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CHARACTERISTICS AND COMPOSITION OF FERMENTATION CONTAINERS, ITS EFFECT ON pH, SOME FUNCTIONAL PROPERTIES AND PROXIMATE COMPOSITION OF FERMENTED LOCUST BEANS (*Parkia biglobosa*)

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ABSTRACT

The choice of container for fermentation of locust bean (Iru) has been of contention by local processors having preference for some materials over others. Calabash gourd, high density polyethylene (plastic) and stainless steel were used as containers to ferment locust bean for a threshold of 72 hrs. PH of significant difference p<0.005 was obtained for calabash gourd 6.02, plastic 5.95, and stainless steel 5.8. Insignificant differences were obtained in bulk density, water absorption capacity and oil absorption capacity for the same experiment. For the proximate analysis, moisture content of significant difference p<0.005 was obtained in plastic 6.31%, calabash 5.90% and stainless steel 5.36%. Furthermore, significant difference were obtained in crude fat, ash and carbohydrate contents with calabash having 35.07%, plastic 34.10%, and stainless steel 33.81%for crude fat while ash content was 2.42% for stainless steel, 2.35%

respectively for calabash and plastic. Carbohydrate was 13.67% for stainless steel, 13.45% for plastic and 11.65% for calabash. Protein and fiber had insignificant mean difference. The three respective containers have low thermal and electrical conductivities. Calabash, a polymer of lignin fused with cellulose has the lowest thermal and electrical conductivities of 0.163W/m^{o}K and 0.01 W/m^{o}K at 298^{0}K followed by plastic, a polymer of polyethylene with 0.4W/m^{o}K and 0.44W/m^{o}at 298 ^{o}K and stainless steel an alloy of Iron, Chromium, Nickel, Molybdenum, Carbon, Manganese and Nitrogen having the highest values of 15 W/m^{o}K and 16W/m^{o}K at 298^{o}K respectively. The insulating capacity and ability to retain and sustain heat in a closed system is inversely proportional to both thermal and electrical conductivities.

Keywords: Fermentation, Material, Characteristics and Composition.

1.0 INTRODUCTION

Materials used as containers for fermentation of pulses are required to retain and sustain heat in its system in order to drive the fermentation reaction. Certain characteristics such as low thermal conductivity [1] and low electrical conductivity are parameters since they are both directly proportional in all materials [2]. Polymer based material [3] which constitutes strong covalent bonds and weak Vander Waals forces [4] with hydrophobic interactions are key indicators of materials with high insulating capacity. Plastics are polymer of ethylene (C_2H_4) and are generally known to be good thermal and electrical insulators [5] as well as the calabash gourd which consist of lignin, an amorphous polymer stiffened with fiber of cellulose [6]. Furthermore, stainless steel which is a non-polymer based material exhibits low thermal conductivity [7] which allows retention of more energy that stabilizes the surrounding temperature. It has an alloy constituent of Fe, Mo, C, Mn, N, 18% Cr, and 8% Ni. These are key indicators materials that help retain heat in their respective systems that help enable sustainable enzymatic reactions in the presence of LAB (Lactic acid bacteria) to produce fermented desired product.

Fermented foods constitute a significant component in African diets. There are many fermented foods known in Africa with different classifications based on their derived substrate [8] of which condiments are a part of. Condiments can be defined as spices that are added to food preparations to impart a particular flavor or enhance its taste. Fermented food flavoring condiments are products usually derived from the fermentative activities of microorganisms on vegetable proteins of legumes and oil seeds origin [9, 10], of which Iru from an African locust bean are amongst others. These fermented food condiments are known to be good source of proteins and vitamins [8].

African locust bean tree (*parkia biglobosa*) is one common plant whose seeds are used as protein source condiment after fermentation. It is consumed by various socio-ethnic groups in the West African sub-region. It is popularly known as “Iru” in south western Nigeria or “dadawwa” in northern Nigeria. The traditional method of preparing “Iru” is tedious and energy consuming [11]. Below is a flow chart illustration of fermented locust beans.

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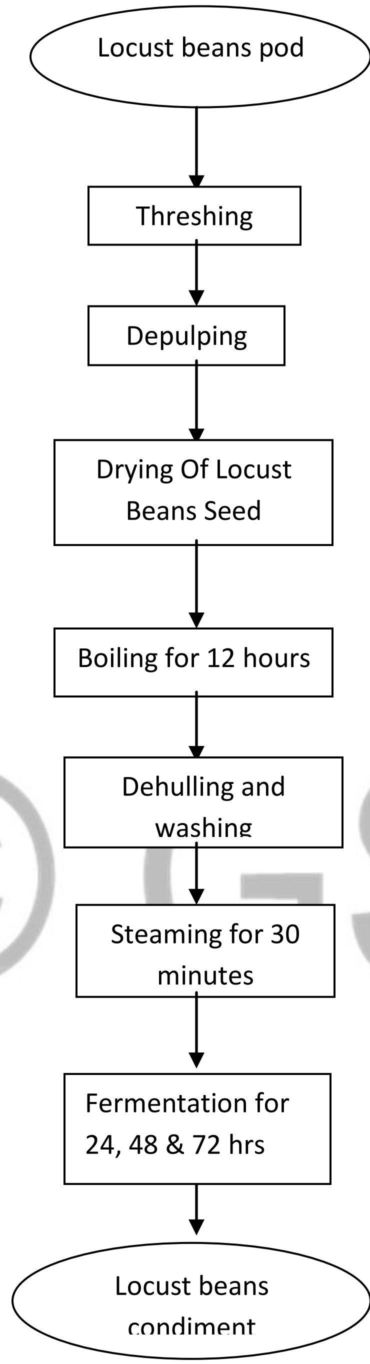

Figure 1: flow chart for the processing of locust beans seed to locust beans condiment.

The basic steps in the production of this condiment involve the dehulling of seeds, boiling and enclosing in a fermentation material and left to ferment. These conditions create very low oxygen tension and help to maintain the optimum conditions of temperature and humidity necessary for the fermentation process. The choice of fermentation material most suitable for the fermentation process is the reason for this research. Below is the table for some characters and constituents of the three fermentation containers used for the experiment.

TABLE 1.0: Fermentation Material, Characteristics and Constituents [7, 12, 13].

Materials Used For Fermentation	**Thermal Conductivity ($W/m\,^{O}K$) at $298^{o}K$**	**Constituents Elements/ Molecule**
Calabash	0.01	Polymers of lignin.
Stainless steel	16.2	Alloy of Fe, Cr, Ni, Mo, C, Mn, & N.
Polyethylene (HD)	0.44	Polymers of Ethylene, C_4H_4

2.0 METHODOLOGY

Fresh locust bean seeds were purchased from an open market in Idofian, Kwara State and further dehulled using National Centre for Agricultural Mechanization (NCAM) designed and fabricated multi-seed dehuller. The dehulled samples were cooked and left to ferment for 24, 48 and 72 hours respectively using calabash, stainless steel and plastic as fermentation containers. The fermented samples were further dried using the sun drying method and the oven drying method at $55^{o}C$.

2.1 DETERMINATION OF pH

Determination of pH was carried out using the HANNA H19813 GROCHEK pH meter. The probe was inserted into the fermentation container and the pH reading was taken, minimizing every possible heat loss.

2.2 DETERMINATION OF ELECCTRICAL CONDUCTIVITY

The determination of electrical conductivity was carried out using a HANNA H19813 GROCHEK meter. After calibrating the pH of deionized water to 7, electrical conductivity of the distilled water was taken and recorded before the respective materials were inserted into the container of distilled water to collect results for each material through the electrical conductivity probe which was also inserted and measured. The electrical conductivity value of the distilled water was then subtracted from values obtained from each respective material to obtain the actual electrical conductivity of each material. The units were measured in W/m^0 273K.

2.3 DETERMINATION OF FUNCTIONAL PROPERTIES

2.3.1. Determination of Bulk Density :This was determined using according to [14] method where the bulk density of locust bean powdered samples were determined by weighing the sample (50g) into 100ml graduated cylinder, then tapping the bottom ten times against the palm of the hand and expressing the final volume as g/ml.

2.3.2. *Determination of Water Absorption Capacity (WAC*): The method of [15] was adopted. Locust bean powdered samples, 1g of each treatment was weighed separately and also together with a clean dry centrifuge tube into which it was placed. Distilled water was mixed with the powder to make up 10ml of dispersion. It was then centrifuged at 3500rpm for 15 minutes. The supernatant was discarded and the tube with its content reweighed as gram water absorbed per g of sample. The gain in mass was the WAC of the powdered sample.

2.3.3. ***The determination of Oil Absorption Capacity (OAC)***: This was determined using [16] method. 2g of sample was mixed with 20mls of oil in a blender at high speed for 30 seconds. Samples were then allowed to stand for 30^{o}C then for 30 minutes then centrifuged at 1000rpm for 30 minutes. The volume of the supernatant in a graduated cylinder was noted. Density of water was taken to be 1g/ml and that of oil determined to be 0.93g/ml. Means of triplicate determination were reported.

2.4 PROXIMATE ANALYSIS

The proximate analyses of the fermented seeds were determined using [17]**;** these include moisture content, crude fat, ash, crude fiber, crude protein and carbohydrate by difference.

2.5 STATISTICAL ANALYSIS

Multivariate analysis (Hotel ling's trace) was used to determine the effect of fermentation time (24, 48 and 72 hrs. respectively), type of fermentation container (calabash, stainless steel and plastic) on the functional and proximate analysis of the fermented locust bean. The test was subjected into triplicates during data collection. Duncan method was used for difference in all parameters analyzed (Post Hoc Test).

3.0 RESULTS AND DISCUSSION

Table 2: Electrical Conductivity of Materials

Materials Used For Fermentation	**Electrical Conductivity (W/m ^oK) at 298 ^oK**
CALABASH	0.163
STAINLESS STEEL	15
PLASTIC	0.4

From table 2, calabash had the least electrical conductivity value of 0.163 W/m ^oK at 298 ^oK followed by plastic with 0.4 W/m ^oK at 298 ^oK and stainless steel with 15 W/m ^oK at 298 ^oK. Indicating calabash as the material with highest insulating capacity followed by plastic and stainless steel having the lowest insulating capacity.

Table 3: Effect of Fermentation Container on the pH and some Functional Properties of the Locust Beans.

FERMENATTION MATERIAL	**pH**	**BULK DENSITY**	**WAC**	**OIL ABS.CAPACITY**
Calabash	6.20[a]	0.95[a]	1.94[a]	1.22[a]
Stainless Steel	5.8[c]	0.96[a]	2.07[a]	1.17[a]
Plastic	5.95[b]	0.93[a]	2.03[a]	1.44[a]

From Table 3, the end product, fermented locust bean usually has an alkaline pH. The pH increases with fermentation time [18].Result indicates that there was significant difference of p> 0.005 in the pH between the fermentation containers, suggesting that the calabash with pH 6.20 could retain heat to drive enzymatic reactions than the plastic, which had a pH of 5.95. Stainless steel recorded a pH of 5.8 suggesting that the container couldn't retain enough heat as much as the calabash and plastic due to its low insulation capacity to drive and sustain enzymatic reactions [19]. In addition, the slightly acidic pH recorded in the three containers suggests less timing to get the pH to become slightly alkaline, since [10] reported that fermentation takes four days (96hrs.) to get the pH to 8.2. The above result on the table is the threshold of the fermented locust bean in their respective containers fermented for 72 hours meaning that pH could increase on longer fermentation time. No significant difference was recorded from bulk density, water absorption capacity and oil absorption capacity.

Table 4: Proximate Composition with respect to Fermentation Container.

Fermentation Container	**M/C**	**Crude Fat**	**Ash**	**Fibre**	**Protein**	**Carbon hydrate**
Calabash	5.90^{b}	35.07^{a}	2.35^{b}	3.17	41.83	11.65^{c}
Stainless steel	5.36^{c}	33.81^{c}	2.42^{a}	3. 17	42. 12	13.67^{a}
Plastic	6.31^{a}	34.10^{b}	2.35^{b}	2.80	40.88	13.45^{b}

For the carbohydrate content with respect to fermentation container, stainless steel was significantly highest followed by plastic and calabash. This is due to extensive use up of crude fat during the fermentation reaction in containers with high insulating capacity. In addition, [20] reported reduction in starch content during fermentation. This was reflected in the table above since effective fermentation is actualized with calabash, plastic and stainless steel in the descending order of effectiveness. The moisture content reflected higher levels in plastic and calabash than the stainless steel. This could be as a result of higher insulating capacity in both the calabash and plastic over the stainless steel. Ash content increased during fermentation due to reduction in other chemical components such as carbohydrate, moisture content and fat as reported by [21, 22].

4.0. CONCLUSION

The lower the thermal and electrical conductivities of materials used as containers for fermentation, the higher the heat retention and ability to sustain fermentation reaction in the system. Thus, calabash gourd with the lowest thermal and electrical conductivities is most suitable and sustainable for fermentation of locust beans, followed by plastic. Stainless steel is the least among the three materials used for the experiment.

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