Croatian Journal of Food Science and Technology
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Production of *Pachira glabra* seed cake (Kulikuli): nutrient and sensory evaluations

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ARTICLE INFO

TYPE: Original scientific paper
https://doi.org/10.17508/CJFST.2024.16.2.01

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ARTICLE HISTORY
Received: September 25, 2022
Accepted: March 6, 2023

CITATION
Bello M, Oladepo M, Arotayo R, Ibrahim A, Ogundola A, Akintola A. Production of *Pachira glabra* seed cake (Kulikuli): nutrient and sensory evaluations. Croatian Journal of Food Science and Technology (2024) 16 (2) 195-202

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ABSTRACT

Utilization of lesser-known food plants through value added processing is a way to develop more sustainable and healthy diets. *Pachira glabra* seed (Malabar chestnut) was processed into snack (Kuli-kuli) and evaluated for nutrient content and acceptability using standard methods. Proximate composition revealed that *P. glabra* seed and its seed cake contain 15.75% and 17.50% crude protein and 32.75% and 38.50% carbohydrate, respectively. Mineral constituent of the seed and its seed cake revealed potassium (K) 58.32 mg/kg and 53.01 mg/kg, calcium (Ca) 8.3 mg/kg and 16.9 mg/kg, magnesium (Mg) 10.2 mg/kg and 11.07 mg/kg, respectively. Sensory score shows that *P. glabra* seed cake was acceptable (p<0.05) in terms of flavour, taste and crispness, compared with groundnut seed cake. The study showed that the seed cake was rich in nutrients. Also, processing *P. glabra* into a value-added product will prevent the waste of natural resources and increase food availability for humans.

KEYWORDS
Pachira glabra; seed cake; nutrients; sensory evaluation; value added product

KEY CONTRIBUTION
A value added food product was obtained from a lesser known plant. Processing increases the protein, carbohydrate and some mineral element contents of *P. glabra* seed. *P. glabra* Kulikuli compared favourably with groundnut kulikuli in sensory evaluations. Added table salt contributed to high level of sodium in the prepared food product. Reduction in the oil content of the food product might be desirable.

Introduction

Seeds have nutritive and calorific value which makes them necessary in animal diet and useful in the production of confectionaries such as sweets, cheese, cookies and for flavouring of foods. Seed flours are also milled with tuber based diets which are low in protein content, in order to enhance their protein content and flavour for infant feeding (Adeleke and Abiodun, 2010; Achimugu and Okolo, 2020).

Peanut cake (Kuli Kuli) is majorly produced from groundnut seed and it has been in existence for a very long period. It is a snack native to the coast of West Africa (Adebesin et al., 2001). It contributes to overall dietary protein intake for the large segment of population, specifically school age children and young adults (Fagbemi, 2006; Aletor and Ojelabi, 2007). Peanut cake is a by-product obtained after the extraction of oil from the kernel, usually fried and used as delicious snack or food supplement (Adebesin et al., 2001). Groundnut cake has been consumed for so long due to its high nutritive value and there had been efforts to produce Kulikuli from blends of groundnut and other seeds (Emelike and Akusu, 2018; Achimugu and Okolo, 2020). However, there is the need to develop more sustainable and nutritious food products from plant-based diets. Many underutilized plants seeds and nuts which could be processed into snacks are neglected, therefore, they are mostly wasted from season to season. One of such plants is *Pachira glabra*.

Pachira glabra, (Homotypic synonyms *Bombacopsis glabra*) is a medium sized tree, native to Brazil. The plant is believed to originate from Brazil, but has extended to almost all parts of the tropics and subtropics, while in the temperate regions, it is a component of urban forest. It is generally known by its common names Guinea nut, French nut, Malabar chestnut, Saba nut, Wild cocoa, Money tree and Lucky tree (Ogunlade et al., 2011). The leaves (15–28 cm) are alternate in length and compound with fan of 5–9 leaflets. It has smooth greenish-gray bark and the trunks are often swollen at the base, even at young age (Oni et al., 2015).

P. glabra are found frequently in marshy land and riparian forests, making it easily adaptive to diverse soil and different climatic conditions. The tree is planted as a shade tree in public places and hotel landscapes (Peixoto and Escudeiro, 2002; Paula et al., 2006; Ogunlade et al., 2011). Flowering and fruiting occur throughout the year and the seeds germinate quickly. The seed is edible, delicious when eaten raw, boiled, fried or roasted. The roasted seed flavour is similar to peanuts and can be ground to make a hot drink similar to chocolate (Ogunlade et al., 2011). Some members of *Bombacaceae* can also be found in several folkloric medicinal uses in many countries, due to their antipyretic, analgesic, anti-inflammatory, astringent, stimulant, diuretic and antimicrobial properties (Oni et al., 2015).

Oni et al., (2015) reported the proximate composition of *P. glabra* seed on dry matter basis and revealed moisture content of (8.17%), protein content (7.67%), ether extract (10.02%), ash content (7.17%) and carbohydrate (75.15%). Moisture content (9.13%), protein (10.38%), crude fibre (8.55%), crude fat (15.29%), ash (4.34%) and carbohydrate (52.32%) was reported by Ogunlade et al. (2011).

The above studies have reported on nutritive value of *P. glabra* seed, but have not examined the possibilities of making cookies from its seeds. Also, the acceptability of *P. glabra* seed cake as a snack has not been established. Therefore, this study aimed at producing Kulikuli from *P. glabra* seeds and characterised it in terms of its nutritional qualities.

Materials and methods

Sample collection, identification and preparation

P. glabra seeds were collected within courtyard (LAT 8.169036, LON 4.264671) at Ladoke Akintola University of Technology (LAUTECH), Ogbomoso. Identification was carried out at the Department of Pure and Applied Biology, LAUTECH, Ogbomoso. Matured sample of *P. glabra* fruits were collected and the pods were allowed to decorticate before the seeds were removed. The seed was oven dried at 50 °C for 3 h 30 min, cooled, de-hulled and kept in a polythene bag. The seed was ground with electric blender (IS: 4250, VTCL Speedo mixer grinder, India) into powdered form for each analytical assay.

Production of P. Glabra and groundnut seed cake (Kulikuli)

P. glabra and groundnut seed cake were produced according to the method described by Emelike and Akusu (2018), with modifications. Milled samples of *P. glabra* seed and groundnut (300 g) were weighed separately in a clean bowl. Warm water (18 mL) was added and samples were thoroughly mixed. Vigorous hand kneading was applied to extract the oil. The mixture gradually became sticky during the kneading process and little water was added for the second extraction until the oil was completely removed. 1.5 g of powdered dry pepper, 1 g of salt, and onion were added as seasoning to the paste, moulded and fried. The seed cakes were cooled at room temperature for about 15 – 20 min and transferred to an air-tight container.

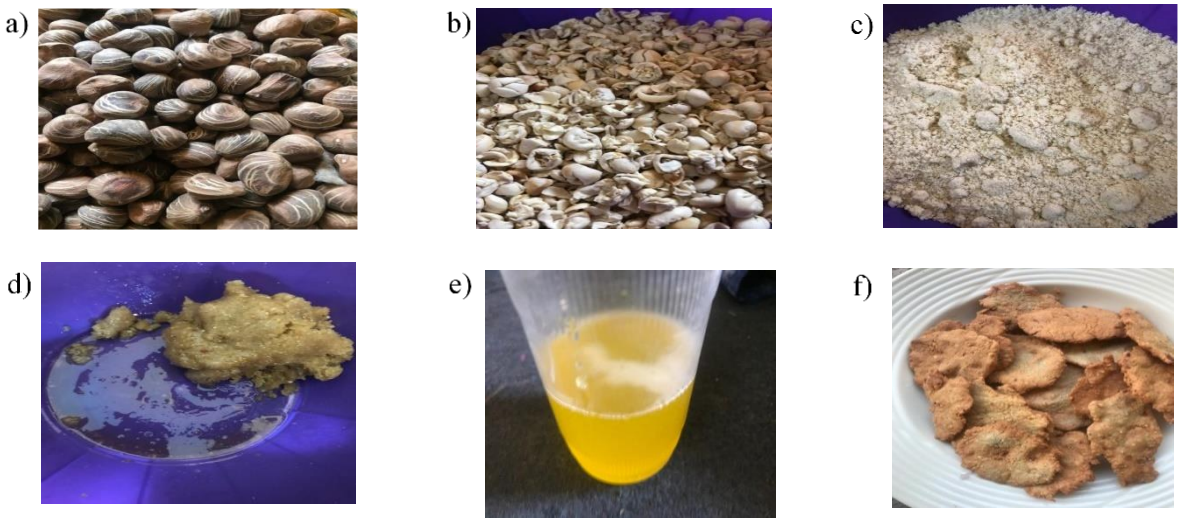

Figure 1. a) *Pachira glabra* seeds; b) Dehulled seed; c) Grounded seed; d) Kneading process; e) Extracted oil; f) Fried seed cake.

Proximate Analyses

The proximate composition (moisture, ash, fat, protein, crude fibre and carbohydrates) of *P. glabra* seed and its seed cake was determined using the recommended method of Association of Official Analytical Chemist (AOAC, 2005).

Quantification of Mineral Elements

Quantification of mineral elements was done by weighing separately 0.5 g of seed sample and its seed cake. Both samples were separately digested with 40 ml mixture of nitric acid and perchloric acid in the ratio 3:1. Following the wet digestion procedure, resultant solution was transferred into 100 mL

volumetric flask and the volume was made to the mark with distilled-deionized water. The solution was analysed in triplicate for its elemental composition using Atomic Absorption Spectrophotometer (Bulk Scientific 210 AAS, Germany) for Na, K, Ca, P, Mn, Mg, Cu, Fe, Zn, and Pb content (Bello et al., 2018).

Sensory Evaluation of P. glabra and groundnut seed cake

Sensory evaluation was carried out using twenty trained panelists, consisting of staff and students of Department of Pure and Applied Chemistry, Ladoke Akintola University of Technology, Ogbomoso. Criteria for the selection were that the panelists were above 16 years of age, that they were regular consumers of seed cake known as "kuli-kuli" and were neither sick nor allergic to nuts. A 9-point hedonic scale described by Iwe (2010) was used to evaluate the seed cake with scores ranging from 1 to 9 (Extremely dislike to Like extremely). The panelists were offered water to rinse their mouth after each sample taste so as to prevent carry over flavour. The evaluated parameters were colour, taste, crispiness, flavour and overall acceptability.

Statistical Analysis

Results were expressed as mean of triplicate analyses. Analysis of Variance (SPSS version 17) was used and means were separated by Duncan multiple range test. Results were accepted at 5% significant level.

Results and discussion

Proximate Composition

Proximate composition (Table 1) showed the moisture contentof *P. glabra* seed (8.00%) and its seed cake (7.00%), the amount which can be compared with 9.13% and 7.12% reported for *P. glabra* seed by Ogunlade et al. (2011) and Enzonga et al., (2020), respectively. The moisture content of any food is an index of its water activity. Low moisture content in the seed and seed cake could make them less vulnerable to microbiological spoilage and enhance the shelf life. Ash content is a measure of mineral content in a biological mass (Obinna-Echem et al., 2021). Ash content of the *P. glabra* seed (5.50%) and its seed cake (5.00%) was lower than 7.12% reported for *P. glabra* seed by Oni et al. (2015), but compared favourably with 4.34% reported by Ogunlade et al. (2011) for the same seed. Meanwhile, the ash content of *P. glabra* seed cake compared favourably with 4.03% and 4.53% reported for melon seed cake and groundnut seed cake, respectively (Achimugu and Okolo, 2020). This is an implication that both *P. glabra* seed and its seed cake could be a good source of mineral elements.

Ether extract content of the *P. glabra* seed (38.00%) was higher compared with (15.39%) reported for the same seed by Ogunlade et al. (2011). The ether extract content of *P. glabra* seed cake (32.00%) was higher compared with the ether extract content of groundnut seed cake (23.21%) reported by Emelike and Akusu (2018) and 19.40 % and 10.16 % reported by Achimugu and Okolo (2020) for melon seed cake and groundnut seed cake, respectively. However, the seed cake that is meant to serve as snack also contained higher level of oil, and this may not be desirable as there had been an advocacy for the low consumption of oil. Therefore, the traditional method of hand kneading employed in the production of the seed cake might have to be discouraged. Thus, the use of mechanical pressing is recommended. In fact, it was suggested earlier that involvement of machine in some unit operations during production of Kulikuli - groundnut based cake and other similar products will save time, conserve energy and product of good sensory attributes are obtained (Akinoso et al., 2021).

Crude protein content of the seed (15.75%) was lower than its seed cake (17.50%), which was also higher compared with (10.39%) reported for *P. glabra* seed by Ogunlade et al. (2011). Also, the protein content

of *P. glabra* seed cake (17.50%) was lower compared with 27.83% and 46.18% reported for melon seed cake and groundnut seed cake, respectively (Achimugu and Okolo, 2020). The high protein value is an indication that the seed cake is a good source of protein and could assist in combating protein energy malnutrition. Crude fibre content of the seed (4.20%) compared favourably with seed cake (4.40%). The crude fibre content of seed was lower compared with 10.00% reported by Enzonga et al. (2020) for *P. glabra* seed. Fiber helps in the maintenance of human health and has been known to reduce cholesterol level of the body (Bello et al., 2008). The carbohydrate content of the seed (32.75%) was lower than that of seed cake (38.50%), but higher than 21.59% reported by Enzonga et al. (2020) for *P. glabra* seed. The carbohydrate content reported for *P. glabra* seed cake (38.59%) compared favourably with 41.84% reported for melon seed cake and 39.53% reported for cashew kernel seed cake (Emelike and Akusu, 2018), but higher compared with 26.41% reported for groundnut seed cake (Achimugu and Okolo, 2020). The carbohydrate content indicates that both *P. glabra* seed and its seed cake could be a good source of carbohydrate.

Table 1. Proximate composition of *P. glabra seed* and seed cake (Kulikuli) g/100 g

Parameters	Seed	Seed cake (Kulikuli)
Moisture	8.00 ± 0.01	7.00 ± 0.01
Ash	5.50± 0.01	5.00 ± 0.00
Ether extract	38.00 ± 0.20	32.00± 0.08
Crude Protein	15.75 ± 0.02	17.50 ± 0.02
Crude Fibre	4.20 ± 0.01	4.40± 0.01
Carbohydrate	32.75 ± 0.20	38.50± 0.10

Means are values of three replicates ± standard error.

Mineral Composition

Levels of mineral elements were presented in (Table 2). Its shows higher concentration of the elements in the *P. glabra* seed cake compared to the seed itself, except for potassium and phosphorous. This can be a result of added seasonings and frying. It is of interest that the most prevalent mineral element in *P. glabra* seed was potassium (Table 2). The level of potassium (K) present in the seed cake (53.01 mg/kg) was higher compared with 18.06 mg/kg and 13.55 mg/kg reported for melon seed cake and groundnut seed cake, respectively (Achimugu and Okolo, 2020). Potassium plays a vital role in many physiological reactions and its deficiencies or excess can affect human health (Khan et al., 2011). High potassium intake with lower sodium can reduce high blood pressure in hypertensive patients (Niyi, et al., 2019).

The *P. glabra* seed cake also has high levels of magnesium (Mg) compared to its seed. The level of Mg reported for melon seed cake (27.01 mg/kg) and groundnut seed cake (24.15 mg/kg) was less compared with 11.07 mg/kg obtained for P. *glabra* seed cake (Achimugu and Okolo, 2020).

Magnesium improves insulin sensitivity, protects against diabetes and its complications and reduces blood pressure (Obiajunwa et al., 2002; Khan et al., 2011).

The level of calcium (Ca) present in the seed and seed cake is 8.32 mg/kg and 16.96 mg/kg, respectively. The values are less compared with 284.00 mg/kg and 247.00 mg/kg, obtained for melon seed cake and groundnut seed cake, respectively (Achimugu and Okolo, 2020). Calcium prevents and overcomes the problems of high blood pressure, heart attack, pre-menstrual syndrome, colon cancer, keeps the bones strong and reduces the risks of osteoporosis in old age (Iwaoka et al., 2011).

The iron (Fe) content in the seed and its seed cake (0.65 mg/kg and 0.77 mg/kg) was less compared with 4.24 mg/kg and 3.19 mg/kg obtained for melon seed cake and groundnut seed cake, respectively (Achimugu and Okolo, 2020). Iron is needed for the formation of oxygen carrying protein heamoglobin

and myoglobin in the human body. It is an essential mineral to prevent anemia and cough associated with angiotensin-converting enzyme (ACE) inhibitors (Khan et al., 2011).

The level of phosphorus (P) present in the seed and its seed cake was 3.15 mg/kg and 2.81 mg/kg, respectively. Phosphorus is helpful in filtering waste and repairing tissues and cells in body system.

The level of sodium (Na) present in the seed and its seed cake was 4.9 mg/kg and 22.31 mg/kg, respectively. The amount present in the seed cake was highly compared with 12.05 mg/kg and 9.62 mg/kg obtained for melon seed cake and groundnut seed cake, respectively (Achimugu and Okolo, 2020). The higher level of sodium in the seed cake reported could be from the added table salt. The level of the salt was acceptable to the consumer. Table salt was earlier observed to enhance other flavours, maintains the osmotic equilibrium between the extra cellular fluid and the tissue cells. Also, it maintains the pH of blood within normal limits and is concerned with the conduction of nervous impulses, muscle contractility and the control of heart muscle conduction. The level of sodium reported for *P. glabra* Kuli-kuli compared favourably with those reported for some ready-to-eat meals (Ahuja et al., 2019; Arotayo et al., 2021). However, lead (Pb) was absent in both samples. Lead is a toxic metal and non-essential element for human body as it causes a rise in blood pressure, kidney damage, miscarriage and subtle abortion, brain damage, declined fertility of men through sperm damage, diminished learning abilities of children and disruption of nervous systems (Bello et al., 2008).

Table 2. Mineral composition of *P. glabra* seed and seed cake (mg/kg)

Parameters	Seed	Seed cake (Kulikuli)
Phosphorous	3.15 ± 0.20	2.81 ± 0.10
Calcium	8.32± 0.01	16.96 ± 0.02
Magnesium	10.21 ± 0.01	11.08 ± 0.02
Potassium	58.32 ± 0.02	53.01 ± 0.01
Sodium	4.90 ± 0.01	22.31 ± 0.10
Manganese	0.02 ± 0.00	0.06 ± 0.01
Iron	0.65 ± 0.01	0.77 ± 0.01
Copper	0.12 ± 0.00	0.15 ± 0.00
Zinc	0.23 ± 0.00	0.32 ± 0.00
Lead	ND	ND

ND: Not detected. Means are values of three replicates ± standard error.

Sensory Scores

Sensory scores (Table 3) show that groundnut seed cake had higher score in terms of colour, taste, flavour and overall acceptability, while *P. glabra* seed cake had high score in crispness. The colour and overall acceptability of both samples are significantly different (p>0.05), while the taste, crispness and flavour of *P. glabra* seed cake and groundnut seed cake were not significantly different (p<0.05) in sensory score. Therefore, *P. glabra* seed cake is acceptable in terms of flavour, taste and crispness compared with groundnut seed cake. It is, however, suggested that the seed cake could also be blend with some other nuts in order to produce more nutrient densed foods.

Table 3. Sensory scores of Groundnuts seed cake and *P. glabra* seed cake

Samples	Colour	Taste	Crispness	Flavour	Overall acceptability
[1]GSD	7.95 ± 0.99	7.90 ± 0.79	7.60 ± 1.04	7.35 ± 0.98	8.35 ± 0.81
[2]PSD	7.35 ± 1.42	7.40 ± 1.27	7.65 ± 1.08	7.10 ± 1.28	7.85 ± 1.04
[3]$LSD_{5\%}$	0.583	0.855	0.818	0.751	0.406

[1] GSD - Groundnut seed cake

[2]PSD – *P. glabra* seed cake

[3]$LSD_{5\%}$ - Least significant difference at 5% level of significance

Conclusions

P. glabra seed and its seed cake have high levels of proteins, carbohydrates and some mineral elements. The Kulikuli produced was preferred and accepted in terms of taste, crispness and flavour. Therefore, the seed may be suitable for the production of seed cakes and can serve as another form of food for man, but it is recommended that the levels of oil should be minimized.

Author Contributions: This research was carried out in collaboration among six authors. Author M.O.B. designed the study and interpreted the data, Author A.F.O. monitored sample collection, identification and literature search, Authors M.A.O. and R.A.A. produced the Kulikuli and monitored sensory evaluation, Authors A.O.I. and A.A.A. gathered the analytical data, Authors M.O.B. and M.A.O. produced the initial draft and all authors read and approved final manuscripts.

Funding: This research received no external funding.

Acknowledgments: The authors appreciate Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

***Conflicts of Interest*:** "The authors declare no conflict of interest."

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