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Influence of Sun and Oven Drying Methods on the Proximate, Phytochemical and Vitamin C Composition of Fermented African Locust Beans (*Parkia biglobosa*) Powder

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Abstract: This research was carried out to determine some of the nutritional compositions of dried fermented African locust beans powder. Fermented locust bean is generally prone to deterioration and therefore adequate preservation methods are essential to obtain bean powder of good quality. In this study, two drying methods (sun and oven drying) were used to produce fermented dried locust bean which was later milled into powder. The oven-drying experiments were conducted for two air drying temperatures, 45°C and 55°C. The rate of moisture removal was determined by the weight loss which was measured at a 1-hour interval until a constant weight was reached. Proximate, phytochemical and vitamin C contents of the dried powder were analysed and the results showed that oven-dried (55°C) locust bean sample has the lowest moisture content of 4.70% when compared to other samples. However, oven-dried locust bean sample at 45°C had higher values of protein and Vitamin C of 37.05% and 3.03 mg/g respectively. It can be concluded from this study that oven-dried African locust beans powder samples generally retained the nutritional compositions studied better than sun dried samples.

Keywords: Proximate composition, Parkia biglobosa, Flavonoids, Saponins, Phytates

I. Introduction

Growing awareness in healthy eating has made some consumers to shift their focus from animal-based protein to plant protein in recent times. Plant proteins possess significant advantages such as reduced cost of production, less difficulty of processing, neutralizing acids in the body system and a higher prospect of boosting energy efficiency than that supplied by animal protein [1]. African locust bean (*Parkia biglobosa*) falls within this category of plant proteins. It is a leguminous plant commonly found in Africa and Asia and in many other tropical areas of the world. Though the entire tree, starting from its roots to the leaves has several uses, its seed is the most useful and is popularly consumed as a fermented, tasty food condiment among both city and rural dwellers [2], [3].

African locust bean (*Parkia biglobosa*) in its raw form is nutritionally deficient and unpalatable. It needs to undergo fermentation in order to enhance its nutritional, physical and chemical properties which makes it suitable for use as the popular flavour intensifier in soups, stews and also as a protein-rich condiment in deficient diet [4], [5]. Fermentation is a processing method that utilises a variety of microorganisms such as fungi and bacteria to break down or convert biologically complex compounds, substrates or molecules such as starch and sugar into simpler compounds [6], [7]. Fermentation is very necessary for the processing of African locust beans because it improves its digestibility, increases nutritional values, and provides important living enzymes and beneficial microorganisms to our diet while helping to get rid of antinutrients [8].

Despite the huge nutritional and culinary

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benefits of fermented locust beans, its odour makes it repulsive and unacceptable to some consumers. Moreover, its high moisture content which makes it prone to fast deterioration necessitates the need for further preservation processes such as drying. Drying has been used extensively in the preservation and further handling of food products and fermented locust bean is not an exemption. Drying is particularly very useful for preserving locust beans because it helps to reduce the moisture content of the bean, lowers its odour (which makes it unacceptable by some people), reduces packaging and handling costs, increase its functionality and allows safe storage over an extended period [9], [10]. Several drying methods have been reported in the literature for the drying of locust beans and they include mechanical (convective) drying, indirect (cabinet) solar drying, oven drying and sun drying [5], [8], [11]. However, sun and oven drying methods are the commonest and this study aimed at comparing the effects of these methods on the proximate, phytochemical and vitamin C composition of dried fermented locust beans powder.

II. Materials and Methods

2000 g of fermented African locust beans were purchased from a medium scale locust bean processor in Ilorin, Kwara State. The seeds were divided into four equal portions of 500 g each. Two samples portions were oven-dried (in a thin layer) at a temperature of 45°C and 55°C respectively, while one portion was subjected to sun drying. The last portion served as the control. The ambient temperature during the sun drying experiment ranged between 25-35°C as the weather condition was favourable due to the season of the year. Differences in the rate of moisture removal were checked at an interval of one hour until constant weights were obtained. A laboratory food-grade blender with a power rating of 3000W, frequency of 50/60Hz, rated capacity of 2.0 L and a speed of about 32000 rpm was used to mill the dried seeds into powder. The powdered samples were stored in air-tight containers. Both fresh and dried samples were subjected to relevant chemical and nutritional analysis.

The Association of Official Analytical Chemists (AOAC) [12] standard procedures were used to determine the proximate composition (moisture, crude protein, crude fat, ash, crude fibre) of the dried fermented locust bean powder while carbohydrate content was calculated by difference. Phytochemical compositions (oxalates, flavonoids, saponins and phytates) of the dried fermented locust bean powder samples were determined using methods similar to those reported by [13]. Vitamin C contents of the samples were estimated by 2, 6-Dichlorophenol- indophenol visual titration (as described by AOAC). All data were analysed in duplicate and Analysis of variance (ANOVA) was carried out using the SPSS 20.0 statistical software at a 5% level of significance and Duncan Multiple Range Test (DMRT) was used to test the mean differences in the treatments.

III. Results and Discussion

A. Effects of Drying Methods on Proximate Composition of African Locust Beans Powder

Table 1: Proximate composition of dried *Parkia biglobosa powder*

Drying Methods	Moisture Content (%)	Crude Fibre (%)	Crude Protein (%)	Ash (%)	Fat (%)	Carbohydrate (%)
OD (55°C)	$4.70^{a} \pm 0.17$	$4.75^{b} \pm 0.00$	$36.19^{a} \pm 0.02$	3.41 ± 0.00	$18.57^{d} \pm 0.01$	$32.22^{a} \pm 0.01$
OD (45°C)	$6.04^{b} \pm 0.00$	$3.54^{c} \pm 0.00$	$37.05^{c} \pm 0.01$	3.27 ± 0.00	$12.08^{c} \pm 0.00$	$38.02^{b} \pm 0.01$
SD	$6.07^{b} \pm 0.00$	$3.67^{d} \pm 0.00$	$37.60^{d} \pm 0.01$	2.69 ± 0.06	$11.72^{b} \pm 0.00$	$38.23^{c} \pm 0.01$
Control	$58.31^{c} \pm 0.00$	$4.88^{a} \pm 0.00$	$35.57^{a} \pm 0.01$	2.97 ± 0.04	$1.66^{a} \pm 0.02$	$54.95^{d} \pm 0.01$

*Means with the same letter are not significantly different ($p \leq 0.05$) according to Duncan's (significance difference) test.

Table 2: Phytochemical composition (mg/g) of dried *Parkia biglobosa* powder

Drying methods	Oxalate	Flavonoids	Saponin	Phytates
OD (55 °C)	$35.21^{c} \pm 0.36$	$2.23^{b} \pm 0.01$	$2.11^{d} \pm 0.01$	$34.93^{b} \pm 0.91$
OD (45 °C)	$27.14^{b} \pm 0.94$	$3.67^{d} \pm 0.00$	$1.21^{b} \pm 0.35$	$28.80^{a} \pm 0.36$
SD	$4.17^{a} \pm 0.36$	$3.42^{c} \pm 0.00$	$0.56^{a} \pm 0.02$	$42.59^{c} \pm 1.14$
Control	$38.17^{d} \pm 1.19$	$1.62^{a} \pm 0.04$	$1.49^{b} \pm 0.00$	$29.41^{a} \pm 0.14$

*Means with the same letter are not significantly different ($p \leq 0.05$) according to Duncan's (significance difference) test.

The effects of drying methods on the proximate composition of African locust beans powder are presented in Table 1. The moisture contents obtained in this study were 4.70%, 6.04%, 6.07% and 58.31% for oven dried at 55°C, 45°C, sun dried and the fresh samples respectively. The result shows a significant ($p \leq 0.05$) difference in the moisture content of fresh fermented locust beans and the dried powders. The locust beans dried with oven at a temperature of 55°C has the lowest moisture content while sun-dried sample has the highest moisture content. This shows the correlation between the drying air temperatures and the rate of moisture removal, that is, the higher the temperature of the drying air, the faster the rate of moisture removal from the product and the lower the moisture content. The moisture content of the fresh locust bean in this study is slightly higher than the one reported by [3] while those of the dried samples are lower than those obtained by [2] and [14] but slightly higher than the values obtained by [5] for dried/powdered locust beans. This indicated that the dried locust beans from this study are microbiologically and shelf stable. The crude fibre, ash and fat contents are higher in oven-dried fermented locust bean samples when compared with sun-dried samples. However, for carbohydrate and protein contents, higher values were observed in the sun-dried sample. Similar proximate values have been reported in literature for various studies on fermented *Parkia biglobosa* seed/powder, whereas some values are higher, some are lower than those obtained in this study [3], [15–18].

B. Effects of Drying Methods on Phytochemical Composition of African Locust Beans Powder

Phytochemicals are referred to as bioactive compounds that are majorly found in plants (plant chemicals) that may provide desirable

health benefits beyond basic nutrition to lower the risk of major chronic diseases [19].

Reports have shown that various phytochemicals are found in the different parts of *Parkia biglobosa* tree [20], [21]. However, the presence of oxalates, flavonoids, saponins and phytates were observed in the dried fermented locust bean powder used in this study and the result obtained are presented in Table 2.

The oxalate content observed from the result reduced drastically when dried under the sun from 38.17 mg/g to 4.17 mg/g, however, with the use of oven drying at a temperature of 55°C, there is considerable retention of oxalates (35.21mg/g) when compared to the fresh sample (control). These values are higher than those reported for dried-cooked and uncooked unripe papaya fruit pulp and cocoyam cornflour [22], [23] but lower than those observed for different varieties of raw *Colocasia esculenta* [24]. The contents of flavonoids and saponins in oven-dried samples were observed to be higher than the sun-dried sample while for phytates content, sun-dried samples had the highest value of 42.59mg/g in comparison to oven-dried and control samples. The values obtained for flavonoids and saponins in this study are lower while those of phytates are higher than the findings of [22] for raw and processed papaya fruit pulp.

C. Effects of Drying Methods on Vitamin C Composition of African Locust Beans Powder

The effects of drying methods on the vitamin C composition of African locust beans powder are presented in Table 3. It has been reported by various authors that vitamin C possesses good antioxidant properties which make it potent in collagen synthesis, protection of cell membrane from oxidative stress, aiding the process of wound healing and prevention of various degenerative diseases [25–28]. Although, the concentration of vitamin C in the wet locust beans used in this study was found to be low (1.52mg/100g), it was observed that there was an increase to 3.01mg/100g in sun-dried, 3.03mg/100g in oven-dried locust beans powder at 45°C and afterwards a decrease to 2.32mg/100g at oven temperature of 55°C after the drying operation. This observation is in contrast to the general saying that drying lowers the vitamin C contents in foods. This may be linked to the fermentation process the locust bean had undergone prior to drying as certain reports stated that fermentation can increase vitamin C content in food [29], [30]. Similar values of vitamin C were reported by [31] for ginger powder. However, higher values were obtained by [32] and [25] for locust bean seeds and pulp respectively.

Table 3: Vitamin C Composition of Dried *Parkia Biglobosa* Powder

Drying methods	Vitamin C (mg/100g)
OD (55 °C)	$2.32^{b} \pm 0.12$
OD (45 °C)	$3.03^{c} \pm 0.03$
SD	$3.01^{c} \pm 0.10$
Control	$1.52^{a} \pm 0.10$

*Means with the same letter are not significantly different ($p \leq 0.05$) according to Duncan's (significance difference) test.

D. Effects of Drying Methods on Rate of Moisture Removal of African Locust Beans

The drying curves showing the rate of moisture removal with the time of the fermented locust is presented in Figure 1. The curves show that the sun-dried sample had the longest drying time than the oven-dried samples which are as a result of lower and fluctuating drying temperature from the sun. Conversely, the drying rate of oven-dried sample at 55°C was the fastest as it almost reached a state of constant mass in just 6

hours, reducing the moisture content from 58.31% to about 4.70%. This implies that the higher the drying air temperature, the faster the drying process, the lower the moisture content and the shorter the drying time. This agrees with the findings of [8] on the influence of drying methods on the drying characteristics and nutritional quality of fermented locust beans. Similar trends were also observed in thin-layer drying papaya peel [33] and mango fruit [34], [35].

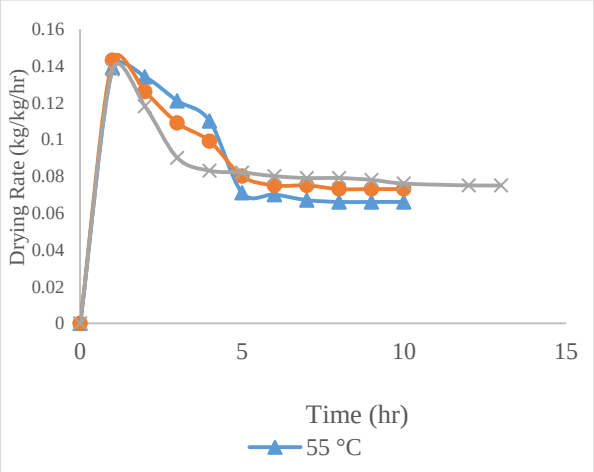

Figure 1: Drying curves of drying rate versus time of sun and solar dried fermented locust bean powder

IV. Conclusion

It was concluded from this study that oven-dried fermented locust bean powder samples had better retention of the nutrients studied than sun drying. It was also established that the oven-dried fermented locust bean had a faster drying rate and consequently a shorter drying time than sun-dried samples. The oven drying method can therefore be used to extend the shelf life of fermented African locust bean powder for culinary and other suitable purposes.

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