Adansonia digitata L.

Protologue

Syst. nat. ed. 10, 2: 1144 (1759).

Family

Bombacaceae (APG: Malvaceae)

Chromosome number

2*n* = 160

Vernacular names

Baobab, monkey-bread tree, dead-rat tree, cream-of-tartar tree (En). Baobab, calebassier du Sénégal, arbre de mille ans (Fr). Baobab, molambeira, imbondeiro, calabaceira, cabacevre (Po). Mbuyu, mkuu hapingwa, mkuu hafungwa, muuyu (Sw).

Origin and geographic distribution

Baobab occurs naturally in most of mainland tropical Africa. Originally it was absent from many Central African countries, but it has been introduced in most of them. In mainland tropical Africa it is still absent from Rwanda, Burundi, Djibouti and Uganda. It has been introduced in Madagascar and many other Indian Ocean islands. In West Africa it often occurs in baobab orchards around villages. Outside Africa it has been widely introduced in tropical and subtropical regions.

In India it is a fairly old introduction most likely brought by Arab traders and it now has many local uses similar to those in Africa. In Barbados two old trees, grown from seed imported in 1738 from West Africa, are considered one of the seven wonders of the island.

Uses

The leaves of baobab are used either fresh as a cooked vegetable or dried and powdered as an ingredient of soups and sauces. The shoots and roots of seedlings are eaten as well. The roots are boiled and eaten in West Africa in times of famine. The flowers are eaten raw.

The fruit contains soft, white, edible and nutritious flesh ('monkey bread'). It is used to curdle milk, it is eaten as a sweet and is used in making gruel and refreshing drinks and ice-cream. In Sudan it is made into a milk-like drink called 'gubdi'. The powdered fruit flesh is added to cold liquid, thus preserving vitamins. An emulsion of the fruit pulp may be used to adulterate milk. The dried pulp is used as a substitute for cream of tartar in baking.

The seeds are eaten raw or roasted and are used to thicken and flavour soup. Fermentation of the seed kernels improves the nutritional value. In coastal Kenya and Tanzania the pulp-coated seeds are coloured and sugar-coated and sold as sweets. The seeds are used to adulterate groundnuts and may be used as a coffee substitute. An oil can be extracted from the seed kernels by boiling and distillation. It is semi-fluid, golden yellow, gently scented, non-drying and has a long shelf life. It is used for cooking and in the cosmetics industry.

The bark fibre is stripped from the lower part of the trunk and is used to make rope, string, cords for musical instruments, snares, fishing-nets, loin cloths, sacking, baskets, mats and waterproof hats. The root bark yields a fibre as well. When the wood disintegrates fibres remain that may be used as packing material.

All plant parts are used for treating fever. The bark gum is used for cleaning sores. A decoction of the bark is used in Congo to bathe rickety children and in

Tanzania to treat toothache. Stem bark and fibres lining the fruit husk are used to treat amenorrhoea. The bark, fruit pulp and seeds are used as an antidote for *Strophanthus* poisoning. In Malawi baobab juice called ‘dambedza’ is served as a cure for hangovers and against constipation. In Zambia a root infusion is used to bathe babies to promote a smooth skin. A root decoction is taken with food in Sierra Leone for strength. Dried powdered roots are included in the treatment of malaria. Leaves are used as a diaphoretic, expectorant, astringent and as a fever prophylactic. Leaves are found in a long list of treatments for ailments including asthma, fatigue, kidney and bladder diseases, diarrhoea and inflammations. Fruit pulp is used as an antidysenteric and in the treatment of smallpox and measles. The seed oil is used for inflamed gums and to ease toothache.

The leaves and fallen flowers are eaten by livestock, and fruit pulp and seeds are fed during the dry season. Residues of oil extraction are fed to livestock as well. The wood is used locally for canoes, wooden platters and floats for fishing nets. It makes poor firewood and charcoal. Use of the wood and bark for the paper industry is possible but not commercially viable. The fruit husks are used as fuel and are made into containers and fishing floats.

Trees with hollow trunks have been used for a long time and are still used for water storage, having capacities of up to 7500 l. Hollow trees are also used as tombs, meeting places, prisons, stables, bus shelters, storage rooms, watchtowers, bathrooms, cool rooms and dairies. Pulp is used for smoking fish and the smoke is helpful in repelling insects that pester livestock. The pollen mixed with water gives a glue that is used in carpentry. The bark is used for tanning and green bark yields a dye. A red dye is obtained from the roots. The powdered peduncle and the husk of the fruit are used as a substitute for tobacco. Introductions outside its native range were made mainly for use as an ornamental or shade tree. The extraordinarily shaped baobab tree is surrounded by a wealth of legends, superstitions, folktales and anecdotal references throughout Africa.

Production and international trade

The bark has been imported in the past into Europe by the packing and paper industry and for medicinal use. Under the name ‘cortex cael cedra’ it was used as a substitute for quinine to reduce fevers. Recently in the Western world, commercial interest has grown for applications in the health food and cosmetics industries. In Zimbabwe small-scale industrial production of fruit pulp and oil takes place. In Malawi fruit juice of baobab is produced commercially. Seeds are exported from East Africa to the Arab world and the Middle East for use as snacks. No statistics are available on production or trade.

Properties

The nutritional composition of fresh baobab leaves per 100 g edible portion is: water 77 g, energy 289 kJ (69 kcal), protein 3.8 g, fat 0.3 g, carbohydrate 16.1 g, fibre 2.8 g, Ca 402 mg, P 65 mg, ascorbic acid 52 mg (Leung, W.-T.W., Busson, F. & Jardin, C., 1968).

The fruit pulp of baobab contains per 100 g: water 8.7 g, energy 1290 kJ (308 kcal), protein 2.7 g, fat 0.2 g, carbohydrate 73.7 g, fibre 8.9 g, Ca 335 mg, Mg 167 mg, P 76.2 mg, Fe 2.7 mg, Zn 1.0 mg, thiamin 0.62 mg, riboflavin 0.14 mg, niacin 2.7 mg, ascorbic acid 209 mg. The seed consists of about 55% seed coat and 45% kernel. The seed kernels contain per 100 g: water 8.1 g, energy 1805 kJ (431 kcal), protein 33.7 g, fat 30.6 g, carbohydrate 4.8 g, fibre 16.9 g, Ca 273 mg, Mg 640 mg, P 5.1 mg, Fe 6.6 mg, Zn 6.7 mg, thiamin 0.25 mg, riboflavin 0.14 mg, niacin 1.0 mg. The fatty acid composition is linoleic acid 34.9%, oleic acid 32.3%, palmitic acid 26.5% and stearic acid 4.4% (Arnold, T.H., Wells, M.J. & Wehmeijer, A.S., 1985). The reported range of oil content of seed kernels is wide: 30–68%.

Nutritional properties reported in the literature vary considerably but a relation between morphology or origin and properties is not evident. In Mali the ascorbic acid content of leaves varied 3-fold between trees; this was consistent over years, and correlations with rainfall or morphological types were not found.

However, small leaves, a tree-specific characteristic, had an approximately 20% higher vitamin A content, whereas the age of the tree did not have an effect on the vitamin A content of the leaves. The highest value for vitamin A in sun-dried leaf powder was 27.2 µg/g.

The air-dry wood is light with a specific gravity of about 210 kg/m^3. The fibres from the inner bark are soft, durable, moderately strong and 90–120 cm long. All plant parts contain mucilage, rich in uronic acid. The bark gum is odourless, tasteless, insoluble and contains betulinic acid. The bark has been shown to have diaphoretic and antiperiodic activities. Adansonin, isolated from the bark, has been found to have febrifugal properties. This compound is also thought to be the active principle that neutralizes strophantin, but other evidence indicates that adansonin itself causes *Strophanthus*-like poisoning. The leaves have hyposensitive and antihistamine activities. Root bark and leaf extracts have antiviral and antibacterial activities. The seed kernel contains a trypsin inhibitor, which can be reduced by 85% by alkali treatment. The tannin content of the leaves (12% of dry matter) has a marked negative effect on their digestibility by livestock.

Description

Massive deciduous tree, up to 20(–23) m tall, trunk often of vast girth; bark smooth, variable in colour; branches stout near the trunk, young branches often tomentose; root system extending up to 2 m deep and horizontally further than the height of the tree. Leaves alternate, simple (in young trees and first leaves of the season in old trees) or digitately compound, at the apex of branches; stipules early caducous; petiole up to 16 cm long; compound leaves 5–7(–9)-foliolate, c. 20 cm in diameter; leaflets sessile or shortly stalked, elliptical, 5–15 cm × 1.5–7 cm, base cuneate, apex acuminate, mucronate, entire. Flowers solitary or paired, axillary, pendulous, bisexual; pedicel up to 90 cm long, tomentose; bracteoles 2, early caducous; calyx 3–5-lobed, 5–9 cm × 3–7 cm, shortly tomentose outside, velvety pubescent inside; petals 5, overlapping, very broadly obovate to oblate,

5–10 cm × 4.5–12 cm, base shortly clawed, apex rounded, white; stamens very numerous, united at base into a staminal tube 1.5–4.5 cm long, free part equally long, reflexed; ovary superior, 5–10-celled, style exserted c. 1.5 cm beyond anthers, stigma 5–10-lobed. Fruit a woody, indehiscent capsule, globose to ovoid or oblong-cylindrical, up to 40(–55) cm long, covered by velvety tomentum, filled with dry, mealy pulp, many-seeded. Seeds reniform, c. 1.5 cm × 1 cm, smooth, dark brown to black, with thick seedcoat. Seedling with hypogeal germination; cotyledons breaking free from testa; first leaves simple, narrowly linear; taproot swollen.

Other botanical information

Adansonia comprises 8 species, one of which is of African mainland origin, one endemic to Australia and 6 to Madagascar.

In the Sahel 4 types of baobab are distinguished: ‘black-bark’, ‘red-bark’, ‘grey-bark’ and ‘dark-leaf’. The ‘dark-leaf’ type is preferred for use as a leaf vegetable, the ‘grey-bark’ type is used for fibre, and the others are preferred for the fruits. In Sudan size, shape and taste of the fruits differ between areas. In Kenya 3 types are distinguished, based on sweetness of the fruit, shape of the tree, size and shape of the fruit, and season of flowering. Distinguishing botanical varieties is tempting, but as variation is poorly understood so far, such a formal classification would be premature.

Chromosome numbers reported for *Adansonia digitata* are 96, 128, 144 and 160. Inaccurate counts are common in the *Bombacaceae* because the chromosomes are small and numerous. Baobab is now considered an autotetraploid that has undergone aneuploid reduction from $4x = 176$ to $2n = 160$. The other *Adansonia* species all have $2n = 88$.

Growth and development

A growth model with 4 distinct growth phases has been developed based on data from South African trees. The first ‘sapling’ phase lasts 10–15 years at the end of

which the diameter at breast height is 7–25 cm, height 3–6 m and crown width 2–4 m. The second or ‘conical’ phase lasts till the tree is 60–70 years old. In this phase growth is fastest and the stem attains its greatest height. At the end of the conical phase the trunk diameter is 0.8–2.2 m, height is 5–15 m and crown width 8–20 m. In the third or ‘bottle’ phase the trunk thickens and the crown widens with long ascending branches. This phase ends when the tree is 200–300 years old with trunk diameter of 2.8–5.5 m, height 10–20 m and crown width 15–35 m. In the last or ‘old age’ phase the trunk further expands, heavy branches droop and lower branches may break off from time to time. The crown becomes wide and flattens, the trunk becomes hollow and the tree ultimately dies at an age of 500–800(–1000) years. In exceptional growing conditions and through secondary growth some trees may become considerably older. In warmer areas the phases tend to be shorter. Seed-propagated trees in West Africa have reached a height of up to 2 m in 2 years and 12 m in 15 years.

Leaves appear shortly after the first rains, with early leaves often simple and soon falling. Flowering takes place at any time of the year except during the height of the dry season; it often precedes the appearance of the leaves. Flowers open late in the afternoon and remain open throughout the night with 1–50 flowers per tree. Flowering of a tree may last 6 weeks. First flowering has been observed on an 8-year-old tree. Grafted trees start flowering after only 3 years and do not become as tall as sown trees. Pollination is mainly by fruit bats, and to a lesser extent by bushbabies (lemurs) and possibly by wind, flies and moths. Pollinators are attracted by the strong carrion smell of the flowers. Animals, notably baboons and elephants, play a role in the dispersal of seed and in breaking its dormancy. Baobab regenerates new bark after the bark has been stripped. The exposed trunk of felled trees can be covered by bark and produce a new shoot from the centre of the stump as well as peripheral shoots.

Ecology

Baobab prefers sandy topsoil overlying a loamy subsoil; it tolerates poorly

drained soils with heavy texture, but is absent on deep sand. It is at its best at altitudes of 450–600 m with an annual rainfall of 300–500 mm; it is common in areas with an annual rainfall of 200–800 mm, and extremes in annual rainfall of 90 mm and 1500 mm have been recorded. It is found from sea-level to 1000(–1500) m altitude. Severe frost will kill even mature trees and in the southern part of its area of distribution it is found mostly on north facing slopes, sheltered from cold southern winds. Seedlings and small trees are vulnerable to fire, but mature trees are fire resistant.

Propagation and planting

Natural regeneration of baobab is poor, mainly because of browsing animals and uncontrolled bush fires. Unaided germination of baobab seeds is generally poor. Seeds that float in water should be discarded. Pre-treatment of seeds can be done by cracking, immersing in boiling water for 5–7 minutes or in sulphuric acid for 6–12 hours, and should lead to a germination rate of 80–95%. Sowing in bags is done 4–6 months before the expected start of the rainy season. Farmers sometimes care for baobab seedlings in their courtyard until they are 2–3 m tall, when they are transplanted along the borders of their fields. Vegetative propagation has the advantage that desirable characteristics like large leaves and good quality can be assured. Stem cuttings can be easily rooted in nurseries. For grafting 3-month-old seedlings can be used with fresh scions. Plants are transplanted at the start of the rainy season. After transplanting in the field, protection against game, livestock and fire are essential until the trees are well established. Planting is done at a spacing of about 10 m × 10 m.

Management

Pollarding encourages leaf production and it helps to prevent toppling of hollow trees, but fruit production will be severely reduced for several years.

Diseases and pests

The insect life associated with baobab has been well investigated as baobab is a potential alternative host for cotton and cocoa pests and diseases. A wide range of cotton bollworms, cotton stainer bugs, flea beetles and mealy bugs have been recorded. Eradicating baobab as a crop protection measure has failed, as numerous other alternative hosts exist. Girdling of stems of young trees by beetles can kill them. A condition called ‘sooty mould’ discolours the bark especially in dry periods; it is a secondary fungal infection resulting from stress. In southern Africa the mopane worm (*Gonimbrasia belina*), considered a delicacy, feeds on the leaves. Bark-eating elephants are the most important threat to older baobab trees.

Harvesting

Harvesting leaves and fruits is done by climbing the tree. Fruits may also be shaken off from the branches. The bark is removed by stripping after horizontal and vertical cuts have been made. Bark regrows and can be harvested again after several years.

Yield

No data are available on leaf or fibre yields. An average mature tree produces about 200 kg of fruit per year.

Handling after harvest

Drying of baobab leaves in the shade results in smaller losses of vitamin A than drying in the sun. Fruit pulp is sun dried or fermented. A machine has been developed for the mechanical separation of the fruit pulp from the rest of the fruit. Traditionally seeds and pulp are sun dried, roasted or fermented. Pulp can be stored for long periods in airtight containers. The seed-coats and kernels can be separated by hand after boiling (1 hour) and soaking (12 hours).

Genetic resources

The variation in size between trees of identical age is usually attributed to site differences. However, the considerable size differences between baobab trees of identical age and at the same location suggest that the variation is mainly of genetic origin. In view of the variation in the species, sampling throughout its range of distribution is required to establish a representative germplasm collection. For the species as a whole there seem to be no threats of extinction or genetic erosion although locally (e.g. in eastern Zimbabwe) populations are under threat due to changes in the hydrology or to overexploitation.

Breeding

In view of the large variation in baobab, breeding and selection offer great opportunities.

Prospects

As a local source of leafy vegetable, fruit, fibre and other products baobab will continue to play an important role. Extension, notably on processing, could promote more intensive production and use. Local and international markets are likely to be able to absorb considerable quantities of produce. In view of the long productive life of baobab it is worthwhile planting only the best seedlings. Screening of seedlings for fast growth may be a tool to increase production. Research to understand the large variation in baobab should lay the foundation for future breeding programmes. Extensive provenance testing is required. As in other tree crops, breeding will be a long-term undertaking. In the short term the best strategy will be vegetative multiplication of superior trees.

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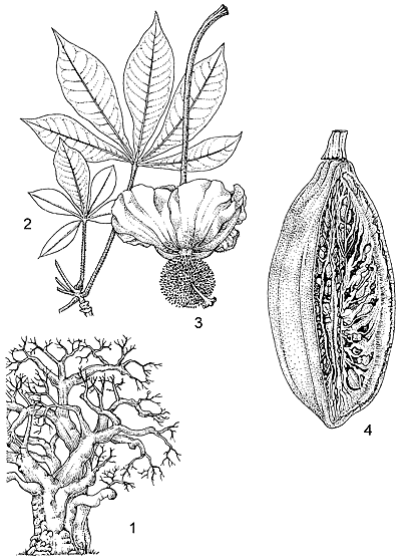
wild and planted



1, tree habit; 2, tip of leafy shoot; 3, flower; 4, opened fruit.
Redrawn and adapted by Achmad Satiri Nurhaman

flower buds and flower

harvested fruits

trunk

trees exploited for their leaves

fruiting branches