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Evaluation of Nutritional and Microbiological Properties of a Beverage Made from *Baobab* (*Adansonia digitata*)

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Abstract

The objective of this study was to evaluate nutritional and microbiological properties of beverage made from baobab (*adansonia digitata*). Specifically, the study evaluated proximate content of beverage made from baobab fruit pulp (*Adansonia digitata*), assessed mineral composition of beverage made from baobab fruit pulp (*Adansonia digitata*), determined microbiological properties of beverage made from baobab fruit pulp (*Adansonia digitata*). A laboratory-based experiment was applied to prepare and analyze samples of the Baobab drink. The results revealed that, even though, the drink had a high moisture content (83.69g) it could supply energy from carbohydrates (12.49g) and contained fat and protein in smaller amounts. Mineral composition was substantial for most nutrients but exceptionally high for potassium (5700ppm). The microbiological properties show that comparatively, the Baobab drink's microbial status was within safe levels. However, the presence and absence of high moisture in drink and powder influenced the microbial load and isolates from both products respectively. It was recommended that the need to carry out consumer acceptance studies on the drink to guarantee adoption among *baobab* drinking growing populations. Also a scale-up of this drink to provide healthier replacements for sugar sweetened beverages.

Keywords: Baobab, Drink, Fruit, Pulp, Powder, Microbial, Status, Nutrition,

Introduction

Baobab (*Adansonia digitata*) is a popular tree in Sub-Saharan Africa that adapt to extreme drought conditions. It absorbs and stores water in its trunk enabling it to produce a nutrient-dense fruit when all vegetation around it dries and become arid (Osman, 2004). In Nigeria, baobab tree is popularly called *igi ose* among Yoruba speaking communities. The baobab tree is usually grown for its leaves and fruit. The fruit consists of acidic pulp and shell with large seeds embedded in it. The utilization of baobab tree for food and crafts dates back to thousands of years and it holds special cultural meaning to people (Blench, 2007; Buchmann et al., 2010). The baobab tree is a multipurpose plant that is widely used. Its leaves and fruits are nutrient-rich and are consumed

regularly by indigenous populations in many African nations for food, medicine, and other purposes (De Caluwé et al., 2009; Gadour et a l., 2017; Muthai et al., 2017). The fruit and seeds may be used for fertilizer, fuel and soap or plaster (Obizoba and Anyika, 1994) while strong fibre that can be used to make ropes can be found in the bark and roots (Sidibe and Williams, 2002). The baobab leaf is one of the most nutrient-dense vegetables particularly rich in micronutrients and it has been successfully made into various recipes such as baobab and banana (*Musa acuminata*) ice-cream, baobab blue berry and different flavours of smoothie. In a community in Kwara State, Northcentral Nigeria, its leaf is used in preparing a sauce known as "*luru*" in the local dialect (Amusa et al., 2017), while the Hausa people uses the leaves to prepare "*Miyan kuka*" a popular soup (Asogwa et al., 2021). Studies on the qualities of baobab have revealed that their seeds, leaves, pulp, root tubers, and bark have the potential to be used for pharmaceutical purposes (Ramadan et al., 1994; Amusa et al., 2017; Lisao et al., 2017).

The dried pulp can also be crushed into powder and then dissolved in water or milk to produce a beverage with a distinctive flavor that resembles grapefruit, pear or vanilla flavours. The milky beverage can be made either using the dried pulp alone or by combining it with the flour of a grain called Acha (*Digitaria exilis*) (Asogwa et al., 2021). The seed are then mixed with the '*kunu*' which is considered as a supplement for milk (Amusa et al., 2017). Baobab fruit pulp contains substantial amounts of nutrients and antioxidants and has also been applied therapeutically in treatment of smallpox and measles (Silvia, 2002; Rahul et al 2015). High levels of vitamin C (Chadare et al., 2008), calcium (Osman, 2004), and antioxidants (Salih and Yahia, 2015) which are useful in protecting cells from damage-causing free-radicals can also be found in baobab pulp

In tropical Africa, beverages especially carbonated drinks are very popular due to the need to rehydrate in hot temperatures. There are renewed public health concerns regarding their consumption especially as it relates to their sugar content and their contribution to the epidemiology of non-communicable diseases overtime (Luger et al., 2017). This is not the case with locally sourced beverages which generally contain more nutrients and are usually cheaper than their sugar sweetened counterparts. Consequently, it is imperative to produce healthy alternatives. Baobab pulp serves as an healthy drink (Gruenwald and Galizia, 2005). It has been used as a beverage and also licked raw in some parts of the Africa (Abdullai et al., 2010, Adekunle et al, 2013). Hence, this study sought to produce a novel baobab fruit pulp beverage using a boiling method and then proximate, mineral and microbiological properties were evaluated.

The general objective was to evaluate nutritional and microbiological properties of beverage made from

baobab (*adansonia digitata*). Specifically, the study:

Specific Objectives

1. evaluated proximate content of beverage made from baobab fruit pulp (*Adansonia digitata*).
2. assessed mineral composition of beverage made from baobab fruit pulp (*Adansonia digitata*).
3. determined microbiological properties of beverage made from baobab fruit pulp (*Adansonia digitata*).

Materials and Methods

***Study Design*:** The study applied a laboratory based experimental design to prepare a drink and analyze its nutritional and microbiological composition.

Preparation of Sample: The drink was produced in the analytical laboratory of the Department of Human Nutrition and Dietetics, University of Ibadan, with some modification (addition of coconut milk).

Frstly, edible portion of the baobab (pulp) was collected and rinsed after removal of the inedible portion (bark, fibre and seeds). It was then steeped for 1hour, then hand pounded and filtered to pass through sieve 40 mesh size. It was then boiled at 105^{o}C, sugar and coconut milk was then added. It was allowed to cool and then packaged. The residue obtained during the filtration process was also evaluated for microbiological properties.

Determination of proximate composition: Proximate composition evaluations were carried out according to the standard methods of AOAC (2005).

Determination of mineral composition: Mineral composition was determined according to AOAC (2005) methods using an Atomic Absorption spectrophotometer.

Isolation and Enumeration of Microorganisms

Duplicate of 10g and 10 ml of the drink was homogenized with 90m1 sterile peptone water. The homogenate was serially diluted to the appropriate levels and directly inoculated into Petri dishes containing various isolation media. Aerobic bacteria were enumerated on Plate Count Agar (PCA), and incubated at a temperature of 37°C for 24h. Poteto Dextrose Agar supplemented with 250mg/ml chloramphenicol was used to enumerate mould and yeast extract agar for isolation of yeast. Inoculated plates were incubated at 25°C for 5 days. The deMan Rogosa Sharpe (MRS) agar were used for enumeration of total Lactic Acid Bacteria (LAB). Plates were incubated micro-aerobically at 37°C for 48h. MacConky agar was used for enumeration and isolation of Enterobacteriaceae. Selected colonies with distinct morphological differences such as colour, shape and size were purified by re-streaking them on the medium used for isolation. Pure isolates were stored on slants at 4°C.

Characterization and Identification of Isolates: Isolates were examined for colony and cell morphology; motility, cell arrangements, Gram reaction;

catalase reaction; growth in broth at 15 and 45°C; growth in the presence of 6.5% NaCl; production of ammonia from arginine; starch hydrolysis; carbon dioxide production and sugars fermentation pattern were determined (Harrigan,1998). Identification was based on morphological, physiological and biochemical characteristics by referencing Bergey's Manual of Systematic Bacteriology (Sneath et al., 1986) and Holzapfel and Wood (1995). Enterobacteriaceae were identified based on their morphological and biochemical characteristics. Microscopy (including Grams staining, motility, cell shape) and the ability to produce gas (from glucose, sucrose, arabinose, mannitol, lactose, raffinose) were done according to Harrigan (1998). Other tests included production of indole from tryptophan, utilization of citrate, hydrogen sulfide production, Voges-Proskauer test and methyl red test. Yeasts were identified using the method described by Deak and Beuchat (1996). The sugar fermentation patterns, growth at 37°C, increase in 50% glucose-yeast extract, growth in the presence of 6% NaC1 and mycelium was examined microscopically (Harrigan, 1998). The mould isolates were identified based on visible and microscopic features. For the macroscopic characteristics; colour and surface texture of colonies on their respective plates were observed. Microscopic examination was based on the use of Lactophenol cotton blue stain that was placed on a clean slide and a small piece of mycelium was carefully transferred into it with the aid of sterile inoculating needle. It was then gently smeared, covered with a clean slip and examined under high-power magnification (x 40) objective lens of the microscope for the presence of fruiting bodies like conidia and sporangiospores (Barnett & Hunter, 1998).

RESULTS

Table 1: Proximate Analyses of Baobab Drink (grams per 100g)

Nutritional Parameter	Composition (g/100g)
Moisture content	83.69
Crude protein	0.98
Crude fat	2.24
Crude fibre	0.68
Ash content	0.61
Carbohydrate content	12.49

Table 1 shows the proximate composition of the baobab drink. Expectedly, the sample had high moisture content (83.69%). Carbohydrate content of the drink was 12.49 percent while the crude fibre was 0.68 percent. The crude fat content was 2.24 percent, crude protein was 0.98 percent and the ash content was 0.61 percent.

Table 2: Mineral Composition of Baobab Drink in Parts Per Million (ppm)

Nutritional Parameter	Composition (ppm)
Phosphorus	300
Calcium	500

Magnesium	400
Potassium	5700
Sodium	64
Manganese	32
Iron	69
Copper	22
Zinc	14

Table 2 shows the mineral composition of baobab drink. Sodium is an essential source of electrolyte for the body system and the value was found to be 64.39 ppm. The drink contained 68.99 ppm of iron. Phosphorus (300 ppm) and calcium (500 ppm) were relatively high. This study reveals baobab drink to be a good source of potassium presented to be 5700 ppm.

Table 3: Microbial Load of Organisms Isolated from Powder and Modified Baobab Drink

Microorganisms	Powder of Baobab Drink (cfu/mg)	Modified Baobab Drink (cfu/ml)
Total plate counts	6.2×10^3	7.0×10^6
Yeast counts	1.7×10^1	3.1×10^4
Moulds counts	3.0×10^1	1.5×10^3
LAN counts	4.1×10^2	1.2×10^5
Coliform counts	6.0×10^2	5.0×10^1

Table 3 shows the microbial load of organisms in the powder and drink. It shows that yeast counts were lowest in the powder (1.7×10^1 cfu/mg) and coliform counts in Baobab drink (5.0×10^1 cfu/ml). The highest were coliform counts for powder (6.0×10^2 cfu/mg) and LAN counts for drink (1.2×10^5 cfu/ml) respectively.

Table 4. Microorganisms isolated from modified Baobab drink

Category	Microorganisms
Yeast	*Saccharomyces cerevisiae and candida tropicalis*
Moulds	*Aspergillus flavus, Penicillium citrinum, Rhizopus stolonifera*
LAB	*Lactobacillus (L) delbrukii, L. fermentum and L. plantarum*
Coliform	*Proteus vulgaris, Klebsiella pneumonia and Escherchia coli*

Table 4 presents results of microorganisms isolated from modified Baobab drink. Yeast contained *Saccharomyces cerevisiae and candida tropicalis* while Coliform contained *Proteus vulgaris, Klebsiella pneumonia and Escherchia coli.*

Discussion

Moisture content plays an important role in food, most especially in terms of freshness and storage stability. The moisture content of the drink was found to be very high (83.69%) which is typical of refreshing drinks. Moreover, the values found were found to be higher than those reported for Kunnun zaki (72.4%) by Adeniji and Keshinro, (2015) and slightly higher for tiger nut drink (86.5%) by Obadesagbo et al. (2023) but lower than soy milk drink (89.3%) by Nwoke et al. (2015). However, the high moisture content of the drink is an indication of its high susceptibility to microbial attack, which goes a long way in determining the shelf life. Carbohydrate is a crucial part of a healthy diet as it provides the body with glucose to sustain metabolic processes and physical activity. In this study, the carbohydrate content of the drink was higher than what was reported for tigernut drink (7.20 %) by

Obadesagbo et al. (2023), Kunu zaki (4.1%) by Adeniji and Keshinro, (2015) and soymilk (1.99 – 2.69%) by Odu et al. (2012). Dietary fibre has been regarded vital for optimum human health. Epidemiological studies have shown that diets that are low in dietary fibre, which is primarily found in plant-based foods, and high in fat, sugar, and salt can predispose an individual to the many chronic diseases of this contemporary times, including diabetes (Shaw and Sicree, 2008), obesity (Feskens et al., 2014), cardio-vascular disease (Kochar et al., 2011), certain cancers (Chajes and Romieu, 2014), and more (Buttriss and Strokes, 2008). The crude fibre content of the drink was found to be higher than soymilk (0.081 – 0.087%) by Nwoke et al. (2015) but lower in tigernut drink (1.52%) by Obadesagbo et al. (2023). The ash content was relatively lower (0.61%) than the pulp (5.83%) by Erwa et al. (2018). Also, the ash content was significantly higher (4.40%) in a drink made by dissolving the pulp in cold water by Adedayo et al. (2011)

Sodium is an essential source of electrolyte for the body system; the value was found to be 64.39 ppm. This presents the drink as a fair source of this essential mineral especially since it is higher than a similar drink evaluated in literature (Adedayo et al., 2011). Iron plays an important role in the formation of red blood cells. Since children, women of reproductive age and pregnant women are the most vulnerable to micronutrient deficiency (especially iron deficiency anemia), the consumption of this drink might serve as a substantial source of dietary iron for this group of individuals. Phosphorus and calcium have been reported as key minerals required by children, pregnant and lactating woman for bones and teeth development (Sodamade et al., 2013). Phosphorus and calcium were found relatively high in the drink which presents it as a good source of these minerals. Copper, which is required for enzyme production and some other biological activities in the body, was found to be substantial while zinc, which plays an influential role in gene expression, formation of co-enzymes and regulation of cellular growth, was found to be lower. Potassium was the most abundant among all the minerals determined in the drink. The role of potassium as a major cation and in the utilization of iron in human body has been reported to be very important and this is mostly beneficial to patients suffering from inefficient utilization of potassium and those taking diuretics to control hypertension (Arinathan et al., 2003).

Total plate counts of the powder and modified Baobab drink (*Adansonia digitata*) were 6.2x101 cfu/g and 7.0 x l06 cfu/ml respectively. These results were higher than was reported for a baobab milk nectar evaluated by Chadare et al. (2017). Total Yeast counts of 1.7 x l01 cfu/g and 3.1 xl03 cfu/ml were detected in the powder and modified Baobab drink (*Adansonia digitata*) respectively. Moulds counts was 3.0 x 101 cfu/g and 1.5 x103 cfu/ml in the powder and modified Baobab drink (*Adansonia digitara*) respectively. However, lactic acid bacteria counts of 4.1 x102 cfu/g and

1.2 x105 cfu/ml was detected in the powder and modified Baobab drink (*Adansonia digitata*) respectively while Coliform counts as not detected in the powder but 5.0 x101 cfu/ml was recovered in the modified Baobab drink (*Adansonia digitata*). A safety assessment of the powder and drink shows that except for the total plate count of the modified drink, the microbial status of the products was within an acceptable level (International Commission on Microbiological Specifications for Foods, 2011; Kamatou et al., 2011).

Among microorganisms isolated from modified Baobab drink (*Adansonia digitata*) are Yeast isolates identified as Saccharornyces cerevisiae and Candida tropicalis while Lactic acid bacteria were Lactobacilius (L) deThrukii, L. fermentum and L. piantarum. Moulds isolated were *Aspergillus Jiavus, Penicillium citrinum* and *Rhizopus stolonifer* while Enterobacteriaceae such as Proteus vuigauis, Kiebsiella pneumonia and Escherichia coli were isolated from the samples. The presence of microorganisms is usually increased with exposure to humidity (Chadare, 2017).

Conclusion

This study was designed to evaluate the nutritional properties of a modified Baobab drink and the microbiological properties of the drink and powder. To the best of our knowledge, this is the first attempt to evaluate such products from Baobab fruit pulp applying the described methodology. The results reveal that the drink has high moisture content and could also supply energy from carbohydrates but contains other proximate in smaller amounts. Mineral composition was high especially for potassium. The microbiological properties show that comparatively the Baobab drink's microbial status is within safe levels. However, the presence and absence of high moisture in drink and powder impacted on the microbial load and isolates from both products respectively.

Recommendation

1. There is need to carry out sensory evaluation/consumer acceptance studies on the drink to guarantee adoption among *Baobab* drinking growing populations.
2. A follow-up study on the willingness to pay should be preformed to explore the commercialization of this drink to provide healthy options for sugar sweetened carbonated beverages.

References

A.O.A.C., 2005. Association of Analytical Chemists, Official Methods of Analysis. Vol.!!, 17tl edition Washington, D.C,USA,

Abdullai M.A., Mohammed M.A. & Mudawi H.A. (2010): Production and Quality Assessment of instant Baobab (Adansonia digitata L.) *Advance Journal of Food Science and Technology* 2(2): 125-133. ISSN 2042-4876.

Adedayo, M .R. Olayemi, F. F. & Bamishaiye, E. I. (2011) Proximate and Mineral Composition of a Local Drink Made from Baobab Fruit (Adansonia digitata) Pulp. *Journal of Advances in Bioresearch, 2(2)*, 82085. ISSN 0976-4585.

Adekunle, A. A., Shittu, T. A., Abioye, A. O., Adeyanju, J. A., & Osanaiye, F. G. (2013). Physical and thermal properties of baobab fruit pulp powder. *International Journal of Engineering Research and Applications*, *3*(3), 925-928.

Adeniji O.P. & Keshinro K.O. (2015). Assessment of Nutritional and Sensory Quality of Zaki – A Home-made Traditional Nigerian Beverage. *J Nutr Food Sci*, 5, 358.

Amusa, T.O., Aderinoye-Abdulwahab S.A., Akanbi S.O. & Idowu O.P. (2017). Uses and prevalence of African baobab (Adansonia digitata L 1759) in Okoo Community, Kwara State, North-Central Nigeria. *J. Agric. Food Environ.,* 13 (1), 43-49.

Arinathan, V., Mohan, V. R., & John De Britto, A. (2003). Chemical composition of certain tribal pulses in South India. *International Journal of Food Sciences and Nutrition*, *54*(3), 209-217.

Asogwa, I.S., Ibrahim, A.N. & Agbaka J.I. (2021) African baobab: Its role in enhancing nutrition, health, and the environment. *Trees, Forests People,* 3, 100043

Barnett, H.L. and Hunter, B.B., 1998. Illustrated genera of imperfect fungi 4th ed. The American Phytopathological Society.

Blench R. M. (2007) The intertwined history of the silk-cotton and baobab. In Fields of change; progress in African ethnobotany (ed. Cappers RTJ), pp. 1–20.

Buchmann C., Prehsler S., Hartl A. & Vogl C. R. (2010) The Importance of Baobab (Adansonia digitata L.) in Rural West African Subsistence—Suggestion of a Cautionary Approach to International Market Export of Baobab Fruits, Ecology of Food and Nutrition, 49(3), 145-172.

Buttriss, J. L. & Stokes, C. S. (2008). Dietary fibre and health: an overview. *Nutr Bull*., 33(3), 186–200.

Chadare, F. J., Linnemann, A. R., Hounhouigan, J. D., Nout, M. J. R., and Van Boekel, M. A. J. S. (2008). Baobab food products: a review on their composition and nutritional value. Crit. Rev. Food Sci. Nutr. 49, 254–274.

Chadare, F. J., Madode, Y. E., Tandji, F. BA. I., Egue, F. O. M., Koffi M., D'almeida, Affonfere, M L. and Hounhouigan, D. J. 2017 Physico-chemical, microbiological characteristicsdrink developed from the bottom of the pyramid in urban Benin, Pages (pp.) 01-09. Agronomique du Bénin (BRAB).

Chajes, V., & Romieu, I. (2014). Nutrition and breast cancer. *Maturitas*., 77(1), 7–11.

De Caluwé, E., Halamová, K. & Van Damme, P. (2010). "Adansonia digitata L. A review of traditional uses, phytochemistry and pharmacology". *Afrika Focus,* 23(1).

Deak, T., and Beuchat, L. R. (1996). Handbook of food spoilage yeasts. Boca Raton, FL: CRC Press.

Erwa, I. Y., Shinger, M. I., Adam, O., Ishag, O., Ali, A. M., Ahmed, R. E., & Mohamed, A. A. (2019). Proximate and Elemental Composition of Baobab Fruit (Adansonia digitata L) Pulp. *Journal of Chemical, Biological and Physical Sciences*, 9(1), 42–51.

Feskens, E. J. M., Sluik, D. & Du, H. D. (2014). The association between diet and obesity in specific European cohorts: DiOGenes and EPIC-PANACEA. *Curr Obes Rep*., 3(1), 67–78.

Gadour, M. O., Khidir, H. B., Adam, I., and Gasim, G. I. (2017). Effects of a powder of the fruit of adansonia digitata (tabaldia, gongolase, or baobab tree) on serum lipids. J. Herbal Med. 8, 14–16.

Gruenwald J, and Galizia MD (2005) Market brief in the European union for

selected natural ingredients derived from native species. Adansonia Digitata L. Baobab. The United Nations Conference on Trade and Development (UNCTAD). Bio Trade Initiative/BioTrade Facilitation Programme (BTFP), Geneva

Harrigan, W.F., 1998. Laboratory methods in food microbiology. Gulf professional publishing.

Holzapfel, W.H. and Wood, B.J.B., 1995. Lactic acid bacteria in contemporary perspective. In The genera of lactic acid bacteria (pp. 1-6). Springer, Boston, MA.

International Commission on Microbiological Specifications for Foods and Swanson, K.M., 2011. Microorganisms in Foods: Use of Data for Assessing Process Control and Product Acceptance. *Springer Science*.

Kamatou, G. P. P., Vermaak, I., & Viljoen, A. M. (2011). An updated review of Adansonia digitata: A commercially important African tree. *South African Journal of Botany*, *77*(4), 908-919.

Kochar, J., Gaziano, J. M. & Djousse, L. (2011). Dietary factors and the risk of coronary heart disease. *Aging Dis*., 2(2), 149–57.

Lisao, K., Geldenhuys, C. J., and Chirwa, P. W. (2017). Traditional uses and local perspectives on baobab (Adansonia digitata) population structure by selected ethnic groups in northern Namibia. S. Afr. J. Bot. 113, 449–456.

Luger, M., Lafontan, M., Bes-Rastrollo, M., Winzer, E., Yumuk, V., & Farpour-Lambert, N. (2017). Sugar-sweetened beverages and weight gain in children and adults: a systematic review from 2013 to 2015 and a comparison with previous studies. *Obesity facts*, *10*(6), 674-693.

Muthai, K. U., Karori, M. S., Muchugi, A., Indieka, A. S., Dembele, C., Mng'omba, S., et al. (2017). Nutritional variation in baobab (Adansonia digitata L.) fruit pulp and seeds based on Africa geographical regions. Food Sci. Nutr. 5, 1116–1129.

Nwoke, F. U., Umelo, M. C., Okorie, J. N., Ndako, Khadijat, J. & Maduforo, A. N. (2015). Nutrient and Sensory Quality of Soymilk Produced from Different Improved Varieties of Soybean. *Pakistan Journal of Nutrition*, 14, 898-906.

Obadesagbo, O., Horsefall, M. & Sibe L. (2023). "Proximate Analysis on Ungingered and Gingered Tiger Nut's Drink Commercialized in Some Major Towns in Rivers State, Nigeria". *Current Research in Interdisciplinary Studies*, 2(3), 1 – 9.

Obizoba, I. C., & Anyika, J. U. (1994). Nutritive value of baobab milk (gubdi) and mixtures of baobab (Adansonia digitata L.) and hungry rice, acha (Digitaria exilis) flours. *Plant Foods for Human Nutrition*, *46*(2), 157-165.

Odu, N. N., Egbo, N. N. & Okonko, I. O. (2012). Assessment of the Effect of Different Preservatives on the Shell-Life of Soymilk Stored at Different Temperatures. *Researcher*, 4(6), 62-69.

Osman, M. A. (2004). Chemical and nutrient analysis of baobab (Adansonia digitata) fruit and seed protein solubility. *Plant foods for human nutrition*, *59*(1), 29-33.

Rahul, J., Jain, M. K., Singh, S. P., Kamal, R. K., Naz, A., Gupta, A. K., & Mrityunjay, S. K. (2015). Adansonia digitata L.(baobab): a review of traditional information and taxonomic description. *Asian Pacific Journal of Tropical Biomedicine*, *5*(1), 79-84.

Ramadan, A., Harraz, F. M., & El-Mougy, S. A. (1994). Anti-inflammatory, analgesic and antipyretic effects of the fruit pulp of Adansonia digitata. *Fitoterapia (Milano)*, *65*(5), 418-422.

Salih, N. K. E. M., and Yahia, E. M. (2015). Nutritional value and antioxidant properties of four wild fruits

commonly consumed in Sudan. Int. Food Res. J. 22, 2389–2395.

Shaw, J. E. & Sicree, R. (2008). Epidemiology of type 2 diabetes. Totowa: Humana Press Inc.

Sidibe, M., & Williams J. T. Baobab. (2002). Adansonia digitata L. Fruits for the future, 4, International Centre For Underutilized Crops, University of Southampton, Southampton, United Kingdom .

Sneath, P.H., Mair, N.S., Sharpe, M.E. and Holt, J.G., 1986. Bergey's manual of systematic bacteriology. Volume 2. Williams & Wilkins.

Sodamade, A., Bolaji, O. S., & Adeboye, O. O. (2013). Proximate analysis, mineral contents and functional properties of Moringa oleifera leaf protein concentrate. *IOSR Journal of Applied Chemistry*, *4*(6), 47-5