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Effect of Storage facilities on Nutritional Contents of Stored Baobab Fruit Pulp (*Adansonia digitata L.*)

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Abstract

Baobab fruit pulp is one of the most nutritious traditional African food consumed in Nigeria. It is used for the treatment of several ailments. This well-priced food is threatened by lack of proper storage which provides a set-back in its exploration. A research was made to identify how shelf life affects different facilities and the pulp nutritional composition. Five different facilities were used to store the pulp: Plastic containers, tins, glass bottles, sacks and pods. The pulp was kept at air-tight conditions at room temperature for a period of four months after which the stored pulp was analyzed for proximate, mineral and vitamins composition using standard methods. Completely Randomized Design was adopted with three replications. Analysis of Variance with Duncan's .New Multiple Range Test was used to obtain the data. Significance means at 5% level was used. The experiment was arranged in Completely Randomized Design with three replications. Data obtained were analyzed using Analysis of Variance with Duncan's New Multiple Range Test used to separate significant means at 5% level. The result obtained revealed significant difference (P<0.05) in the proximate, mineral and vitamin contents of the pulp with storage type. The result showed that, the pulp stored in glass bottles give higher values for the nutritional composition studied. This means that, storing baobab pulp in glass bottles is the best for conserving its nutritional status.

Keywords: Baobab, Nutrition, Proximate composition, Pulp.

1. INTRODUCTION

Baobab *(Adansonia digitata* L.) is one of the naturally occuring fruit trees native to Savannah of sub-saharan Africa (Aluko et,el., 2018; Muthai et al., 2017) more especially northern Nigeria (Ezeagu, 2007). It is a high-valued tree belonging to the family Malvaceae (Musyoki *et al.* 2022) known to produce large silvery green or brownish indehiscent dry fruits that contained soft whitish pulp with powdered texture that bear many dark-brownish kidney-shaped seeds. The pulp is also rich in thin light brown fibres (Sidibe and Williams, 2002). Previous studies (Cisse *et al.,* 2013; El yahyaoui *et al.,* 2015; Barakat, 2021; Ifeyinwa *et al.,* 2021) have reported that, the pulp is highly nutritious with several medicinal properties. Nutraceutically, Baobab fruit pulp contains sufficient amounts of carbohydrates, dietary fibres, and essential amino acids and vitamins with significant amount of mineral elements such as Sodium, Magnesium, Potassium, Calcium, Iron, Zinc and Manganese (Chadare *et al.,* 2009; De Caluwe *et al.,* 2010). It was reported that, the Vitamin C content of the pulp is six times higher than that of orange (Donatien *et al.,* 2011). The pulp is consumed traditionally in various forms (Aluko *et al.,* 2016) as candies (James *et al.,* 2022) and beverages such as commonly made smoothies, oat meals, locally made fruit extracts and breads.(Latifou *et al.,* 2012). It therefore contributes immensely to healthy diets, availability of food, health and marketing in local communities especially in the Savanna ecological zones of Africa (Muthai *et al.,* 2017), especially during periods of droughts or famine (Saka *et al.,* 2004).

Medicinally, the pulp is an alternative remedy against various ailments in the traditional African Pharmacopoeia (FAO, 1993; Kamatou *et al.,* 2011). The pulp mixture was reported to be used against stomach aches, dysentery and diarrhea (El yahyaoui *et al.,* 2015) with strong antimicrobial potentials (El Yahyaoui *et al.,* 2022). It also has strong effect in preventing liver damage (Hanafy *et al.,* 2016) and shows cardioprotective abilities (Ghoneim *et al.,* 2016), anti-inflammatory (UN, 2005) and antidiabetic properties (Irondi *et al.,* 2017). Baobab fruit pulp mixture intake improves non-heme iron absorption in the populations most vulnerable to iron deficiency (Charlotte *et al.,* 2021). However, despite its nutraceutical, pharmaceutical and commercial importance of baobab fruit pulp, its shelf-life is negatively affected by improper storage. This effect of storage on the nutritional composition of the pulp is less studied (Russo *et al.,* 2019) and there is paucity of information regarding to its preservation and therefore remains underutilized in Nigeria. There is an urgent need to explore different storage facilities that could be used to keep its shelf-life and nutritional qualities. This study therefore aimed at assessing the effects of various storage facilities on the nutritional composition of baobab fruit pulp.

2. MATERIALS AND METHODS

Sample Collection

The baobab fruits were flucked and used from the fields in Kano state, Nigeria according to the procedure described by the Southern African Natural Products Trade (2008) and verified at the Herbarium of the Department of Botany, Ahmadu Bello University, Zaria, Nigeria. A voucher specimen number of ABU02512B was assigned to the specimen. The fruits were transported to the Department of Botany, Bayero University Kano Nigeria.

Preparation of Fruit Pulp

The hard shell of the baobab fruits were cracked open mechanically by knocking them against hard material to remove the inner contents (pulp). Seeds and fibres were removed and lOOg of the fruit pulp was taken and used for nutritional analysis of fresh samples. Another 3200g of the fruit pulp was weighed and then divided into four parts. The first part 800g was stored in tins closed tightly with a lid. The second, third and fourth portions were kept in sacks, plastic containers and glass bottles closed tightly. Another set of pulp was allowed to be kept in the fruit ERE pods. All the fruit pulp kept in the laboratory at room temperature until the required date for nutritional analyses. The pulp kept in the pod/shell served as the control. The samples were analyzed monthly for a period of four months. The experiment was arranged in Completely Randomized Design with three replications.

Proximate Analysis

Analysis for proximate composition was made using the official methods of analysis recommended by the Association of Official and Analytical Chemists (AOAC, 2005).

Crude fat, crude fibre, ash and moisture contents were assayed. Nitrogen content was estimated by the AOAC Kjeldahl method. Crude protein content was subsequently calculated by multiplying the nitrogen content by a factor of 6.25 as described by AOAC (2005) formula. The carbohydrate content of the samples were determined by subtracting the values of protein, fat, ash and moisture from the total dry matter as reported by Onyeike *et al.* (1995).

Percentage carbohydrate = 100 - (% moisture+%ash+%crude protein+%crude fat+%crude fibre).

Minerals Content Analysis

The mineral contents of the samples were extracted using dry ashing method as described by Nielsen (2002). One gram (lg) of each sample was weighed in a crucible, burned on hot plate until the fumes fade entirely and then ashed in a muffle furnace at 500"C for 3 hours. The crucible was transferred into a desiccator and allowed to cool. The ashed sample was transferred into a 250ml beaker to which 15ml of concentrated hydrochloric acid and 5ml of concentrated nitric acid added. The dissolved ashed sample was evaporated to dryness on a hot plate set at 100 °C. 5ml of 5M hydrochloric acid was added and transferred to 100ml standard volumetric flask. It was then made up to grade with distilled water and filtered. The elemental analyses of the prepared samples were performed using Atomic Absorption Spectrometer.

Vitamins Composition Determination

The vitamins contents of the samples were analysed using the method referenced by AOAC (2005). Fat soluble vitamins contents of each sample were analyzed using Shimadzu LC10A VP Series liquid chromatograph equipped with a 250 x 4.0 mm stainless steel ODS reversed-phase column fitted with a UV-Vis detector while the water soluble vitamins were determined by Shimadzu LC-10A VP Series liquid chromatograph fitted with a photo-diode detector (Waters 2996) as described in the method of Ekinci and Kadakal (2005).

Statistical Analysis

The data obtained were analyzed using Analysis of Variance (ANOVA) using SAS package (SAS, 2008) version 9.0 with Duncan's New Multiple Range Test used to separate means that were significant at 5% level.

3. RESULTS

The result for the proximate composition of baobab fruit pulp after 4 months of storage is showed in Table 1. The result indicated significant variation ($P<0.05$) in proximate composition of the pulp stored in different containers. The percentage moisture contents ranges between 18.84-19.85% with the highest value found in plastic-stored pulp (19.85%). The crude protein content varies from 5.195.95% with the highest value found in pulp stored in bottles. Similar result was found in terms of fat, fiber, dry matter and ash contents with the highest values obtained among pulp stored in bottles. More so, the result for the Nitrogen free extracts of the samples was found to have higher value among pulp stored in bottles.

The values for the mineral composition of baobab fruit pulp after 4 months of storage is shown in Table 2. The result revealed significant difference (P<0.05) in the amount of minerals present. The highest values for all the minerals were found among the pulp stored in bottles followed by sack stored pulp for Ca and Mg and the controls for Fe, Zn, Na and K. The least values were obtained among pulp stored in Tins.

Table 1: Proximate Composition of Baobab Fruit Pulp after 4 Months of Storage

Facility	Moisture (%)	%Crude Protein	%Fat	Crude Fiber (%)	Nitrogen Free Extract (%)	% Carbohydrate	% Ash
Plastic	19.85a	5.23b	20.35c	7.75b	34.77c	79.52c	7.13c
Tin	18.84c	5.19b	20.26c	7.85b	34.2 Id	79.65c	7.29c
Sack	19.15b	5.27b	21.20b	8.10a	34.99c	79.92cb	8.36b
Bottle	19.83a	5.95a	21.89a	8.28a	35.95a	81.08a	9.09a
Pod	19.13b	5.42b	21.44b	7.88b	35.39b	80.31b	8.49b
Mean	19.39	5.41	21.03	7.97	35.06	80.09	8.07
SE±	0.30	0.39	0.34	0.22	0.48	0.62	0.52

Table 2: Mean Values of Mineral Contents in Baobab Fruit Pulp after 4 Months of Storage

Facility	Ca	Mg	Fe	Zn	Na	K
Plastic	0.38b	0.27d	0.16d	1.42c	7.07 d	2.2 Id
Tin	0.21c	0.22e	0.17d	1.23d	6.14e	2.3 2d
Sack	0.41b	0.39b	0.23c	1.43c	8.35c	2.86c
Bottle	0.59a	0.50a	0.45a	2.04a	13.71a	4.66a
Pod	0.42b	0.34c	0.32b	1.86b	11.06b	3.34b
	0.01	0.01	0.01	0.04	0.19	0.07

The values for the vitamin composition of baobab fruit pulp after 4 months of storage is shown in Table 3. The result revealed significant difference (P<0.05) in the amount of both water soluble and fat soluble vitamins. The highest values for all the vitamins was found among the pulp stored in bottles followed by sack stored pulp. The least vitamin values were found among Tin-stored pulp.

Table 3: Mean Values of Vitamin Contents in Baobab Fruit Pulp after 4 Months of Storage

Facility	Vitamins A	Vitamins E	Vitamins B	Vitamins C
Plastic	3.57c	67.60c	1.76b	232.93b
Tin	3.17d	63.37d	1.58c	228.83c
Sack	3.44c	69.41b	1,68bc	230.18c
Bottle	4.11a	73.69a	1.89a	238.42a
Pod	3.79b	68.86b	1.77b	234.36b
SE±	0.07	0.43	0.04	0.80

DISCUSSION

Exploration of beneficial role of baobab fruit pulp has recently experienced a resurgence the world over due to significant amount of nutrients and active constituents found in it that are of commercial, cosmetic and therapeutic concerned as stressed by previous researchers such as Ofori *et al.* (2023), Silva *et al.* (2023), Rahul *et al.,* (2015), Sidibe and Williams (2002), and Codjia *et al.* (2001). However, these vast reservoir of wealth conserved in the pulp were threatened by storage. This study presented decreased in the proximate composition of the baobab pulp with storage type after four months of storage at various capacities. It shows that, the shelf-life of the pulp depends on the type of storage facility used. The study indicated that, storing baobab fruit pulp in bottles preserved its proximate composition better than the remaining storage facilities such as tins, plastics and sacks. This may probably be attributed to the fact that, glass bottles being transparent and made from congeal liquids conserved and maintained the storage temperature conditions of the pulp as temperature determines how long foods could be stored as reported by Jeihani (2015).

Proximate composition of food samples provides a clear picture of the nutritional content present therein as it shows the amount of macronutrient in food samples as nutritional data on the labels of finished food products (Ofori *et al.,* 2023). The proximate contents of the baobab fruit pulp presented by this study revealed significant amount of Carbohydrates, Crude fiber, fats and proteins in the pulp; the amount of which varies with the type of storage facility. The value of carbohydrates contents stored in bottles and sack reported by the present study is in agreement with the value of 79.9 g/100 g dw obtained by Chadare *etal.* (2009).This as Murray *etal.* (2001) puts it is responsible for the sweet taste of the pulp due to presence of high concentration of simple sugars. Ndiaye *et al.* (2023) reported the presence of considerable amount of unsaturated fatty acids, sterols and tocopherols.

Previous studies carried out by Aluko *et al.* (2016), Parkouda *et al.* (2015), and Chadare *et at.* (2008) have established variations in not only the storage conditions of the baobab fruit pulp but to the differences in proximate composition of the pulp obtained due to factors including storage condition (Fagbohun et al., 2012) and physico-chemical characteristics of the soil (Assogbadjo et al., 2012). Similarly, the crude protein values of the pulp stored in bottles and sack by the present study are within the range of values 2.5-17% obtained by Ibrahima *et al.* (2013) but higher than the range of values (2.1-2.4%) reported by Gebauer *et al.* (2002) and Magaia *et al.* (2012) respectively. More so, the crude fiber contents were found to be slightly higher than that reported by Osman (2004). Similarly, Lockett *et al.* (2000) reported a total ash content of 6.4 g/100 g dw which is slightly lower than the value reported by this study. It was inferred that, the storage conditions improve the proximate composition of the pulp with bottles storage providing the best results.

The study proved the fact that baobab fruit pulp is an essential reservoir of mineral elements needed for human well-being such as Calcium, Magnesium, Iron, Zinc, Sodium and Potassium. However, the reported mineral contents of baobab pulp varied greatly among authors as stressed by Chadare *et al.* (2009). There is high concentration of Vitamin C and E present in stored baobab pulp, the concentration depends on the storage facility. The values reported by the present study are almost in consistence with those reported by Cisse *et al.* (2018) who reported the presence of high concentration of vitamins A, and E in the fruit pulp of baobab. Edogbanya *et al.* (2021) reported significant variation in the nutritional composition of baobab leaves under storage for four weeks. Foods packed in more air-tight containers prevent oxidation of the compounds in food. A high oxygen environment causes oxidation which leads to discolouration, flavor loss, odours rancidity and breakdown of nutritional value in foods (Jeihani, 2015). Plastics and sacks do not prevent air contact with the foods kept within for long period of time as they absorb gases, moisture and odours. The best long term storage containers are glass bottles which have zero gas transmission rate.

CONCLUSION

It was concluded that, baobab fruit pulp contains essential nutrients which deteriorate with the type of storage facility. The pulp can be stored effectively in glass bottles for atleast a period of four months without much loss of essential nutrients. The pulp can therefore serve as a nutrient supplement against many dietary deficiency disorders.

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