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Adansonia digitata L. (baobab): a review of traditional information and taxonomic descriptionJitin Rahul^{1*}, Manish Kumar Jain¹, Shishu Pal Singh², Rakesh Kant Kamal¹, Anuradha¹, Aliya Naz¹, Anup Kumar Gupta¹, Sujeet Kumar Mrityunjay¹¹Centre of Mining Environment, Department of Environmental Science & Engineering, Indian School of Mines, Dhanbad-826004, Jharkhand, India²Department of Botany, Dayanand Brajendra Swarup College, Kanpur-208006, Uttar Pradesh, India

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ABSTRACT

Adansonia digitata L. (Malvaceae) is commonly known as baobab tree native to Africa. Baobab is a multi-purpose tree which offers protection and provides food, clothing and medicine as well as raw material for many useful items. The fruit pulp, seeds, leaves, flowers, roots, and bark of baobab are edible and they have been studied by scientists for their useful properties. The fruit pulp have very high vitamin C, calcium, phosphorus, carbohydrates, fibers, potassium, proteins and lipids content, which can be used in seasoning as an appetizer and also make juices. Seeds contain appreciable quantities of phosphorus, magnesium, zinc, sodium, iron, manganese, whereas they have high levels of lysine, thiamine, calcium and iron. Baobab has numerous biological properties including antimicrobial, anti-malarial, diarrhoea, anaemia, asthma, antiviral, anti-oxidant and anti-inflammatory activities amongst others. Phytochemical investigation revealed the presence of flavonoids, phytosterols, amino acids, fatty acids, vitamins and minerals. The review summarizes the information on various aspects of traditional information, taxonomic description, medicinal properties and importantly nutritional value.

1. Introduction

African baobab is a very long-lived tree with multipurpose uses. It is said that some trees are over 1000 years old. Earlier attempts to describe African Baobab on the basis of fruit difference are not accepted till now as they are not grown agronomically or domesticatedly[1,2]. *Adansonia digitata* (*A. digitata*) is commonly found in the thorn woodlands of African savannahs, which tend to be at low altitudes with 4-10 dry months per year. It tends to grow as solitary individuals, though it can be found in small groups depending on the soil type. It is not found in areas where sand is deep. It is sensitive to water logging and frost. All locations where the tree is found are arid or semi-arid[3]. *Adansonia digitata* (Malvaceae) (*A. digitata*) is a majestic tree revered in Africa for its medicinal and nutritional value. The plant parts are used to

treat various ailments such as diarrhoea, malaria and microbial infections[4]. Several plant parts have interesting anti-oxidant and anti-inflammatory properties, and baobab has been used extensively since ancient times in traditional medicine[5]. The seeds, leaves, roots, flowers, fruit pulp and bark of baobab are edible. Baobab leaves are used in the preparation of soup. Seeds are used as a thickening agent in soups, but they can be fermented and used as a flavoring agent or roasted and eaten as snacks[6]. The flora from Tikamgarh District in Bundelkhand Region has immense pharmaceutical and commercial potential[7]. India has about more than 45000 plants species and among them several thousand are claimed to possess medicinal properties[8]. Medicinal plants play an important role in providing knowledge to the researchers in the field of ethnobotany and ethnopharmacology[9].

Baobab trees are indigenous to Africa. The trees can tolerate high temperatures and long spans of drought, and are grown for their sour fruit and leaves. The fruit consists of pulp and large seeds embedded in the dry acidic pulp and shell. The leaves are used to make soup, and the pulp is used to make beverage and for food preparation[10,11]. In recent years, due to industry seeks natural alternatives, demand for seed oils as ingredients for food, cosmetics

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and biofuel has been greatly increased. A study on biodiesel production and fuel properties was conducted by Modiba *et al*[12]. The seeds are pressed for oil, but the by-product baobab oilseed meal is typically underutilized. Most of previous studies on the baobab fruit have focused on the seed oil[13]. The total land area of Orchha wild life sanctuary in Madhya Pradesh is about 40-45 km², which is very rich in medicinal plant species[14].

2. *A. digitata*

The baobab tree (Figure 1), and its related species belong to the family of Malvaceae and the genus *Adansonia*. The tribe, which is pantropical, includes *Bombax* and *Ceiba* producing fruit fibres used as kapok. The family includes about 30 genera, 6 tribes and about 250 species[2]. A number of these species are used locally for leaves, wood, fruits, seeds or gum. The African baobab (*A. digitata*) occurs naturally in most countries of Sahara as a scattered tree in the savannah, and is also present in human habitation. In the past, some ethnic groups in Mali such as the Dogon, Kagolo and Bambara used to take seedlings from the wild to plant them around their villages[15]. The tree has been introduced in many countries used as an ornamental plant. It is also known as the dead-rat tree (from the appearance of the fruits), monkey-bread tree (the dry fruit as food for monkeys), upside-down tree (the bare branches looked like roots) and cream of tartar tree (the acidic taste of the fruits)[16].

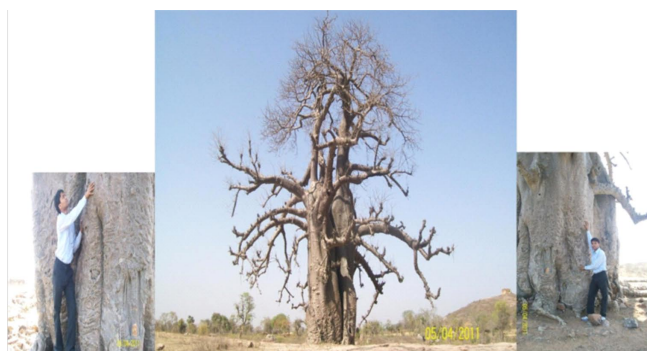


Figure 1. The *A. digitata* in central part of India, region of Bundelkhand (Orchha, Madhya Pradesh, India).

3. Taxonomic description and habitat

Kingdom: Plantae; Phylum: Tracheophyta; Class: Magnoliopsida; Order: Malvales; Family: Malvaceae; Genus: *Adansonia*; Species: *digitata*; Botanical name: *A. digitata*; English name: Baobab[17]. Synonyms: *Adansonia bahobab* L. (synonym), *Adansonia baobab* Gaert. (synonym), *A. digitata* var. *congolensis* A. Chev. (synonym), *Adansonia somalensis* Chiov. (synonym), *Adansonia sphaerocarpa* A. Chevall. (synonym), *Adansonia sulcata* A. Chevalier (synonym), *Baobabus digitata* Kuntze (synonym)[18].

A. digitata is a massive deciduous tree, up to 20-30 m tall with a diameter up to 2-10 m at adult age. The trunk is often of vast girth. The bark is smooth, reddish brown to grey, soft and possesses longitudinal fibers. *A. digitata* is highly branched. *A. digitata* produces an extensive lateral root system until 50 m from the trunk. The roots tips are often in the form of tubers. But the main roots of old trees are relatively shallow and rarely extend beyond 2 m depth. Therefore they are very sensitive to strong winds and can be uprooted by storm[19]. Leaves of young trees are usually simple. Adult trees begin each season by producing simple leaves followed by 2-3-leaflets leaves; mature leaves (20 cm diameter with about 5 to 9 leaflets) appear later. The inflorescence of baobabs consists of a single flower, situated in the axils of leaves near the tips of reproductive branches. The flowers are white, large, pendulous, solitary or paired in the leaf axils, showy[20]. Flowering begins about the end of dry season or just before the first rains; often when the first leaves appear. The flowers open in late afternoon and fall the next day at dawn. The flowers emit a sulfur fragrance that attracts particularly the bats which play the role of pollinators[18].

The history of known references to African baobab is well documented[2]. The binomial name of *A. digitata* was given by Linnaeus, the generic name honouring Michel Adanson who had been to Senegal in the eighteenth century to describe baobab[21]. Taxonomic details of *A. digitata* are shown in Table 1 and explanation is given below.

The African baobab is named a very large number of local names. A selection of important ones is shown in Table 2.

Table 1

Nomenclature of *Adansonia* species (after Baum, 1995)[2].

Genus	Species	Synonyms	Area	References
<i>Adansonia</i>	<i>A. digitata</i> L.	<i>Adansonia baobab</i> L. (1763), <i>Adansonia baobab</i> Gaertn. (1791), <i>Adansonia sphaerocarpa</i> A. Chev. (1901), <i>Adansonia sulcata</i> A. Chev. (1906), <i>Adansonia digitata</i> var. <i>congolensis</i> A. Chev. (1906)	Widespread in Africa	[42]
<i>Brevitubae</i>	<i>Adansonia grandidieri</i> Baill.		Restricted to Madagascar	[43]
<i>Hochreutiner</i>	<i>Adansonia suarezansis</i> H. Perrier		Restricted to Madagascar	[44]
	<i>Adansonia gibbosa</i> (A. Cunn.) Guym. ex D. Baum	<i>Adansonia gregori</i> Mueller (1857), <i>Adansonia rupestris</i> W. Saville-Kent (1897), <i>Adansonia stanburyana</i> Hochreutiner (1908)	Restricted to NW Australia	
<i>Longitubae</i>	<i>Adansonia rubrostipa</i> Jum. & H. Perrier	<i>Adansonia fony</i> Baill. ex H. Perrier (1952)	Restricted to Madagascar	[45]
<i>Hochreutiner</i>	<i>Adansonia madagascarensis</i> Baill.	<i>Adansonia bernieri</i> Baill. ex Poisson (1912)	Restricted to Madagascar	[46]
	<i>Adansonia za</i> Baill.	<i>Adansonia bozy</i> Jum. & H. Perrier, <i>Adansonia alba</i> Jum & H. Perrier	Restricted to Madagascar	[47]
	<i>Adansonia perrieri</i> Capuron		Restricted to Madagascar	[1]

Source: Sidibe and Williams (2002)[16].

Table 2

Common names for African baobab.

Language	Common name
English	Baobab, monkey bread tree, Ethiopian sour gourd, cream of tartar tree, senegal calabash (fruit), upside-down tree
French	Baobab, pain de singe (fruit), arbre aux calebasses, arbre de mille ans, calebassier du Sénégal
Hindi	Gorakh-imli, hathi-khatiyani
Tamil	Papparappuli, anaipuliya-marum
Gujarati	Sumpura
Telegu	Brahma-mlinka, seemasinta

Other local names can be found in Burkill, 1985 and Von Maydell, 1986[48,49].

Table 3Traditional medicinal uses of *A. digitata* in different types of ailments[4].

Ailments	Part(s) used	Preparation	References
Diarrhoea, fever, inflammation, kidney and bladder diseases, blood clearing, asthma	Leaves	Decoction, infusion	[24]
Malaria, fever	Leaves	Mixed with water	[22]
Toothache, gingivitis	Leaves	Decoction	[25]
Diaphoretic, fever remedy	Leaves	Decoction	[50]
Diaphoretic, kidney and bladder diseases, asthma, insect bites	Leaves	Decoction	[51]
Fever, diarrhoea	Seeds	Mixed with water	[22]
Microbial diseases	Fruits	Decoction	[52]
Anaemia	Bark	Aqueous extract	[53]
Coughs	Powdered seeds	Decoction	[22]
Wound healing	Stem bark	Decoction	[54]

4. Traditional information

The various parts of the plant (leaves, bark and seeds) are used as a panacea, that is, to treat almost any disease and specific documented uses include the treatment of malaria, tuberculosis, fever, microbial infections, diarrhoea, anaemia, dysentery, toothache, etc. (Table 3)[22,23-28]. The leaves and fruit pulp are used as febrifuge as well as an immune stimulant[27,29].

In India, it is reported that baobab pulp is used externally with buttermilk for the relief of diarrhea and dysentery, while the young leaves are crushed and used to treat painful swellings[16].

In some countries in West Africa, the leaves, fruit pulp and seeds are the main ingredients in sauces, porridges and beverages[27,30,31]. Recently, baobab has been referred to as a “super fruit” based on its nutritional profile (e.g. vitamin, fatty acid, mineral)[32]. The nutritional value of baobab is only briefly discussed since a comprehensive report on the nutritive aspects is already available[27,30]. The major interest in baobab products is as a result of its ascorbic acid and dietary fiber content. The level of vitamin C contained in fruit pulp is high and can range from 2.8 to 3 g/kg[33]. It was noted that baobab fruit pulp has very high vitamin C content (280–300 mg/100 g), which is seven to ten times more than oranges (51 mg/100 g)[34,35]. One study demonstrated that the consumption of 40 g of baobab pulp provided 100% of the recommended daily intake of vitamin C in pregnant women (19–30 years)[30]. The ascorbic acid content was evaluated in the fruit of *A. digitata*[36]; and it was found to contain 337 mg/100 g of ascorbic acid[37,38]. Sidibe and Williams recommended that baobab leaves should be stored as whole leaves rather than ground leaf powder in order to preserve the high vitamin content[16].

Although *A. digitata* is mostly regarded as a fruit-bearing forest tree, it is a multipurpose and widely-used species with medicinal properties, numerous food uses of various plant parts, and bark fibers that are used for a variety of purposes. Centuries ago the products were traded: it was well known in Cairo markets in the

sixteenth century[16].

4.1. Leaves of *A. digitata*

Leaves are 2-3-foliolate at the start of the season and they are early deciduous, of which more mature ones are 5-7(-9)-foliate. Leaves are alternate at the ends of branches or occur on short spurs on the trunk. Leaves of young trees are often simple. Leaflets are sessile to shortly petiolulate with great variation in size. Overall mature leaf size may reach a diameter of 20 cm and the medial leaflet can be 5-15 × 2-7 cm, leaflet elliptic to ovate-elliptic with acuminate apex and decurrent base. Margins are entire and leaves are stellate-pubescent beneath when young becoming glabrescent or glabrous. Stipules are early caducous, subulate or narrowly triangular, 2-5mm long, glabrous except for ciliate margins(Figure 2)[16].



Figure 2. Leaf of *A. digitata*.

The leaves of baobab tree are a staple for many populations in Africa, especially the central region of the continent[10,38]. During the rainy season when the baobab leaves are tender, people harvest a fresh batch of leaves. During the last month of the rainy season, leaves are harvested in great abundance and are dried for domestic use and for marketing during the dry season. The leaves are typically sun-dried and either stored as whole leaved or pounded and sieved into a fine powder[38]. Young leaves are widely used, cooked as spinach, and frequently dried, often powdered and used for sauces over porridges, thick gruels of grains, or boiled rice[16].

4.2. Fruits pulp of *A. digitata*

There is no doubt that baobab pulp is a valuable source of vitamin C. If an added value would be given to the pulp by improving its handling quality and storage stability by using adequate methods, this might can help to enhance the interest of pulp uses and thus, it can lead to a better organization of food chain in developing countries (Ethiopia, Nigeria, Tanzania, Kenya, Ghana and India). At present, the preservation of the pulp is beyond the control of population, which leads to undesirable losses of it. It is important to overcome problems in prolonging the shelf-life of the pulp in order to retain its nutritive value and sensorial properties. Bioavailability studies are necessary for a better appreciation of the contribution to human health since the dietary intake can never be fully utilized by the human body[39].

The fruit pulp has very high vitamin C content, almost ten times that of oranges (Table 4). It contains sugars but no starch and is rich in pectin. It can be dissolved in water or milk. The liquid is then used as a drink and sauce for food, a fermenting agent in local brewing, or as a substitute for cream of tartar in baking (Figure 3).

Table 4

Analysis of baobab fruit pulp (mg/100 g)[34].

Constituent	Content (mg/100g)
Ascorbic acid (vitamin C)	280.00-300.00**
Calcium	293.00**
Phosphorus	96.00-118.00
Carbohydrates	75.60
Soluble and insoluble dietary fibers	52.00
Potassium	2.31
Protein	2.30
Lipids	0.27

** : Ascorbic acid compared with oranges of 51 mg/100 g and calcium compared with milk of 125 mg/100 g[35].



Figure 3. Fruit and seeds of *A. digitata*.

4.3. Seeds of *A. digitata*

The seeds of *A. digitata* are uniformed and embedded in the pulp, the color is dark brown to reddish black with smooth testa (Figure 3). Seed kernels are widely used. They are eaten fresh, dry or ground and used in cooking. Kernels have an energy value of 1 803 kJ/100 g, approximately 50% higher than leaves[36]. The proximate mineral compositions of baobab seed shown in Table 5. The seed is a good source of phosphorus, calcium and magnesium. Seed oils are important sources of nutritional oils, industrial and pharmaceutical importance[41].

Table 5

Mineral contents of *A. digitata* seeds ($\mu\text{g/g}$ dry weight).

Mineral	Content ($\mu\text{g/g}$ dry weight)
Phosphorus	6 140.0
Calcium	3 950.0
Magnesium	3 520.0
Zinc	25.7
Sodium	19.6
Iron	18.3
Manganese	10.6

Significant potassium and measurable copper were recorded by Arnold *et al.* (1985) and potassium by Odetokun (1996)[40,44,55].

5. Conclusion

A. digitata is a multipurpose tree species, mostly used for medicine, food, fodder and clothing as well as raw material for many useful items. The fruit of the baobab is the most important foodstuff. The fruit pulp is dry and used in cold and hot drinks. The fruit pulp can dissolve in water and milk, and the liquid is used as a drink and sauce for food as a fermentation agent in local brewing. The fruit pulp of baobab is very rich in vitamin C, calcium, phosphorus, carbohydrates and soluble and insoluble fibers. The worldwide demand of baobab has increased dramatically in more sectors, such as the medical industry, food industry and cosmetic industry. In reality, due to it was found to show interesting pharmacological properties, the whole plant is used for the multiple medicinal purpose in many parts of Africa as well as other states. I hope that the review will encourage researches towards better understanding and utilization of *A. digitata*.

Conflict of interest statement

We declare that we have no conflict of interest.

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