CHARACTERISTICS AND COMPOSITION OF FERMENTATION CONTAINERS, ITS EFFECT ON PH AND SOME FUNCTIONAL PROPERTIES FOR EFFECTIVE AND SUSTAINABLE FERMENTATION OF LOCUST BEANS (PARKIA BIGLOBOSA)

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ABSTRACT: *The choice for type of container to be used for effective and sustainable fermentation of locust bean (Iru) has been of contention by local processors having preference for some materials over others. Calabash gourd, highly dense polyethylene (plastic) and stainless steel were used to ferment locust bean for a threshold of 72 hrs. pH of significant difference p<0.005 was obtained from 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.Iheke et al 2017 reported increase in pH with fermentation time and Olasupo et al 2016 reported a threshold of pH 8.2 after four days of fermentation. The three respective containers have low thermal and electrical conductivities but calabash, a polymer of lignin fused with cellulose has the lowest thermal and electrical conductivities of 0.163W/MK and 0.01 W/mK at 25^{o}c respectively, followed by plastic a polymer of polyethylene with 0.4W/Mk and 0.44W/mK at 25^{o}c respectively, and stainless steel an alloy of Iron, Chromium, Nickel, Molybdenum, Carbon, Manganese and Nitrogen having the highest values of 15 W/mK and 16W/Mk at 25^o c. The insulating capacity and ability to retain and sustain heat in a closed system is inversely proportional to both thermal and electrical conductivities.*

KEY WORDS: fermentation, material, characteristics, composition.

INTRODUCTION

Materials used as containers for fermentation of pulses are required to retain and sustain heat in its system. Certain requirements such as low thermal conductivity (Huang et. al. 2006), low electrical conductivity since they are both directly proportional in all materials (Ahmed et. al. 2013). Polymer based materials (Uleanya K.O 2016) which constitutes strong covalent bonds and weak vander waals forces (Ashby and Jones 2012) 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 (Inzelt G. 2008) as well as the calabash gourd which consist of lignin, an amorphous polymer stiffened with fibre of cellulose (Konan et. al. 2018). Furthermore, stainless steel which is a non-polymer based material exhibits low thermal conductivity of (15 w/mK) 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 of 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 (Olasupo N. 2006) of which condiments are a part of. Condiments can be defined as spices that are added to food preparations to impart

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https://doi.org/10.37745/ejms.2014

European Journal of Material Science
Vol.8, No.2, pp.24-28, 2021
Print ISSN: ISSN 2055-6551(Print),
Online ISSN: ISSN 2055-656X (Online)

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 (Ofiya C. O 2000, Olasupo et. al. 2010) 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 (Olasupo N. 2006).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 or dadawwa. The traditional method 0f preparing Iru is tedious and energy consuming (Olasupo N and Okorie C.P. 2019). Below is a flow chart illustration of fermented locust beans:

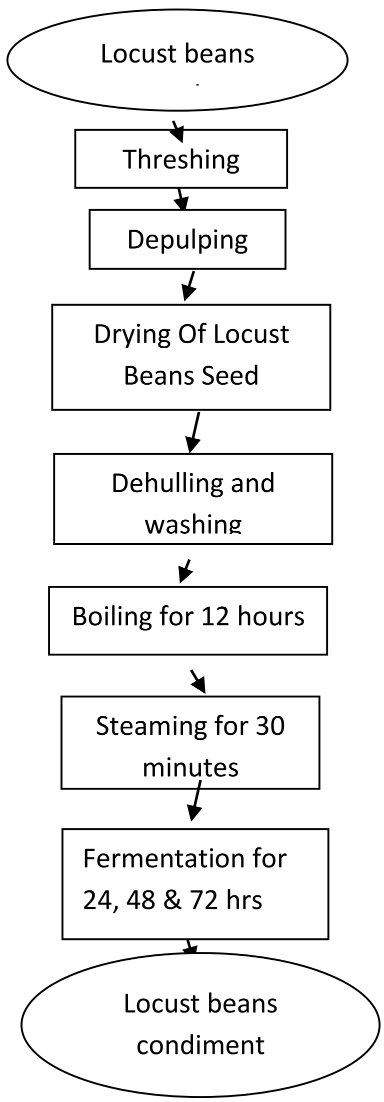

Figure 1: flow chart for the processing of locust beans seed to locust beans condiment.

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The basic steps in the production of this condiment involves the dehulling of seeds, boiling and enclosing in a fermentation material and left to ferment. This condition create very low oxygen tension and helps to maintain the optimum conditions of temperature and humidity necessary for the fermentation process. Below is the table for some characters and constituents of the three fermentation containers used for the experiment.

TABLE 1: FERMENTATION MATERIAL, ITS CHARACTERISTICS AND CONSTITUENTS.

Materials used for fermentation	**Electrical conductivity (W/m K)**	**Thermal conductivity (W/m °K) at 25°C**	**Constituents elements/ molecule**
Calabash	0.163	0.01	Polymers of lignin.
Stainless steel	15	16.2	Alloy of Fe, Cr, Ni, Mo, C, Mn, & N.
Polyethylene (HD)	0.4	0.44	Polymers of Ethylene, C_4H_4

METHODOLOGY

Fresh locust bean seeds where purchased from an open market in Idofian,Kwara State and further dehulled using 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 degrees centigrade.

Determination of pH

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

Determination of Functional Properties

Determination of Bulk Density. This was determined using (Giami and Bekebain,1992) method where the bulk density of flour 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.

Determination of Water Absorption Capacity (WAC). The method of Abbey and Ibeh was adopted. Flour 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 flour 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 flour sample.

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2.2.3. *The determination of oil absorption capacity*. This was determined using Onwuka 2005 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 degrees centigrade then for 30 minutes then centrifuged at 1000 R.P.M 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.

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 properties 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).

RESULTS AND DISCUSSION

The end product, fermented locust bean usually has an alkaline pH since pH increases with fermentation time Iheke et al 2017
Table2.0. 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^b	0.95^a	1.94a	1.22^a
Stainless Steel	5.95^b	0.96^a	2.07a	1.17^a
Plastic	5.85^c	0.93^a	2.03^a	1.44^a
F. Value	82.73	0.385	2.693	2.10
Sign. Value	0.0001	0.683	0.165	0.137

From Table 2.0 result indicates that there was significant difference of $p > 0.005$ in the pH between the fermentation containers. Suggesting that the calabash could retain high temperature for 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 to encourage enzymatic reactions. In addition, the slightly acid pH recorded in the three containers suggests less timing to get the pH to become slightly alkaline, since Olasupo et al 2016 reported that fermentation takes four days 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 for 72 hours meaning that pH could increase on sustained fermentation. No significant difference was recorded from bulk density, water absorption capacity and oil absorption capacity.

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https://doi.org/10.37745/ejms.2014

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