued as important dietary component among developing nations like Nigeria.

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