RUFORUM Working Document Series (ISSN 1607-9345)2019, No. 18 (1): 46 - 53.
Available from htttp://repository.ruforum.org

Research Application Summary

Mutchayan a derived product from Baobab fruit pulp used as complementary food in Benin

Fassinou, F.T.K.[1], Chadare, F.J.[1,2*], Affonfere, M.[1] & Gbaguidi, M.A.[1]

[1]Laboratory of Food Science, Faculty of Agronomic Science, University of Abomey-Calavi, BP 526, Abomey-Calavi, 229 Atlantique, Benin
[2]Ecole des Sciences et Techniques de Conservation et de Transformation des Produits Agricoles, Université Nationale d'Agriculture, République du Bénin
***Corresponding author:** fchadare@gmail.com

Abstract

The present study was carried out in Benin and aimed at assessing nutritional values of the baobab (*Adansonia digitata*) fruit pulp and its important derived products consumed by under five year old children. Field survey was performed in West of Sudanian zone (Materi, Tanguiéta and Natitingou) to collect data on baobab and its derived products. Consumption frequency of baobab fruit pulp and its derived product by under five years old children, the proportion of population using the fruit pulp and its derived products and the processing techniques of the derived products were collected. The score of consumption frequency was computed for the derived food selection using the frequency consumption and the proportion of population that used the derived products. The macronutrient composition (protein, fat, fibre, ash) were estimated for baobab fruit pulp and its derived food according to AOAC method. The mineral iron, zinc calcium, magnesium, phosphorus and cupper content were evaluated using inductively coupled plasma–optical emission spectrometer method. Mutchayan, a fermented cereal dough enriched with baobab fruit pulp (BFP), baobab fruit pulp juice, moukou-moukou, BFP with sugar and cereals porridge enriched with BFP were the derived products found integrate the baobab fruit pulp and consumed by the children 6 to 59 months in West Sudanian zone. Mutchayan recorded the highest frequency consumption and thus is the most important local derived product from baobab fruit pulp consumed by these childrens. BFP nutritional values was 73.12±4.36g/100g dw for carbohydrate and 2.70 ± 0.71g/100g dw for protein content. The minerals content of BFP was estimated to 11.17 ± 2.64mg/100g dw for iron, 277.5 ± 24.75mg/100g dw for calcium, 1.25 ± 0.78mg/100g dw for zinc. Content of vitamin C was 389.66 ± 7.02 mg/100g dw for baobab fruit pulp. Its highest derived product, Mutchayan are 88.62 ± 0.40g/100g dw for carbohydrate and 1.77 ± 0.48 g/100g dw for protein. Mutchayan iron, calcium and zinc content were respectively 1.75 ± 0.02 mg/100g dw, 0.10 ± 0.01 mg/100g dw and 0.35 ± 0.04 mg/100g (dw). Regarding the nutritional values of the baobab fruit pulp it could be promoted as local food fortificant to enrich food for under five years old children. However, Mutchayan micronutrient composition appears poor so further research is needed to improve its mineral composition.

Keywords: Baobab, Benin, cereals dough, enriched food, food supplement

Résumé

La présente étude a été réalisée au Bénin et visait à évaluer les valeurs nutritionnelles de la pulpe du fruit du baobab (*Adansonia digitata*) et de ses importants produits dérivés consommés par les enfants de moins de cinq ans. Une enquête était réalisée sur terrain dans l'ouest de la zone soudanienne (Materi, Tanguiéta et Natitingou) pour recueillir des données sur le baobab et ses produits dérivés. La fréquence de consommation de pulpe de fruit de baobab et de ses produits dérivés par les enfants de moins de cinq ans, la proportion de la population utilisant la pulpe de fruit et ses produits dérivés et les techniques de transformation des produits dérivés étaient enregistrés. Le score de fréquence de consommation était calculé pour la sélection d'aliments dérivés en utilisant la fréquence de consommation et la proportion de la population qui avait utilisé les produits dérivés. La composition en macronutriments (protéines, lipides, fibres, cendres) était estimée pour la pulpe de fruit de baobab et ses aliments dérivés selon la méthode AOAC. La teneur en fer minéral, en zinc, en calcium, en magnésium, en phosphore et en cuivre était évaluée à l'aide d'un spectromètre d'émission plasma-optique à couplage inductif. Les produits dérivés retrouvés intégrant la pulpe de fruit de baobab et consommés par les enfants de 6 à 59 mois en zone ouest-soudanienne étaient la pâte de céréales fermentée dénommée Mutchayan, enrichie en pulpe de fruit de baobab (PFB), du jus de pulpe de fruit de baobab, du moukou-moukou, du PBF avec sucre et de la bouillie de céréales enrichie en PBF. Mutchayan avait enregistré la fréquence la plus élevée de consommation et est donc le produit localement dérivé de la pulpe de fruit de baobab le plus consommé par ces enfants. Les valeurs nutritionnelles du BFP étaient de 73,12 ± 4,36 g/100 g poids sec (p.s) pour les glucides et de 2,70 ± 0,71 g/100 g poids sec pour la teneur en protéines. La teneur en minéraux du BFP a été estimée à 11,17 ± 2,64mg/100g p.s pour le fer, 277,5 ± 24,75mg/100g p.s pour le calcium, 1,25 ± 0,78mg/100g p.s pour le zinc. La teneur en vitamine C était de 389,66 ± 7,02 mg/100g p.s pour la pulpe de fruit de baobab. Le produit localement dérivé à fréquence de consommation élevée, Mutchayan, avait enregistré les teneurs allant de 88,62 ± 0,40 g/100 g de poids sec de glucides et de 1,77 ± 0,48 g/100 g de poids sec des protéines. Les teneurs en fer, calcium et zinc de Mutchayan étaient respectivement de 1,75 ± 0,02 mg/100g ps, 0,10 ± 0,01 mg/100g ps et 0,35 ± 0,04 mg/100g (ps). Compte tenu de valeurs nutritionnelles de la pulpe du fruit du baobab enregistrées, elle pourrait être promue comme fortifiant alimentaire local pour enrichir l'alimentation des enfants de moins de cinq ans. Cependant, la composition en micronutriments de Mutchayan semble être déficient, en conséquence des recherches supplémentaires sont nécessaires pour l'améliorer.

Mots clés : Baobab, Bénin, pâte de céréales, aliment enrichi, complément alimentaire

Introduction

In most tropical countries, the Non Timber Forest Products (NTFPs) play an important role in the daily life and well-being of the local population (Babalola and Agbeja, 2009). In Africa, NTFPs contribute highly for rural livelihoods outcomes. These NTFPs are needed to ensurie food security, meet medicinal needs, and provide sources of income, especially in periods of drought and starvation (Kafoutchoni *et al*., 2018). Sardeshpande and Shackleton (2019) reported that about one billion of people worldwide derive livelihoods and food from forests, and around 300 million of these people depend extensively on NTFPs. In northern Benin, the contribution of NTFPs to total household income was estimated at 39 % yearly and *Adansonia digitata* is one tree commonly used (Heubes *et al*., 2012). *Adansonia digitata* is known to be used daily by local populations in Africa because of its economic key importance among the numerous forest food resources (Cissé, 2012). Especially, the baobab fruit pulp are used to make a gruel, the sour dough and the beverage (Kaboré *et al*., 2011). The fruit pulp products are reported to be used to improve food security (De Caluwé *et al*., 2010). Despite studies conducted within *Adansonia digitata* plant part nutritional values (Giami *et al*., 1994; Oboh and Ekperigin, 2004; Chadare, 2010), nutritional values on its derived products are poorly investigated. The objective of this study was to characterizing baobab (*Adansonia digitata*) fruit pulp from west sudanian zone of Benin and its most important derived product usually consumed by the under-five in this area.

Material and methods

Three steps were followed in this study. Firstly, field surveys were conducted to check the consumption frequency of baobab and its derived products. Secondly the most important derived product was selected and the processing of its derived product followed up. Thirdly the laboratory analysis was conducted on the baobab fruit pulp (BFP) and its selected derived product.

Field survey. This study was carried out in West-Sudanian biogeographical zones of Benin mainly Materi,Tanguiéta and Natitingou where baobab naturally occur and are used by the populations (Assogbadjo *et al*., 2005). The number of interviewees in each municipality was calculated according to Dagnelie (1998) as follows:

$N_i = (4P_i (1-P_i))/d^2$

With:

P_i is the proportion of consumers of baobab part in the Sudanian zone and among 50 randomly selected consumers,
d is the margin mistake fix to 0.07

A random check was performed on 50 persons who were asked if they use/consume or not the species under investigation to determine the proportion Pi. The proportion of persons who provide a positive answer as considered as Pi. As such 50 under five mothers who used the baobab fruit pulp in their children feeding were enrolled.

Data collection. Structured questionnaires were used to collect data on plants parts used and their derived products. Their consumption frequency for under five years old children was collected. The diet history method was conducted with mothers to collect the consumption frequency of baobab and its derived product. The number of day of consumption of each part of Baobab and its derived products per week was collected. The proportion of population using the plant parts and their derived products were computed. The processing techniques of the derived products were also collected.

Selection and precessing of the most important derived products from baobab fruit pulp. The most important fruit pulp derived product was selected using the frequency consumption and the proportion of the population using the derived product. A score (DP score) of the fruit pulp was computed and the derived product with the highest score was considered as the most important derived product.

DP Score=(consumption frequency *proportion using the derived product)

The processing follow-up was performed for each selected derived products with three (3) household experienced women. Successive weighting of ingredients used was performed at each processing step for each derived products. At the end of the process, samples of derived products were collected and packed in impermeable bag kept on ice (0 to 4°C) and transported to the laboratory and frozen at -11°C until analysis.

Physico-chemical and nutritional analysis characterization. The ripe fruits were washed thoroughly, peeled and the flesh was separated from the seed. The pulp was packaged and frozen at -11°C until laboratory analysis. Baobab fruit pulp was collected in Natitingou and Tanguieta (Soudanian zone) in March 2018. It was sieved, packaged in impermeable bag and frozen at -11°C until analysis. Mutchayan was collected after the processing follow up in April 2018 and stored with ice and carbogaz at low temperature and was transported to laboratory. It was stored at laboratory at -11°C until analysis.

The physical parameters determined on the different samples are the pH, the Brix value and the titratable acidity. Sample pH was measured with a pH meter according to ISO1842 (EAS, 2000) method. The sample brix value was determined using an ATAGO digital refractometer according to ISO 2173: 2003. Twenty millilitre (20ml) of distilled water was added in 10g of baobab fruit pulp to determine its pH and brix value. Titratable acidity was assessed as described by Nout *et al*. (1989). It was expressed in citric acid per gram of product considering 1 ml of NaOH 0.1 N.

The sample moisture, ash and fiber contents were determined according to AOAC (1993) method. The protein was assessed using Kjeldahl method (AOAC, 1993) while the fat was determined using Soxhlet method (AOAC, 1993). The carbohydrate content was estimated according to differential method as describe by Abdullahi *et al*. (2014). Energy values (kcal/100 g) were calculated using Atwater coefficients.

Carbohydrate (g/100g) = 100 - %(Fat + Ash + Protein + Crude fiber)
Energy value (Kcal/100g) = 4 * %Protein + 4* %Carbohydrate + 9 * %Fat

The minerals content determined in the BFP, ABMF and their derived products were: iron, calcium, zinc, copper, phosphorus and magnesium (Mn). They were determined using an inductively coupled plasma–optical emission spectrometer (ICPAES) according to Temminghof *et al*. (1997). The vitamins assessed were vitamin C and the vitamin A. Vitamin C content was determined using High Liquid Phase Chromatographic (HPLC) as describe by Hernandez *et al*. (2006) while vitamin A content was determined using the method describe by Bushway and Wilson (1982).

Results

Most important derived product from baobab fruit pulp. The consumption frequency score of baobab fruit pulp derived products ranged from 0.48 to 328.8 (Table 1). The field survey showed that porridges from cereals, nectar (mixture of baobab fruit pulp and water), mutchayan (traditional fermented maize, sorghum or millet porridge with baobab fruit pulp) and mukou_mukou (baobab fruit pulp + sugar) were main derived products from baobab fruit pulp. Mutchanyan score was 328.84 while porridge score was 278.14. Mutchayan was selected as the most important derived product from baobab fruit pulp.

Table 1. Frequency consumption score of baobab derived products

Derived product	Average consumption frequency (Nbr day/week)	Proportion of consumers (%)	Frequency consumption score
Porridge	3.44	80.80	278.14
Juice	1.62	96.20	155.40
Mutchayan	4.38	75.00	328.84
Mukou-Mukou	1.00	25.00	25.00

Nbr day/week: Number of day per week

Processing of mutchayan. The processing diagram of mutchayan showed that cooking and fermentation are the most important steps (Figure 1). At the beginning, maize (75 ± 10g) and millet (25 ± 10g) were mixed and ground to make flours. This flour (24.4 ± 4.6g) is homogenized with water (81.4 ± 28.6g) and cooked for 20 ± 7.07 minutes to make 89.1 ± 9.9g (maize and millet dough). Subsequently, 5.1 ± 1.4g of baobab fruit pulp was mixed with 89.1 ± 9.9g of the hot dough. The mixed product was fermented during about 18±8.48 hours at room temperature to make mutchayan (Figure -a). After obtaining mutchayan, 43.12 ± 5.77g of mutchayan dough was mixed with 60.79 ± 8.06g of water to make 100g of the thick drink mutchayan ready to be consumed (Figure -b).

Physical characteristics of baobab fruit pulp and mutchayan. Table 2 presents the physical characteristics of baobab fruit pulp, African bush mango fruit pulps and mutchayan. The baobab fruit pulp pH was 3.56 ± 0.75 and mutchayan 3.83 ± 0.01. Baobab fruit pulp and mutchayan had respectively a brix value of 10.75 ± 2.48 and 4.75 ± 0.44. Titratable acidity values was 1.54% of citric acid for baobab fruit pulp and 0.54% of citric acidity for mutchayan.

a) Mutchayan dough (fermented millet and maize dough with BFP) b) Mutchayan thick drink

Figure 1. Mutchayan dough and thick drink

Table 2. Physic characteristic of *Adansonia digitata f*ruit pulp and mutchayan

Parameters	Baobab fruit pulp	Mutchayan
pH	3.56 ± 0.75	3.83 ± 0.01
Brix	10.75 ± 2.48	4.75 ± 0.44
Titratable Acidity (% of citric acid)	1.54 ± 0.01	0.54 ± 0.01

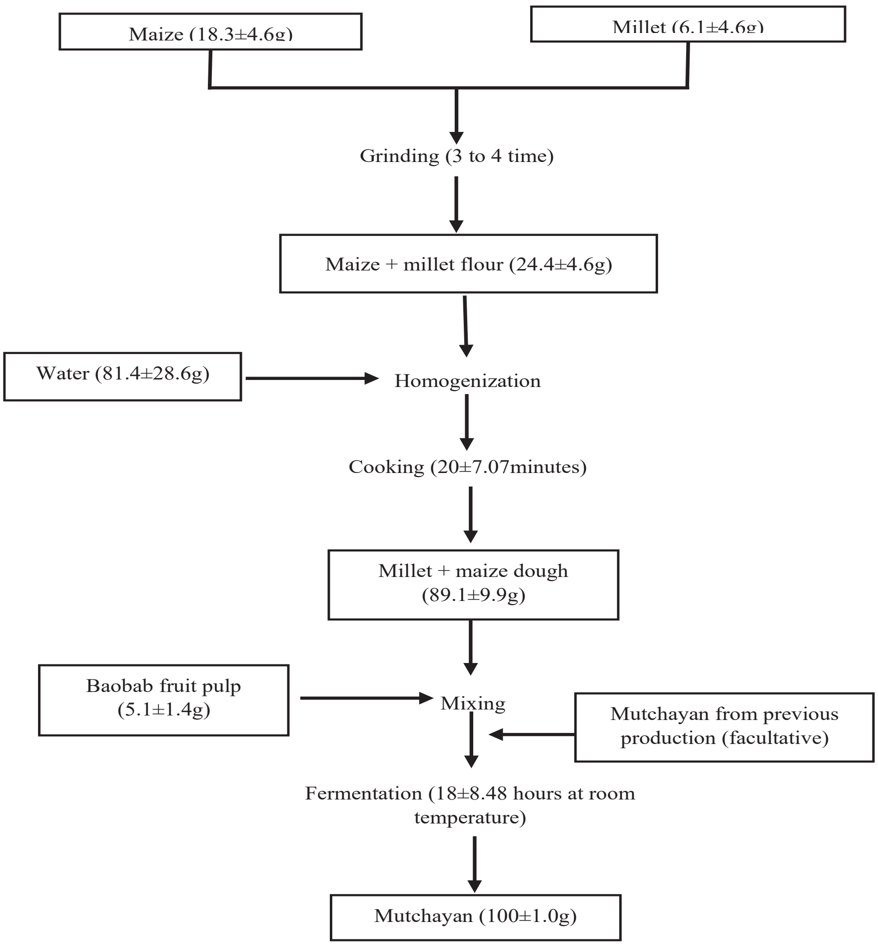

Figure 2. Flow diagram for mutchayan production

Proximate composition of baobab fruit pulp and mutchayan. Table 3 shows the proximate composition of *Adansonia digitata* fruit pulp and mutchayan. It showed that the baobab fruit pulp contained 5.11 ± 0.86g/100g dw of ash, 73.12 ± 4.36g/100g dw of carbohydrate and 2.70 ± 0.71g/100g dw of protein. Mutchayan contained 0.07 ± 0.03g/100g dw of ash, 88.62 ± 0.40 g/100g dw of carbohydrate and 1.77 ± 0.48 g/100g dw of protein.

Table 3. Proximate composition of *Adansonia digitata* fruit pulp and mutchayan

Nutrients	Baobab Fruit Pulp	Mutchayan
Dry matter (g/100g)	89.15 ± 0.65	21.25 ± 3.03
Ash (g/100g) dw	5.11 ± 0.86	0.07 ± 0.03
Carbohydrate (g/100g) dw	73.12 ± 4.36	88.62 ± 0.40
Protein (g/100g) dw	2.70 ± 0.71	1.77 ± 0.48
Fat (g/100g) dw	0.34 ± 0.05	0.19 ± 0.06
Fiber (g/100g) dw	8.28 ± 4.07	9.36 ± 0.01
Energy (Kcal)	306.26 ± 19.86	363.13 ± 0.64

Nutritional composition of baobab fruit pulp and mutchayan. Mineral composition of the baobab fruit pulp and mutchayan are presented in Table 4. Baobab fruit pulp (BFP) iron content was 11.17 ± 2.64 mg/100g dry weight (dw), calcium 277.5 ± 24.75 mg/100g dw, zinc 1.25 ± 0.78 mg/100g dw and vitamin C 389.66 ± 7.02 mg/100g dw. Mutchayan composition was 1.75 ± 0.02 mg/100g dw of iron, 0.10 ± 0.01mg/100g dw of calcium, 0.35 ± 0.04 mg/100g dw of zinc and vitamin C 50 ± 0.01mg/100g dw.

Table 4. Mineral and vitamin composition of baobab pulp fruit (BFP) and mutchayan

Nutrients	Baobab fruit pulp	Mutchayan
Iron (mg/100g)	11.17 ± 2.64	1.75 ± 0.02
Zinc (mg/100g)	1.25 ± 0.78	0.35 ± 0.04
Calcium (mg/100g)	277.5 ± 24.75	0.10 ± 0.01
Phosphorus (mg/100g)	59.24 ± 13.36	0.03 ± 0.01
Magnesium (mg/100g)	112.52 ± 31.85	27.48 ± 0.46
Cupper (mg/100g)	1.04 ± 0.80	0.10 ± 0.01
Vitamin A (µg/100g)	2.48 ± 0.78	50 ± 0.01
Vitamin C (mg/100g)	389.66 ± 7.02	2.7 ± 0.01

Discussion

Baobab pulp macronutrient composition was consistent with the ones reported in several studies (Lockett *et al*., 2000; Osman, 2004; De Caluwé *et al*., 2010; Rahul *et al*., 2015) and mineral composition (Muthai *et al*., 2017) especially for calcium, magnesium and phosphorus in Kenya and Mali. However, the discrepancies were observed for calcium content 410±10mg/100g dw and magnesium 270±30mg/100g dw content reported from Saudi Arabia (Osman, 2004). This discrepancies could be explained by the origin of baobab fruit pulp. Muthai *et al*. (2017) in their study which compared nutritional values of baobab fruit pulp from Tanzania, Zambi, Kenya, Mali and Malawi found significant differences in the mineral composition of Ca, Mg, P, Fe, Cu and Zn, depending on the country. Moreover, the difference on mineral composition of baobab fruit pulp could be attributed to methods of sample preparation and analytical methods (Chadare *et al*., 2009).

Abdullahi *et al*. (2014) reported that variations in the nutritional composition of baobab fruit pulp may be due to environmental factors including different soil and climate conditions. Baobab fruit pulp nutritional values especially its vitamin C content, suggest that BFP could be used as agent to improve mineral especially iron availability. Indeed, the vitamin C is known to improve mineral bioavailability (Zimmermann *et al.*, 2005). The beneficial efforts of incorporation of *A. digitata* fruit pulp was demonstrated to increase the bioavailability of some nutrients (Abdullahi *et al*., 2014). In addition, mutchayan, one of the most important derived product from BFP consumed by under five years old children in west-sudanian zone of Benin was identified as nutritious by Chadare (2010). Mutchayan frequency consumption was 4.38 day/week and 75% of children under-five consumed it.

It is usually consumed by these under five years as beverage when they are hungry and largely as their breakfast. Children consumed it directly or add sugar before eating. In addition, mutchayan thick drink is often considered as a complementary food for the children. Fortunately, mutchayan macronutrient composition show that it is a good source of carbohydrates (88.62 ± 0.40 g/100g dw) and hence good source of energy (363.13 ± 0.64 Kcal/100g dw) for the under five years old children. These macronutrient values are comparable to macronutrient composition of maize (9.2 g/100g dw of protein, 63.9 g/100g dw of carbohydrate and 9.7 g/100g dw of fiber) (FAO, 2012) and millet (10.9 g/100g dw of protein, 62.6 g/100g dw of carbohydrate and 8.5g/100g dw of fiber) (FAO, 2012). However, its low ash content 0.07 ± 0.03 g/100g dw is a consequence of its low mineral content particularly calcium, iron, zinc and phosphorus. This low mineral content could be due mainly to the low mineral content of maize and millet and the low amount of baobab fruit pulp added (5.1g for 100g) of mutchayan on wet basis. Thus it becomes important to improve mutchayan mineral content for a better impact on these under five children health. Further research could investigate the enrichment of mutchayan through food to food fortification using local resources.

Conclusion

The minerals and vitamin content of baobab fruit pulp showed that it was an excellent source of calcium (277.5 ± 24.75mg/100g dw) and vitamin C (389.66 ± 7.02mg/100g dw). Mutchayan, fermented cereals (millet and maize) dough with baobab fruit pulp was the most important derived product from baobab fruit pulp consumed by under five years old children in West-Sudanian zone of Benin. The present study underscores that fruit pulp of baobab could be used to improve the nutritional characteristic of food especially mineral and vitamin for feeding under five years olds children. However, the muchayan nutritional values need to be improved for better impact on heath of under five years old children who consumed it.

Acknowledgement

The authors are thankful to the Agropolis, Cariplo and Daniel & Nina Carasso Foundations through the TREEFOOD project 1507-143. This paper is a contribution to the Fifteenth RUFORUM Annual General Meeting held 2-6 December 2019 in Cape Coast, Ghana.

References

Abdullahi, M., Zainab, F. A., Pedovoah, M. M., Sumayya, U. B. and Ibrahim, A. D. 2014: Evaluating the suitability of Adansonia digitata fruit pulp for the production of yoghurt. *International Journal of Biology and Chemestry Science* 8: 508-516.

AOAC, 1993: Methods of analysis for nutrition labeling. AOAC. pp. 771.

Bushway, R. and Wilson, A. 1982: Determination ofαα and β-carotene in fruits and vegetables by high performance liquid chromatographiy. *Canadian Institute of Food Science and Technology Journal* 15 (3): 165-169.

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. *Critical Reviews in Food Science and Nutrition* 49 (3): 254-274.

Cissé, I. 2012. Caractérisation des propriétés biochimiques et nutritionnelles de la pulpe de baobab des espèces endémiques de Madagascar et d'Afrique continentale en vue de leur valorisation. Doctorat, Montpellier Supagro, Ecole doctorale : Sciences des Procédés – Sciences des Aliments, 167.

Hernandez, Y., Lobo, M. and Gonzalez, M. 2006: Detrmination of vitamin C in tropical fruits : A comparative evaluation of methods. *Food Chemistry* 96: 654-664.

Heubes, J., Heubach, K., Schmidt, M., Wittig, R., Zizka, G., Nuppenau, E.A. and Hahn, K. 2012. Impact of future climate and land use change on non-timber forest product provision in Benin, West Africa: Linking niche-based modeling with ecosystem service values. *Economic Botany* 66 (4): 383-397.

Muthai, K.U., Karori, M.S., Muchugi, A., Indieka, A.S., Dembele, C., Mng'omba, S. and Jamnadass, R. 2017. Nutritional variation in baobab (*Adansonia digitata* L.) fruit pulp and seeds based on Africa geographical regions. *Food Science & Nutrition* 5 (6): 1116-1129.

Rahul, J., Jain, M.K., Singh, S.P., Kamal, R.K., Naz, A., Gupta, A.K. and 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.

Temminghoff, E.J.M., Plette, A.C.C., Van der Zee, S.E.A.T.M. and Van Riemsdijk, W.H., 1997. Speciation of heavy metals in soil in relation to availability and mobility. *Recent Research Developments in Soil Science* 1: 55-65.