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Review Article

Baobab Tree (*Adansonia digitata L*) Parts: Nutrition, Applications in Food and Uses in Ethno-medicine – A Review

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Abstract

Baobab (*Adansonia digitata*) is a multi-purpose tree with tender root, tubers, twigs, fruit, seeds, leaves and flowers which are edible. Owing to the nutritional and medicinal benefits of baobab tree parts, it have been used for various purposes for the past two centuries in Africa, and some parts of Asia. This has in recent times led to some statutory bodies approving its use in certain food products. This paper presents a review on the nutritional benefits of the baobab tree parts vis-à-vis its fruit pulp, seeds and leaves. In addition, the medicinal applications of the tree parts as well as the medicinal compounds contained are discussed. This paper finally concludes with the nutritional benefits of the seed oil for possible use as a premium oil.

Keywords: *Adansonia digitata* L; Baobab tree; Baobab leaves; Baobab fruit pulp; Baobab seeds

Introduction

Africa has an abundant novel plant species which are known to be rich in health-promoting compounds, many of which remain undiscovered or unused by the western society [1]. The Baobab *(Adansonia digitata L.)* is widely distributed throughout the sub-Saharan Africa and Western Madagascar areas and has many uses, such as medicine, food, and beverages [2,3]. The name *Adansonia digitata* was given by Linnaeus, the generic name honouring Michel Adanson who had been to Senegal in the eighteenth century and described Baobab [4]. The history of the African baobab is well documented in Baum [5]. Darwin documented baobab trees on the St Jago in the Cape Verde Islands in 1832 and he commented on their size and longevity [6]. *Adansonia digitata L.* is the most widely spread of the Adansonia species on the African continent which belongs to the family of Bombacaceae a sub family of the Malvaceae. Adansonia species comprises of 8 different species with large, spectacular, nocturnal flowers [5]. One of these species is the *A. digitata L.*, it occurs throughout the drier parts of Africa. A second species is restricted to North-Western Australia (A. gibbosa), and the remaining six species are endemic to Madagascar [7]. The African baobab is known by a very large number of local names: English (Baobab, Monkey bread tree, Ethiopian sour gourd, Cream of tartar tree, Senegal calabash fruit, Upside-down tree), French (pain de singe, arbre aux calebasses), Portuguese (Cabaçevre), Arabic (Buhibab, hamao-hamaraya, Habhab, Hamar, Tebeldi,), Afrikaans (Kremetart), Hausa (Kuka), sotho (Seboi), tswana (Mowana), Tsonga (Shimuwu), venda (Muvhuyu) (Burkill, 1985).

African baobab is a very long-lived tree with multipurpose uses. It is thought that some trees are over 1000 years old. Since it is not grown agronomical nor properly domesticated [8,9]. It has been introduced to areas outside Africa and grown successfully. The tree provides food, shelter, clothing and medicine as well as material for hunting and fishing [3]. Every part of the baobab tree is reported to be useful [10] cited in [11] and [3]. The baobab has an extensive root system and high water holding capacity. Its mean annual temperature range is 20–30°C, but it can tolerate well high temperatures up to 40–42°C (in West Africa), it's resistant to fire, and survive low temperature as long as there is no frost. It is drought tolerant and frost sensitive. This adaptation allows it to grow in zones with 100–1000 mm annual rainfall, but trees are often stunted in the lower rainfall areas [12]. The tender root, tubers, twigs, fruit, seeds, leaves and flowers are all edible and they are common ingredients in traditional dishes in rural areas in Africa.

The fruit is said to have high vitamin C content 10 times that of an orange, while leaves are high in mineral content and pro-vitamin A. the oils extracted from the seeds are said to be edible due to the fatty acid composition. Knowledge of all this properties is limited due to the consumers and researchers. This paper will focus on review of seeds, fruit pulp and leaves of *Adansonia digitata L.*

Applications of Baobab Tree Parts

Leaves

The leaves are staple food for many populations in Africa most especially the central region of the continent [13,3]. In Malawi they are boiled with potash [14]. In Zimbabwe, they provide fresh vegetables that are substituted for the commercially grown leafy vegetables such as cabbages and lettuce [15]. In the northern part of Nigeria, the Hausas use the leaves for soup e.g. miyan kuka [13]. In Mali, the leaves are called lalo and they are used in making sauce and they usually mix it with seeds of *Parkiabig lobosa*, onion, okra, pepper, ginger, sometimes meat, but more often fish. The sauce is used with a thick porridge made from millet, sorghum or maize, but also for couscous and rice [16]. A survey in southern Mali regarding the use of baobab leaves in both rural and urban areas was conducted by Nordeide [16].

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The result shows that out of over 100 rural households, 26% used baobab leaves in the rainy season, and 56% in the dry season and out of over 150 urban households, 6% used baobab leaves in the rainy season and 13% in the dry season.

The leaves contain 13-15% protein, 60-70% carbohydrate, 4-10% fat and around 11% fibre and 16% ash [17]. Energy value varies from 1180-1900kJ/100g of which 80% is metabolized energy. The leaves are rich in pro-vitamins A and C. In terms of protein content and WHO standards, leaves of baobab can be rated 'good' in that they score well for 5 of the 8 essential amino acids as shown in Table 1.

The highest level of pro-vitamin A was detected in young leaves especially when used as dried material [20], expressed in retinol equivalent it was between 9 and 27 mg/kg. Nordeide [16] recorded that the level of pro-vitamin A was about one-third the content in *Amaranthus* dried leaves. Becker [21] noted the absence of vitamin C but a significant content of vitamin B2. Scheuring [22] published the analysis of dried leaf samples carried out by Hoffman-La Roche, Switzerland, for pro-vitamin A (Table 2).

In terms of mineral content, baobab leaf is said to be an excellent source of calcium, iron, potassium, magnesium, manganese, molybdenum, phosphorus, and zinc [13]. A research was conducted by [18] and he point out that baobab leaves have a high content of iron compared to numerous other wild-gathered foods, and are a rich source of calcium. Table 3 shows the mineral content of the baobab leaf from Burkina Faso according to [18] and from Nigeria according to [13].

The data of the research shows that in terms of both quality and quantity, *A. digitata* leaf could serve as a significant protein and mineral source in the staple food of the local population. Several plant parts of *A. digitata* have anti-oxidant, anti-inflammatory antimicrobial, anti-viral, ant-hepatotoxicity, anti-diarrhoeal, and trypanocidal properties, and baobab leaf has been used extensively since ancient times in traditional medicine.

Mucilage (Baobab leaves): Numerous foodstuffs in West Africa are mucilaginous; this provides a desired slimy consistency to local soups and stews. Woolfe *et al.*, [23] in Ghana conducted a detailed study of the mucilage produced from baobab leaves. The most interesting feature about the leave mucilage was the high protein and mineral content both in crude and purified mucilage. The mucilage contains a very small amount of neutral sugars: rhamnose and galactose. Uronic acid is present as a mixture of galacturonic and glucuronic acids. The relatively high proportion of uronic acids classifies the mucilage as a galacturonorhamnan polysaccharide which is acidic. The Viscosity depends on the mix of carbohydrates, proteins and minerals in the mucilage and is lowered with cooking at high temperatures. Nonetheless, baobab mucilage has great potential as a thickening agent.The study by [23] on the Mucilage's extracted from okra fruits and baobab leaves confirm their role as effective thickening agent.

Fruit pulp

The fruit pulp is one of the most important parts of the tree that

Table 1: Amino acid composition of baobab parts (mg/g dry weight) [13,18,19,42,103].

Amino acid composition	Fruit pulp (mg/g dry weight)	leaves (mg/g dry weight)		Seed (mg/g dry weight)	% of total protein WHO ideal
		A*	B**		
Aspartic acid	2.96	10.3	12.9	21.1	-
Glutamic acid	3.94	13.4	11.4	48.9	-
Serine	1.18	4.7	4.6	11.4	-
Glycine	1.21	6.0	5.6	10.4	-
Histidine	0.42	2.1	2.2	5.05	-
Arginine	2.28	8.5	7.1	2.21	-
Leucine	-	8.7	8.7	14.0	7.0
Threonine	0.65	4.1	3.6	6.98	4.0
Proline	2.35	5.6	6.8	9.55	-
Tyrosine	1.06	4.5	4.1	5.59	-
Valine	1.62	6.3	6.5	11.6	5.0
Methionine	0.14	2.4	1.0	2.29	-
Isoleucine	1.37	6.7	5.5	8.27	4.0
Phenylalanine	2.06	5.7	6.0	10.3	-
Cysteic acid	1.09	2.7	2.1	3.60	-
Lysine	1.63	6.1	6.1	11.2	5.5
Tryptophan	0.18	1.6	2.0	2.81	4.0
Alanine	2.21	6.2	6.7	10.6	-
Phenylalanine + tyrosine	-	-	-	-	16.0
Methionine + cystine	-	-	-	-	3.5

*Data from Burkina Faso.
**Data from Maiduguri, Nigeria.

Table 2: Pro-vitamin A contents of baobab leaves.

Leaves	Sun dried			Shade dried		
	1	2	3	1	2	3
Young trees, Small leaves	5.7	74.5	12.9	12.9	156.5	27.2
Young trees, Large leaves	6.7	54.0	9.3	5.1	130.0	22.0
Old trees, Small leaves	9.9	87.0	15.3	19.4	147.5	26.2
Old trees, Large leaves	4.1	69.0	11.5	7.1	107.0	18.5

1 = µ/g α carotene; 2 = µ/g β carotene; 3 = RE µ/g

Table 3: Mineral contents of baobab leave(µg/100gdryweight).

Minerals	A*	B**	C**	D**
Aluminum	-	1230	228	2870
Barium	-	187	182	454
Calcium	20000	26400	3070	3150
Copper	11.6	1	-	-
Magnesium	5490	3120	4360	5350
Manganese	31	43.8	79.5	89.3
Molybdenum	-	9.1	19.8	17.6
Phosphorus	3020	1480	2880	1200
Potassium	-	10800	5400	3210
Sodium	1630	-	-	-

*Data from [18]
**Data from [13]

is used as food. Ripped fruit pulps are removed from the fibers and seeds by kneading in cold water: the resulting emulsion is sieved. This is then added to thick grain preparations to make thinner gruels. The dry pulp is either eaten fresh or used to add to gruels on cooling after cooking and that is also a good way of preserving the vitamin content. The pulp is also ground to make a refreshing drink with a pleasing wine-gum flavor. More so, in Tanzania, it is added to aid fermentation of sugar cane for beer making [24,25]. The cattle-owning Fulani and the Hausa of the northern Nigeria use the fruit pulp emulsion to mix with milk as a drink. Pulp can be stored for fairly long period of time for use in soft drink production but it needs airtight containers. Storage is improved by the use of sodium metabisulphite [26]. It can also be frozen if ground to a powder [27]. Baobab powder mixtures are commonly available in many public markets but quality can be poor and some can be fraudulent. Fruit pulp is usually sundried, but occasionally fermented, for use in cooking or as a substitute for cream of tartar in baking. The fruit pulp is important in local diets as a seasoning component and appetizer [28]. The fruit pods are also good for burning and a potash-rich vegetable salt may be obtained from this ash for making soap [29].

The fruit pulp is said to have very high vitamin C content; almost ten times that of an oranges [17]. Ighodalo *et al.* [30] recorded 337 mg ascorbic acid/100g of the pulp for fruits in Nigeria. The Baobab Fruit Company in 2002 recorded 34-200mg/100g of ascorbic acid; and [31] stated levels were higher than in orange. Special attention has been given to measuring vitamin C in baobab fruit pulp due to occasional reports of high content. There was a joint effort between the Malian Agronomic Research Institute and the Novartis Foundation for Sustainable Development reveals a range from 1505-4991 mg/kg [20]. However the vitamin C content of the bulk fruit pulp varied from 1623mgkg^{-1} in one tree to 4991mgkg^{-1} in another [20]. Proximate analysis of ripe fruit shows an average of 8.7% moisture with 2.7% protein, 0.2% fat, 73.7% carbohydrate, 8.9% fibers and 5.8% ash [32]. The pulp sweetness is provided by fructose, sucrose and glucose contents. Fruit pulp is acidic due to the presence of organic acids including citric, tartaric, malic, succinic as well as ascorbic acid [33]. The energy value of pulp is similar to that of baobab leaves [21]. Tables 1, 4 and 5 show the amino acid composition,mineral contents andchemical compositionof the baobab fruit pulp respectively.

Research on the fruit pulp has been conducted by some researchers. Osman [35] studied the chemical and nutritional component of the *Adansonia digitata L.* fruit pulp and seed protein solubility. Results from his study showed that the *Adansonia digitata L.* kernel is rich in energy, protein and mineral content and also has a potential usefulness as a food protein source in tropical and subtropical region. The fruit pulp serves as a calcium supplement due to its high calcium content. More so, the high protein solubility at acidic and alkaline pH suggests that the baobab seed protein could be a desirable food ingredient as well. A study on the chemical composition of baobab fruit (*Adansonia digitata L.*) was conducted by [34], the researchers concluded that the pectin of baobab fruit pulp has a low degree of esterification and low intrinsic viscosity and therefore, probably not given it a good media to form jelly with high solid content due to rapid precipitation and therefore form an irregular gels. In addition, the pectin of the baobab was lower quality compared to that of commercial apple pectin and citrus wast pectin. Charles *et al.* [36] studied the Variability of Baobab (*Adansonia digitata L.*) fruits, its physical characteristics and nutrient content in the West African Sahel. They concluded that the variation of vitamin C, sugar and the proximate composition of seeds

Table 4: Mineral contents of baobab fruit pulp and seed (µg/g dry weight) [18,46].

Mineral	Seeds µg/g dry weight	Fruit pulp µg/g dry weight
Iron	18.3	17
Calcium	3950	3410
Magnesium	3520	2090
Manganese	10.6	-
Zinc	25.7	10.4
Sodium	19.6	54.6
Phosphorus	6140	733

Table 5: Chemical composition of baobab fruit pulp [34].

Constituent	(%)
Total soluble solids	79.3
Alcohol soluble solids	57.3
Total sugars	23.2
Reducing sugars	18.9
Total pectin	56.2
Total starch	0
Proteins (%Nx6.25)	2.6
Fat	0.2
Fibre	5.7
Ash	5.3

within populations observed is a first indication that valuable gains could be made by selection of good varieties. Shelly *et al.,* [37] study the polyphenol-rich baobab fruit (*Adansonia digitata L.*) in terms of reduction of starch digestion and glycemic response in humans. These result concluded that the *Adansonia digitata L.* fruit is a rich source of bio-accessible polyphenols, and the current study shows the potential of baobab for reducing the Glycemic Response (GR) to carbohydrate-rich foods both in vitro and in vivo.

A lot of studies have shown that *Adansonia digitata L* fruit pulp is rich in vitamins and minerals [3,17,35,38] and contains a high amount of both the soluble and insoluble dietary fiber [3,17,35,38,32,39]. The vitamin C content present in the fruit is what contributes to its overall antioxidant capacity (lamien*et al.*), and is a good source of polyphenols, including certain flavonoids [1,40] and tannins [41]. The fruit is of increasing nutritional interest because it may be a significant contributor to the daily intake of important nutrient and non-nutrient compounds [34].

Seeds

The Seeds are used as a thickening agent in soups; they are also fermented and used as a flavoring agent, or roasted and eaten as snacks [31,42]. When they are roasted, they are sometimes used as a substitute for coffee. In some cases, seeds are de-hulled by boiling, rubbing by hand, and then sun drying the kernels before grinding. Fermentation of powdered de-hulled seeds is known to increase protein digestibility. It also reduces the trypsin inhibition activity but increases tannin content [43]. The baobab seeds are ground with peanuts and water and sugar added to make a sauce used with porridge [44]. Seed pulp is sometimes known as monkey bread and is eaten and traded in the different regions [15]. The seeds have an energy value of 1803 kJ/100g approximately 50% higher than leaves, moisture 8.1%, protein 33.7%, and fat 30.6%, carbohydrates 4.8%, fibre 16.9% and ash 5.9% [32]. The vitamin C content of the baobab seeds has not been researched extensively but they are known to contain high levels of lysine, thiamine, Ca and Fe [45]. Nkafamiya*et al.* [46] reported that the phosphorous, calcium and magnesium are the major mineral elements present in baobab seeds (Table 4).

Seeds are also said to be a good source of cooking oil but this is not widespread, although there has been interest in expanding such use due to deficits of vegetable oils. The oils are extracted by pounding the seeds. Glew *et al.*[18] study the essential amino acids of the baobab seed from Burkina faso, while [42] studied the seeds from Maiduguri Nigeria and the results are presented in Table 1. The results showed similarities between samples from Burkina Faso and from Maiduguri, Nigeria.

Seed oils

The oils have been used for centuries by local communities for the purpose of food, medicine, cosmetic applications and production of lubricants, soaps and personal care products. The oils were used in topical treatment of various conditions such as hair dandruff,muscle spasms, varicose veins and wounds [47,48]. The baobab seeds oils contained high proportions of linoleic and oleic acid as well as palmitic and α-linolenic acid [18,49]. Osman [35] reported that the baobab seed oil is an excellent *source* of mono-and polyunsaturated fatty acids. The principal fatty acids in baobab oil are linoleic and oleic acid, 39.42% and 26.07% respectively of the total fatty acids 73.11% which is unsaturated while 26.89% is saturated [29]. Polyunsaturated fatty acid plays an important role in modulating human metabolism. Therefore, the high linoleic acid content is of nutritive significance because of the ability of some unsaturated vegetable oils to reduce cholesterol levels [29]. This high content of mono- and polyunsaturated fatty acids suggests that baobab seed oil would be useful as food oil [35]. The saponification value is high, suggesting that baobab oil may be suitable for soap making [46] as well. Essien and Fetuga [50] provided basic information on the physical and chemical characteristics of the seed oil and they observed that the iodine value showed a similar degree of unsaturation when compared with corn oil. The low peroxide value points to a higher level of unsaturated fatty acids. This study, in Nigeria, also showed that β-carotene content was 43.36μg/100g, twice that of palm kernel oil and 7 times that of corn oil. This characterization of the baobab seed oil makes it unique anddesirable oil especially in domestic and industrial cooking/ frying and other application such as soap making. The Baobab Fruit Company [51] has collated data from a series of publications and provides the most comprehensive overview of seed oil properties and constituents as shown in Table 6.

In recent years, demand for seed oils as ingredients for food,

Table 6: Properties and constituents of the seed oil of baobab.

Composition	Quantity
Specific Gravity (SG) 25/25oC	0.937
Refractive index(RI) 40oC	1.4596-1.4633
Iodine value	55-96
Saponifiable Value	133-195
Unsaponifiable matter%	2.8-3.8
Volatile matter%	1.65
Moisture%	2.08
Fatty acid Composition (%)	
12:0	0-0.3
14:0	0.3-1.5
16:0	25-46
16:1	0.3-1.7
18:1	21-59
18:2	12-29
18:3	0-8
20:0	0.5-1.0
20:1	0-3.6
Others	**Others**
Malvalic	1-7
Sterculic	1-8
Dihydrosterculic	2-5
Sterol Composition (%)	**Sterol Composition (%)**
Cholesterol	2
Camperterol	6
Stigma sterol	1-2
β-Sitosterol	75
5-Avenasterol	0.5
7-Stigmasterol	0.6
7-Avenasterol	12

cosmetics and biofuel has increased greatly as industry seeks natural alternatives. A study on the production of biodiesel production and fuel properties was conducted by [52]. The result of the experiment shows that it was feasible to produce biodiesel from baobab seed oil (*Adansonia digitata L.*) using a one-step trans esterification process using sodium methoxides as the homogenous catalyst. Optimum conditions obtained for the biodiesel production were: reaction temperature (60°C), reaction time (1h), catalyst to the oil ratio (1.4wt %) and methanol to oil ratio (30wt %) and they obtained an optimum biodiesel yield of 96wt %.The world production of seed oils has increased drastically and therefore creating pressure on countries that are providing the raw material to meet the growing demands.

Non-Food Application of Baobab

Apart from food application the baobab can also be used so many purposes. Fibre from the inner bark is strong and it's widely used for making rope, basket nets, snares, fishing lines and is even used for weaving. In East Africa roots are used to make a soluble red dye. The green bark is also used as a dye and for decoration [53]. The hard fruit shells are used in the manufacture of pots for food and drink. The wood is a poor source of fuel; however, fruit shells are used as fuel in Tanzania and they are used as water dippers [54]. Shells from the fruits and the seedcake, left after pounding to extract seed oil, are usually fed to animal stock.

Medicinal Applications of Baobab

Traditional medicine

The bark, roots, leaves, fruits and seeds of baobab are widely used by indigenous peoples for human and animal medicines. Leaves and fruit pulp are used in folk medicine as an antipyretic or febrifuge to overcome fevers. The powdered leaves can be used as anti-stress properties. They are variously used to treat fatigue, as a tonic and for insect bites, guinea worm and internal pains and to treat dysentery. The fruit pulp and powdered seeds are used in cases of dysentery and to promote perspiration. Seeds are also used in cases of hiccough. Oil extracted from seeds is used for inflamed gums and to ease diseased teeth. Maybe the widest use in folk medicine is the use of the bark as a substitute for quinine in cases of fever or as a prophylactic. Decoction of the bark decomposes rapidly due to the mucilaginous substances present. In Malawi, hangovers and constipation are treated with a traditional drink known as *dambedza*, made by soaking fruit pulp in water [55].

The witchdoctors in Senegal treat *endu*/oedema (numbness of the limbs) with incantations and a salve of *A. digitata.* Baobab bark forms part of a concoction used in Namibia for treating swollen limbs [56]. The bark, leaf, fruit pulp and seed are used in India to reduce swellings [57]. Baobab fruit pulp improves the iron status of children with low iron levels in their blood [58]. An aqueous bark extract of *A. digitata* is traditionally used in Nigeria for treating sickle-cell anaemia. However, Adesanya *et al.*[59] found that although water and methanol bark extracts possessed reversal anti-sickling properties, the low reversal activity of the extracts compared to *p*-hydroxybenzoic acid, and the absence of any *in vitro* activity did not justify the local use of the baobab for the prevention of sickling crisis by sufferers. Baobab stem-bark is considered beneficial in Nigeria as a heart tonic with diuretic properties [60]. In Senegal baobab leaves and the fruit pulp are used for external bleeding; *lalo* (baobab leaf) is taken for anaemia and also claimed to lower blood pressure [61,62]. In Benin the Otomari prepare a decoction from the seeds known as *mantofamen*, it is used to treat high blood pressure. The leaves and pulp are also used in the treatment of haemorrhoids [63]. A drink made from fruit pulp and seeds of *A. digitata* are given to treat haemoptysis [64].

In West Africa the sap, or a paste from roasted crushed seeds, is applied to the diseased teeth and gums [45,62,65,66] while in Tanzania the bark decoction is used as a mouthwash for toothache [63,67]. The bark has been used for treating caries and the fruit stalk used as a tooth stick in Mali [67] and India [68]. The Chewa of the southern Malawi treat sore throats with a draught of an infusion of baobab roots [69] and Children with sore gums (gingivitis) are treated with roasted, powdered seeds [10]. The same condition is also treated with bark in India [68]. In West Africa, eye complaints, such as conjunctivitis, are treated by bathing the eyes in a decoction of baobab bark from young trees, an infusion of the leaves and flowers [62,66]. In Tanzania the stem-bark and leaves are boiled with meat and used against a condition locally known as *kambaku*, resembling sinusitis [70].

In Benin a preparation of the baobab seed is taken to relieve stomach ache in adults [63]. The roots of *A. digitata* are used in Tanzania for treating stomach ache as well. The fruit pulp in water or milk is taken alone with gruel of millet, or a decoction of the crushed or roasted seeds and water, is used to treat intestinal inflammations, diarrhoea and dysentery throughout much part of Africa [28,41,45,64–66,71–74].

The Fulani in Guinea-Bissau treat urinary diseases with the root of *A. digitata* [75]. In Somalia, fresh or dried roots are boiled in two to four glasses of water and two cups are taken in the morning as a remedy for urine retention [76]. In West African,a solution of the baobab fruit matrix and water, or preferably rice water in which iron rust has been boiled, was used to treat smallpox. Patients with measles had a thick paste of baobab pulp, cereal flour and water placed on their eyes several times a day. Before smallpox was eliminated its victims used to receive the same treatment [28,45,62,65,66,72,77]. In Tanzania people who are HIV positive drink the liquid obtained by boiling baobab roots, bark and fruit pulp [78]. In South Africa the Venda use a baobab bark decoction together with the root of *Osyrislanceolata*to treat sexually transmissible diseases [79]. The bark, leaf, fruit rind, pulp and seed are also used in India for treating venereal diseases [57].

In Senegal enteritis (due to dust, fungi, etc.) is treated either by bathing in *lalo*or with a decoction of crushed seeds, or the fruit pulp in water [62]. A poultice of leaves crushed in hot water is used in Nigeria for healing circumcision wounds [10,41]. Wounds may also be treated with an application of a seed paste [74].The gum and a powder scraped from the outside of the baobab fruit are used for cleansing wounds and sores and promoting granulation in Senegal and Mali [65,74]. In many parts of the African countries, there is a common but unconfirmed belief that baobab bark, pulp and seeds are an antidote to *Strophanthus*spp., (an arrow poison) [80]. Thus, in Tanzania, a specially delegated member of any Shangaan hunting party is made responsible for carrying some baobab bark, pulp and seeds. In Senegal and Malawi, hunters squeeze the sap from baobab

bark into the wound of an animal killed by a poisoned arrow to neutralise the poison [66,81]. According to [82] the active principle of the arrow poison is strophanthin, consisting of a mixture of glycosides, including K-strophanthin, B. cymarin, etc. 'Adansonin', present in the stem-bark is considered to have a cardiotonic effects [62,70], while the tannins in the baobab bark precipitate the glycosides [83].

In Nigeria, to prevent post-coital seminal expulsion during visits to the toilet, a decoction, prepared from baobab stem-bark and a sliced lime fruit (*Citrus aurantifolia*), is boiled in a clay pot with fermented maize water. Half a glassful of the mixture is drunk three or four times a week. Alternatively, the finely powdered, burnt ashes of baobab fruit and a pod of melegueta pepper (*Aframomummelegueta*) are placed in a bottle containing honey and one teaspoonful is taken in water once a day for 7 days [84]. Pregnant women in Malawi drank baobab juice made from fruit pulp mixed with water [55]. Australian Aboriginal mothers with newborn babies also used to drink boab fruit pulp crushed into water [85]. Baobab roots and flowers have unspecified gynaecological applications in Mali [67] but in Benin the flowers are used to speed the ejection of the foetus [63]. In Tanzania the Maasai use the bark and leaves for treating afterbirth retention [86]. Mukamuri and Kozanayi [87] reported that pregnant women in Zimbabwe use the bark from mature baobabs to enlarge their birth canals in order to reduce pain during delivery. In India, to relieve delivery pains, pregnant women bathe in water in which baobab bark has been boiled [88]. Senegal use a mixture of the powdered roots of *A. digitata*and *Sterculiasetigera*plus bulrush millet bran (*Penisetumglaucum*) to stimulate lactation [62], while in Mali, the fruit pulp is eaten to stimulate lactation [67]; the seeds are similarly used in Benin [63].

In Senegal, kwashiorkor is treated using a mixture of the powdered roots of *A. digitata*, *Acacia albida*, *Bauhinia rufescens*, *Waltheriaindica*, *Mitracarpusvillosus*(syn. *M. scaber*) and the leaves of *Chrozophorasenegalensis*in milk; the same draught is also recommended for pellagra or fox-evil [62]. While in southern Malawi treat kwashiorkor is also treated by drinking an infusion of baobab root [89]. In Senegalreport the use of baobab bark as a remedy against rickets and as a tonic [62]. A decoction of the bark is also used in the Republic of the Congo and East Africa to bathe rickety children. A root decoction is given as a tonic for lassitude and as a strengthening medicine [69,86,90,91]. The pulp is eaten as an appetizer in Benin [63], while in Namibia the pounded seeds are used as a tonic [56]. Gelfand [92] stated that David Livingstone successfully treated indolent sores with poultices of powdered baobab leaf and considered that Livingstone's ulcers may have been of dietetic origin. The Chewa of southern Malawi treats vitamin C deficiency by eating pulp and they also considered the pulp to be an appetizer [69]. In Benin, a decoction known as *tutonakankount* is prepared from baobab leaves crushed in boiling water to which a few grammes of potash are added; it is used to cure iron and calcium deficiencies [63]. The bark, leaf, fruit pulp and seed are used in India for relieving body and joint pains [57].

Medicinal compounds

In the late 16th century the powdered pulp of A. digitata was reputedly imported to Europe as a substitute for, or an addition to, the medicinal earth known as terra lemnia or terra sigillata. In many medicinal uses, stem bark is used. When prepared it is made into a decoction for internal use and functions due to its soluble and insoluble tannin, gummy and albuminious constituents. The bark has anti-haemorrhagic properties (due to the tannin), as well as being diaphoretic, antipyretic and anti-ophthalmic [62]. In Nigeria baobab stem-bark is regarded as a 'heart tonic' with diuretic properties. This was tested by [60]. They found that an ethanolic extract of the bark improved contractions of heart muscles in rats. The flavonol glycoside quercetin-7-O-β-d-xylopyranoside in A. digitata is an antioxidant with anti-carcinogenic, anti-HIV and antibiotic properties. Thetriterpenoid 7-baueren-3-acetate and derivatives of betulinic acid, also present in the baobab's bark, may also possess anti-HIV activity [93]. A methanol extract of the dried and powdered stem-bark showed anti-microbial activity against the bacteria *Streptococcus* sp. and *Pseudomonas aeruginoa*, and the fungus *A. niger* [94]. The root-bark and leaves were active against the bacteria *B. subtilis*, *E. coli*, *Mycobacterium phlei*, *S. aureus*and *Streptococcus faecalis*but resistant to *Klebsiellapneumoniae*, *Pseudomonas aeruginosa*, *Salmonella typhimurium* and the fungus *C. albicans* [95].

The Leaf preparations also have hypotensive, antihistaminic, calmative and emollient effects [66]. The anti-asthmatic effect of baobab leaves is attributed to the flavonosidedehydroxyflavane [96]. The Baobab fruit pulp acts as a palliative and diaphoretic for fevers and dysentery, the fruit fibres (funicles) act as an emmenagogue, and the seeds are anti-inflammatory [62,65].

A clinical trial was set up in Dakar [97] to compare the clinical efficacy of a baobab pulp solution with the standard WHO solution to treat children aged 6 months or older (mean age: 16.6 ± 8.8 months) with diarrhoea and associated mild to moderate dehydration. Seventy-nine children received the WHO solution and 82 the baobab solution. The effects on the diarrhoea and subsequent weight gain were followed for 4-48 h. The WHO solution was found to be superior but not statistically significant, while the baobab solution had additional nutritional, economic and cultural benefits, and was therefore recommended for home use. A similar study in Khartoum was conducted on 160 children with a mean age of 8 months. They found out that an aqueous solution of baobab pulp was significantly more effective than the traditional WHO solution for the rehydration of children affected by diarrhoea [98] (cited by [51]). Köhler *et al.* [99] investigated the anti-plasmodal activity of an aqueous extract of baobab pulp against chloroqinine-sensitive and -resistant strains of *Plasmodium falciparum* (malarial sporozoa). They obtained an IC50 value of >50 μg mg^{-1} (concentration at which growth is inhibited by 50%), which was considered as being inactive.

In Nigeria 142 school children aged 6–8 years with a haemoglobin (Hb) concentration <11 g dl^{-1} were dewormed. Half were fed cereals, legumes and vegetables plus 250 mm baobab pulp drink; the control received the same diet but without the baobab drink. The Hb concentration of the first group rose to 13 g dl^{-1}, that of the control to 11 g dl^{-1}. The number of children with <12 g l^{-1} serum ferritin fell from 75% to 30% for children receiving the baobab drink; the control remained unchanged [58]. The lubricating, binding and thinning properties of the carbohydrates and pectin present in the pulp make it suitable for use by local pharmacists as a hydrophilic matrix for paracetamol and theophyllin controlled-release tablets [100,101].

*A. digitata*seeds contain *O*-acetylethanolamine, which is believed to have anti-inflammatory properties [102].

The adverse health effects of cyclopropenoic fatty acids (CPEFA) in edible food are well documented [103]. Rats fed fresh baobab seed oil containing 1.75% CPEFA showed retarded growth and enlarged livers compared to rats fed heated seed oil containing 0.046% CPEFA. The CPEFA in fresh oil either inhibited fatty acid desaturation or specifically inhibited the desaturation of substrate previously incorporated into membrane phospholipids. The monounsaturated fatty acid content of kidneys and liver significantly decreased with fresh oil, whereas there was virtually no effect on tissue fatty acid profile from heated oil [78].

Conclusion

It is evident that the iconic baobab tree of Africa is an important nutritional and medicinal resource. Several plant parts have interesting anti-oxidant, anti-viral and anti-inflammatory properties, and based on the review, baobab has been used extensively since ancient times in traditional medicine and food application. Numerous studies on the biological activities of baobab have been conducted with promising results. However, the major trend found is that baobab fruit pulp is rich in vitamin C and the anti-oxidant capacity of the fruit pulp is greater than that of other common fruits known for high anti-oxidant activity. Baobab fruit pulp has been approved by statutory bodies for use in certain nutritional products. Seed oils have been used for topical skin application since ancient times and due to the toxic effects of synthetic oils, there is a growing trend to replace them and revert to the use of natural oils in the cosmetic and pharmaceutical industries. Baobab seed oil is used in pharmaceutical and cosmetic industries due to its fatty acid content known to have beneficial effects when applied onto the skin.

Based on the review, it can be seen that the baobab tree is promising considering the nutritional benefits of the fruit pulp in terms of its vitamins C content, while the leaves based on their mineral and vitamin A content. The seed oil's fatty acid composition and antioxidant activity is what makes it unique as functional oil. Oleic acid is probable the most abundant monounsaturated fatty acid in all the common edible oils compared with polyunsaturated fatty acids, oleic acid is more stable towards oxidation both at high temperatures and storage temperatures. Therefore, oils with high amounts of oleic acid are more oxidative stable during shelf life or undergo oxidative decomposition during frying than those oils that contain high amounts of polyunsaturated fatty acids. The fatty acids compositions in baobab oil are linoleic and oleic acid. Due to the fatty acid composition of the oil, the oil can be classified as premium oil and can be used in replacement of the other vegetable oils.

References

1. Lamien-Meda A, Lamien CE, Compaoré MM, Meda RN, Kiendrebeogo M, Zeba B, et al. Polyphenol content and antioxidant activity of fourteen wild edible fruits from Burkina Faso. Molecules. 2008; 13: 581-594.
2. Diop AG, Sakho M, Dornier M, Cisse M, Reynes M. The African baobab (*Adansonia digitata* L.): key features and uses. Fruits. 2006; 61: 55-69.
3. Gebauer J, El-Siddig K, Ebert G. Baobab (Adansonia digitata L.): a review on a multipurpose tree with promising future in the Sudan. Gartenbauwissenschaft. 2002; 67: 155-160.
4. Adanson M. Description dun arbre nouveau genre appele Baobab, observe au Senegal [in French]. HistAcad Roy Sci (Paris). 1771; 1791: 218-243.
5. Baum DA. A systematic revision of Adansonia (Bombacaceae). Annals of the Missouri Botanical Garden 1995: 440-471.
6. Armstrong P. Baobabs: remnant of Gondwanaland? Trees in South Africa. 1977; 28: 92-96.
7. Baum DA, Small RL, Wendel JF. Biogeography and floral evolution of baobabs (Adansonia, Bombacaceae) as inferred from multiple data sets. Syst Biol. 1998; 47: 181-207.
8. Chevalier MA. Les baobabs (Adansonia) de l'Afrique continentale. Société Botanique de France. 1906; 53: 480-496.
9. Baum DA. The comparative pollination and floral biology of baobabs (Adansonia-Bombacaceae). Annals of the Missouri Botanical Garden. 1995: 322-348.
10. Aitzetmüller K. Intended use of *Malvales* seed oils in novel food formulations-A warning. Journal of the American Oil Chemists' Society. 1996; 73: 1737-1738.
11. Igboeli L, Addy E, Salami L. Effects of some processing techniques on the antinutrient contents of baobab seeds (< i>*Adansonia digitata*). Bioresource Technology. 1997; 59: 29-31.
12. Manuals of food quality control. 9. Introduction to food sampling. Food and Agriculture Organization of the United Nations. FAO Food Nutr Pap. 1988; 14: iii-vii.
13. Yazzie D, VanderJagt DJ, Pastuszyn A, Okolo A, Glew RH. The Amino Acid and Mineral Content of Baobab (*Adansonia digitata* L.)Leaves. Journal of Food Composition and Analysis. 1994; 7: 189-193.
14. Williamson J. Useful plants of Malawi: Zomba: University of Malawi. Illus., col. illus., maps. Icones, Maps. Geog. 1975; 336.
15. Dovie DBK, Shackleton CM, Witkowski ETF. Involving local people: Reviewing participatory approaches for inventorying the resource base, harvesting and utilization of non-wood forest products. Joint FAO/ECE/ILO Committee on Forest Technology, Management and Training, Harvesting of Non-Wood Forest Products. Menemen-Izmir, Turkey. 2000.
16. Nordeide MB, Hatløy A, Følling M, Lied E, Oshaug A. Nutrient composition and nutritional importance of green leaves and wild food resources in an agricultural district, Koutiala, in southern Mali. Int J Food Sci Nutr. 1996; 47: 455-468.
17. De Caluwe E, Halamova K, Van Damme P. *Adansonia digitata* L: a review of traditional uses, phytochemistry and pharmacology. Afrika focus. 2010; 23: 11-51.
18. Glew RH, VanderJagt DJ, Lockett C, Grivetti LE, Smith GC, Pastuszyn A, et al. Amino acid, fatty acid, and mineral composition of 24 indigenous plants of Burkina Faso. Journal of Food Composition and Analysis. 1997; 10: 205-217.
19. Committee JFWAHE, Organization WH. Energy and protein requirements: World Health Organization. 1973.
20. Sidibe M, Scheuring J, Tembely D, Sidibe MM, Hofman P, Frigg M. Baobab-homegrown vitamin C for Africa. Agroforestry Today.1996; 8: 13-15.
21. Becker B. The contribution of wild plants to human nutrition in the Ferlo (Northern Senegal). Agroforestry Systems. 1983; 1: 257-267.
22. Scheuring J, Sidibe M, Frigg M. Malian agronomic research identifies local baobab tree as source of Vitamin A and vitamin C. Sight and Life Newsletter . 1999; 1: 21-24.
23. Woolfe ML, Chaplin MF, Otchere G. Studies on the mucilages extracted from okra fruits (Hibiscus esculentus L.) and baobab leaves (*Adansonia digitata* L.). Journal of the Science of Food and Agriculture. 1977; 28: 519-529.
24. Fleuret A. Nonfood uses of plants in Usambara. Economic Botany. 1980; 34: 320-333.
25. Fleuret P, Fleuret A. Nutritional implications of staple food crop successions in Usambara, Tanzania. Human Ecology. 1980; 8: 311-327.

26. Ibiyemi S, Abiodun A, Akanji S. *Andasonia digitata Bombax* and *Parkia filicoideae Welw:* Fruit pulp for the soft drink industry. Food chemistry. 1988; 28: 111-116.

27. Obizoba IC, Amaechi N. The effect of processing methods on the chemical composition of baobab (*Adansonia digitata*. L) pulp and seed. Ecology of food and nutrition 1993; 29: 199-205.

28. Burkill HM. The useful plants of west tropical Africa. Royal Botanic Gardens, Kew. 1995.

29. Al-Qarawi A, Al-Damegh M, El-Mougy S. Hepatoprotective influence of *Adansonia digitata* pulp. Journal of herbs, spices & medicinal plants. 2003; 10: 1-6.

30. Eromosele IC, Eromosele CO, Kuzhkuzha DM. Evaluation of mineral elements and ascorbic acid contents in fruits of some wild plants. Plant Foods Hum Nutr. 1991; 41: 151-154.

31. Palmer E, Pitman N. Trees of southern Africa covering all known indigenous species in the Republic of South Africa, South-West Africa, Botswana, Lesotho and Swaziland. Cape Town, AA Balkema. 1972.

32. Arnold T, Wells M, Wehmeyer A. Khoisan food plants: taxa with potential for future economic exploitation. Plants for arid lands: Springer. 1985; 69-86.

33. Airan TW, Desai RM. Sugars and organic acids in *Adansonia digitata* L. Journal of the University of Bombay. 1954; 22: 23-27.

34. Nour A, Magboul B, Kheiri N. Chemical composition of baobab fruit. *Adansonia digitata*. 1980: 383-388.

35. Osman MA. Chemical and nutrient analysis of baobab (Adansonia digitata) fruit and seed protein solubility. Plant Foods Hum Nutr. 2004; 59: 29-33.

36. Parkouda C, Sanou H, Tougiani A, Korbo A, Nielsen DS, Tano-Debrah K, et al. Variability of Baobab (*Adansonia digitata* L.) fruits physical characteristics and nutrient content in the West African Sahel. Agroforestry systems. 2012; 85: 455-463.

37. Coe SA, Clegg M, Armengol M, Ryan L. The polyphenol-rich baobab fruit (Adansonia digitata L.) reduces starch digestion and glycemic response in humans. Nutr Res. 2013; 33: 888-896.

38. Oyeleke G, Salam M, Adetoro R. Some Aspects of Nutrient Analysis of Seed, Pulp and Oil of Baobab (*Adansonia digitata* L.). J EnvSciTox Food Tech. 2012; 1: 32-35.

39. Magaia T, Uamusse A, Sjöholm I, Skog K. Dietary fiber, organic acids and minerals in selected wild edible fruits of Mozambique. Springerplus. 2013; 2: 88.

40. Mulaudzi RB, Ndhlala AR, Kulkarni MG, Finnie JF, Van Staden J. Antimicrobial properties and phenolic contents of medicinal plants used by the Venda people for conditions related to venereal diseases. J Ethnopharmacol. 2011; 135: 330-337.

41. Ghani A, Agbejule A. A pharmacognostic study of the fruits of *Adansonia digitata* L.The state of medicinal plant research in Nigeria Nigerian Society of Pharmacognosy. 1986: 181-185.

42. Addy EO, Eteshola E. Nutritive value of a mixture of tigernut tubers (Cyperusesculentus L) and baobab seeds (*Adansonia digitata* L.). Journal of Science, Food and Agriculture. 1984; 35: 437-440.

43. Addy EO, Salami LI, Igboeli LC, Remawa HS. Effect of processing on nutrient composition and anti-nutritive substances of African locust bean (Parkia filicoidea) and baobab seed (Adansonia digitata). Plant Foods Hum Nutr. 1995; 48: 113-117.

44. Pele J, Le Berre S. Les aliments d'origine vegetale au Cameroun. Le Cameroun agricole, pastoral etforestier. 1967: 49-66.

45. Abbiw DK. Useful Plants of Ghana: West African uses of wild and cultivated plants. London: Intermediate Technology Publishers. 1990.

46. Nkafamiya I, Osemeahon S, Dahiru D, Umaru H. Studies on the chemical composition and physicochemical properties of the seeds of baobab (Adasoniadigitata). African Journal of Biotechnology. 2007; 6.

47. Zimba N, Wren S, Stucki A. Three major tree nut oils of southern central Africa: Their uses and future as commercial base oils. International Journal of Aromatherapy. 2005; 15: 177-182.

48. Chivandi E, Davidson BC, Erlwanger KH. A comparison of the lipid and fatty acid profiles from the kernels of the fruit (nuts) of Ximenia caffra and Ricinodendron rautanenii from Zimbabwe. Industrial Crops and Products. 2008; 27: 29-32.

49. Ezeagu IE, Petzke KJ, Lange E, Metges CC. Fat content and fatty acid composition of oils extracted from selected wild-gathered tropical plant seeds from Nigeria. Journal of the American Oil Chemists Society. 1998; 75: 1031-1035.

50. Essien AI, Fetuga BL. Beta-carotene content and some characteristics of under-exploited seed oils of fruit trees of Nigeria. Food Chemistry. 1989; 32: 109-116.

51. Baobab Fruit Company. Baobab Fruit Pulp (*Adansonia digitata*). 2014.

52. Modiba E, Osifo P, Rutto H. Biodiesel production from baobab (< i>*Adansonia digitata* L.) seed kernel oil and its fuel properties. Industrial Crops and Products. 2014; 59: 50-54.

53. Dovie DB. Rural economy and livelihoods from the non-timber forest products trade. Compromising sustainability in southern Africa? The International Journal of Sustainable Development & World Ecology. 2003; 10: 247-262.

54. Nkana Z, Iddi S. Utilization of baobab (*Adansonia digitata*) in Kondoa District, Central Tanzania. Record-Faculty of Forestry, Sokoine University of Agriculture. 1991.

55. Wickens GE, Lowe P. The Baobabs: Pachycauls of Africa, Madagascar and Australia: The Pachycauls of Africa, Madagascar and Australia: Springer. 2008.

56. Mshigeni KE, Hangula L. Africa baobab resource: unlocking their economic potential and unrealised virtues within the framework of the zero waste concept. UNDP/UNOPS: University of Namibia. 2001.

57. Yoganaraimhan SN. Medicinal Plants of India. Karnataka. Bangalore: Interline Publishing. 1996; 1.

58. Nnam NM, Obiakor PN. Effect of fermentation on the nutrient and antinutrient composition of baobab (adansonia digitata) seeds and rice (oryza sativa) grains. Ecol Food Nutr. 2003; 42: 265-277.

59. Adesanya SA, Idowu TB, Elujoba AA. Antisickling activity of Adansonia digitata. Planta Med. 1988; 54: 374.

60. Ashorobi R, Joda A. Positive Inotropic Effect of the Extract of *Adansonia digitata* (Linn) on Isolated Atrial muscle of the Rat. Discovery and Innovation. 1998; 10: 250-254.

61. Kerharo J, Adam JG. Plantes medicinales et toxiques des Peul et des Toucouleur du Senegal. J Agr trop Bot appl. 1964; 11: 384-444.

62. Kerharo J, Adam JG. La pharma coupe senegalaise traditionnelle. Plantes Medicinales Et Toxiques. Paris: VigotFreres. 1974.

63. Codjia JTC, Fonton-Kiki B, Assogbadjo A, Ekue MRM. Le baobab (Adansonia Digitata): une espèce usage multiple au Benin: CECODI Cotonou. 2001.

64. Hines DA, Eckman K. Indigenous multipurpose trees of Tanzania: uses and economic benefits for people. Cultural Survival Canada. 1993.

65. Dalziel JM. The Useful Plants of West Tropical Africa. Appendix to Flora of West Tropical Africa. London: Crown Agents. 1937.

66. Adam JG. Le baobab (*Adansonia digitata* L.). Notes Africaines. 1962; 94: 33-44.

67. Gustad G, Dhillion SS, SidibÉ D. Local use and cultural and economic value of products from trees in the parklands of the municipality of Cinzana, Mali. Economic Botany. 2004; 58: 578-587.

68. Joshi P, Bhati D, Parmar R, Dodia S, Lashkari P, Trivendi P, et al. Medicinal value of *Adansonia digitata* L. in Kutch, Gujarat. Ethnomedicinal Plants. 2004:160-3.

69. Morris B. Chewa medical botany: a study of herbalism in Southern Malawi: LIT Verlag Münster. 1996.

70. Hedberg I, Hedberg O, Madati PJ, Mshigeni KE, Mshiu E, Samuelsson G. Inventory of plants used in traditional medicine in Tanzania. I. Plants of the families Acanthaceae-Cucurbitaceae. J Ethnopharmacol. 1982; 6: 29-60.

71. Cooke MC. Baobab, *Adansonia digitata* L. Pharmaceutical Journal and Transactions. 1870; 1:4.

72. SÃ©bire A. Les plantes utiles du Sénégal: plantes indigènes-plantes exotiques: Librairie JB. Bailliere. 1899.

73. Anonymous. Leaves and fruits of the baobab tree. Bulletin of Imperial Institute 1906; 4: 252-253.

74. Thoyer-Rozat A. Plantesmedicinales du Mali: auteur. 1979.

75. Diniz M, Silva O, Paulo M, Gomes E. Medicinal uses of plants from Guinea-Bissau. The Biodiversity of African Plants: Springer. 1996; 727-731.

76. Samuelsson G, Farah MH, Claeson P, Hagos M, Thulin M, Hedberg O, et al. Inventory of plants used in traditional medicine in Somalia. I. Plants of the families Acanthaceae-Chenopodiaceae. J Ethnopharmacol. 1991; 35: 25-63.

77. AubrÃ©ville A. Flore forestiere sodano-guineenne, AOF, Cameroun, AEF. 1950.

78. Wickens GE. Human and veterinary medicine. The Baobabs: Pachycauls of Africa, Madagascar and Australia. 2007: 81-100.

79. Arnold HJ, Gulumian M. Pharmacopoeia of traditional medicine in Venda. J Ethnopharmacol. 1984; 12: 35-74.

80. Christy T. New commercial plants with Directions how to Grow Them to the Best Advantage. 1878.

81. Neuwinger HD. African ethnobotany: poisons and drugs: chemistry, pharmacology, toxicology: CRC Press. 1996.

82. Verdcourt B, Trump EC. Common Poisonous Plants of East Africa. London: Collins; 1969.

83. Kreig MB. Green medicine: the search for plants that heal: Rand McNally Chicago. 1964.

84. Elujova A. Female infertility in the hands of traditional birch attendants in South-Western Nigeria. Fitoterapia. 1995; 66: 239-248.

85. Batty D. Outback Boab Trees. 2002.

86. Baerts M, Lehmann J, Ansay M. Le utilisation de quelquesaplantes en médecine traditionnelle humaine et vétérinaire en Afrique sub-saharienne. Laboratoire de botaniquemedicale, University de Louvain-la-Neuve, Louvain-la-Neuve, Belgium. 2002.

87. Mukamuri B, Kozanayi W. Institutions surrounding the use of marketed bark products: the case of Berchemimadiscolors,Warburgiasalutaris and *Adansonia digitata*. Harare: University of Zimbabwe. 1999.

88. Reddy A, Anjaria K, Rao V. Baobab: An exotic tree with a promise? Asian Agri-History (India). 2002.

89. Morison C, Hoyle A, Hope-Simpson J. Tropical soil-vegetation catenas and mosaics: a study in the south-western part of the Anglo-Egyptian Sudan. The Journal of Ecology. 1948; 1-84.

90. Bouquet A. Feticheur set medecines traditionnelles du Congo (Brazzaville). 1969.

91. Kokwaro JO. Medicinal plants of east Africa. 1976.

92. Gelfand M. Livingstone the doctor: his life and travels: Blackwell. 1957.

93. Van Welzen PC, Slik JF, Alahuhta J. Plant Diversity and Complexity Patterns: Local, Regional and Global Dimensions: Proceedings of an International Symposium Held at the Royal Danish Academy of Sciences and Letters in Copenhagen, Denmark, 25-28 May, 2003. Kgl. Danske Videnskabernes Selskab; 2005; 199.

94. Hussain H, Deeni Y. Plants in Kano ethnomedicine; screening for antimicrobial activity and alkaloids. Pharmaceutical biology. 1991; 29: 51-56.

95. Anani K, Hudson JB, de Souza C, Akpagana K, Tower GH, Arnason JT, et al. Investigation of medicinal plants of togo for antiviral and antimicrobial activities. Pharm Biol. 2000; 38: 40-45.

96. Manfredini S. The Health Properties of Baobab (*Adansonia digitata*). 2014.

97. Tal-Dia A, Toure K, Sarr O, Sarr M, Cisse MF, Garnier P, Wone I. [A baobab solution for the prevention and treatment of acute dehydration in infantile diarrhea]. Dakar Med. 1997; 42: 68-73.

98. Galil NE. Evaluation of baobab (gonglase) solution for home management of diarrhoea in Sudanese children [Dissertation]. University of Khartoum, 1996.

99. Kohler ORA. Languages of the World. African Languages. The New encyclopedia Britannica. Chicago. 2002; 747-760.

100. Arama E, Michaud P, Rouffiac R, Rodriguez F. [A new excipient in pharmaceutical formulation of theophylline tablets of the hydrophilic matrix type: the pulp of the baobab fruit (Adansonia digitata L.)]. Farmaco Prat. 1988; 43: 303-315.

101. Arama E, Michaud P, Rouffiac R, Rodriguez F. [Bioavailability of prolonged-liberation tablets of theophylline and paracetamol formulated in pulp from the fruit of baobab (Adansonia digitata L.)]. Pharm Acta Helv. 1989; 64: 116-120.

102. Hayman AR, Gray DO. O-acetylethanolamine a natural product from the leguminosae. Phytochemistry. 1987; 26: 839-841.

103. WHO. Energy and Protein Requirements. WHO, Geneva, Switzerland. Tech-Rep. 1973; 522.

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