THE TAMARIND (Tamarindus indica L.) ITS FOOD, MEDICINAL AND INDUSTRIAL USES

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In recent years, there has been a steadily increasing interest in the potentialities of the world's plant resources and many investigators are today busily "screening" known economic plants for new applications in science and industry. New uses are being found for species even as time-honored in their utility as the tamarind (*Tamarindus indica* L., syns. *T. occidentalis* Gaertn., *T. officinalis* Hook.), every part of which, from roots to leaftips, has been employed to meet some human need.

DESCRIPTION

The tamarind tree, a handsome, massive, tropical legume, ascends, under favorable conditions, to a height of 80 feet and may attain a spread of 40 feet and a trunk circumference of 25. It is slow-growing and wind-resistant, with strong, supple branches, gracefully drooping at the ends, and has dark-grey, rough, fissured bark. The mass of bright-green, fine, feathery foliage is composed of pinnate leaves, 3 to 6″ in length, each having 10 to 20 pairs of oblong leaflets ½ to 1″ long and ⅛ to ¼″ wide, which fold at night. Inconspicuous, inch-wide flowers, borne in small racemes, are 5-petaled (2 reduced to bristles), yellow with orange or red streaks. The flower-buds are distinctly pink due to the outer color of the 4 sepals which are shed when the flower opens.

The fruits, flattish, bean-like, irregularly curved pods, are borne in great abundance and usually vary from 2 to 7″ in length and from ¾″ to 1¾″ in diameter. Exceptionally large tamarinds found in Abaco, Bahamas, are illustrated in the Proceedings of the Florida State Horticultural Society, Vol. 68, page 296. The pods may be cinnamon-brown or greyish-brown externally and, at first, are tender-skinned with green, highly acid flesh and soft, whitish, under-developed seeds. As they mature, the pods fill out somewhat and the juicy, acidulous pulp turns brown or reddish-brown. Thereafter, the skin becomes a brittle, easily-cracked shell and the pulp dehydrates naturally to a sticky paste enclosed by a few coarse strands of fiber extending lengthwise from the stem. The fully formed seeds are hard, glossy-brown, squarish in form, ⅜ to ½″ in diameter, and each is enclosed in a parchment-like membrane.

ORIGIN AND DISTRIBUTION

Native to tropical Africa, the tree grows wild throughout the Sudan and was so long ago introduced into and adopted in India that it has often been reported as indigenous there also, and it was apparently from this Asiatic country that it reached the Persians and the Arabs who called it *"tamr hindi"* (Indian date, from the date-like appearance of the dried pulp), giving rise to both its common and generic names. Unfortunately, the specific name, *"indica"*, also perpetuates the illusion of Indian origin. The fruit was well known to the ancient Egyptians and to the Greeks in the 4th century B.C.

The tree has long been naturalized in the East Indies and the islands of the Pacific and was early introduced into tropical America and the West Indies. In all tropical and near-tropical areas, including South Florida, it is grown as a shade and fruit tree, along roadways and in dooryards and parks. It is a long-lived, some specimens in Africa and India being estimated to be over 200 years old. While the tamarind thrives best in deep soil, it flourishes even in rocky terrain with little or no cultural attention. Since it withstands salt-spray, it can be planted fairly close to the seashore. Only in India are there extensive tamarind orchards, though Standley and Steyermark report that in the lower Motagua Valley of Guatemala there are so many large tamarind trees in one area that it is called "El Tamarindal". Dry weather is important during the period of fruit development. In South Malaya, where there are frequent rains at this time, the tamarind does not bear.

SUPERSTITIONS

Few plants will survive beneath a tamarind tree and there is a superstition that it is harm-

ful to sleep or to tie a horse beneath one, probably due to the corrosive effect that fallen leaves have on fabrics in damp weather. Some African tribes venerate the tamarind tree as sacred. To certain Burmese, the tree represents the dwelling-place of the rain god and some hold the belief that the tree raises the temperature in its immediate vicinity. Hindus may marry a tamarind tree to a mango tree before eating the fruits of the latter. In Nyasaland, tamarind bark soaked with corn is given to domestic fowl in the belief that, if they stray or are stolen, it will cause them to return home. In Malaya, a little tamarind and coconut milk is placed in the mouth of an infant at birth, and the bark and fruit are given to elephants to make them wise.

As a Food and Beverage

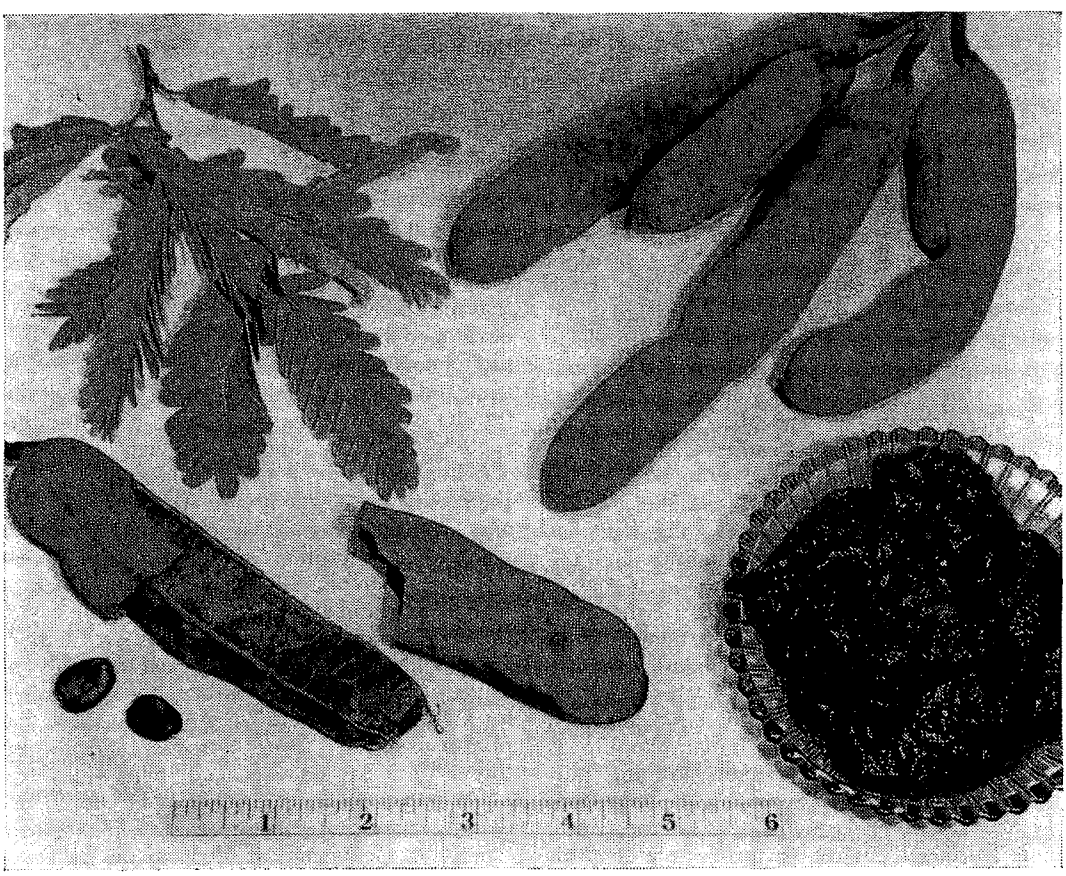
The food uses of the tamarind are many. The young seedlings, also the leaves and flowers of mature trees are eaten as vegetables and in curries, salads and soups. But it is the fruit that plays the major role in the dietary. In the tender, immature stage, the sour pods are cooked as seasoning with rice, fish and meats. The fully-grown but still unripe fruits, called "swells" in the Bahamas, are roasted in coals until they burst and the skin is then peeled back and the sizzling pulp dipped in wood ashes and eaten. The fully ripe, fresh fruit is relished out-of-hand by children and adults, alike. The dehydrated fruits are easily recognized when picking by their comparatively light weight, hollow sound when tapped and the cracking of the shell under gentle pressure. The shell lifts readily from the pulp and the lengthwise fibers are removed by holding the stem with one hand and slipping the pulp downward with the other. The fruit has exceptionally good keeping qualities and the unshelled fruits are commonly sold in native markets. The pulp is made into a variety of products. It is an important ingredient in chutneys, curries and sauces, including some brands of Worcestershire and barbecue sauce, and in a special Indian seafood pickle called "tamarind fish". Sugared tamarind pulp is often prepared as a confection. For this purpose, it is desirable to separate the pulp from the seeds without using water. If ripe, fresh, undehydrated tamarinds are available, this may be done by pressing the shelled and defibered fruits through a colander while adding powdered sugar to the point where the pulp no longer sticks to the fingers. The seeded pulp is then shaped into balls and coated with powdered sugar. If the tamarinds are dehydrated, it is less laborious to layer the shelled fruits with granulated sugar in a stone crock and bake in a moderately warm oven for about 4 hours until the sugar is melted, when the mass is rubbed through a sieve, mixed with sugar to a stiff paste, and formed into patties. This sweetmeat is commonly found on the market in Jamaica, Cuba and the Dominican Republic. In Panama, the pulp may be sold in corn husks, palm-leaf fiber baskets, or in plastic bags. To preserve tamarinds for future use, they may be merely shelled, layered with sugar in boxes or pressed into tight balls and covered with cloth and kept in a cool, dry place. For shipment to processors, tamarinds may be shelled, layered with sugar in barrels, and boiling sirup poured over them. East Indians shell the fruits and sprinkle them lightly with salt as a preservative. In Java, the salted pulp is rolled into balls, steamed and sun-dried, then exposed to dew for a week before being packed in stone jars.

Tamarind ade is a popular drink in the Tropics and is now being bottled in carbonated form in Guatemala, Mexico and elsewhere. Formulas for the commercial production of spiced tamarind beverages are being developed by technologists in India. The simplest home method of preparing the ade is to shell the fruits, place 3 or 4 in a bottle of water, let stand for a short time, add a tablespoonful of sugar and shake vigorously. For a richer beverage, a quantity of shelled tamarinds may be covered with a hot sugar sirup and allowed to stand several days (with or without the addition of seasonings such as cloves, cinnamon, allspice, ginger, pepper or lime slices) and finally diluted as desired with ice water and strained. In another method, shelled tamarinds with an equal quantity of sugar, may be covered with water and boiled for a few minutes until stirring shows that the pulp has loosened from the seeds, then pressed through a sieve. The strained pulp, much like apple butter in appearance, can be stored under refrigeration for use in cold drinks or as a sauce for meats and poultry, plain cakes or puddings. A delicious, foamy "tamarind shake" is made by stirring this sauce into an equal

amount of dark-brown sugar and then adding a tablespoonful of the mixture to eight ounces of a plain carbonated beverage and whipping in an electric blendor.

If twice as much water as tamarinds is used in cooking, the strained product will be a sirup rather than a sauce. Sometimes a little soda is added. Tamarind sirup is bottled for domestic use and export in Puerto Rico. In Mayaguez, street vendors sell cones of shaved ice saturated with tamarind sirup. Recently, the Corn Products Refining Company reported that tamarind sirup has been experimentally added to Karo to enhance the flavor. Tamarind pulp can be made into a tart jelly, and tamarind jam is now canned commercially in Costa Rica. Tamarind sherbet and ice cream are refreshing, and Dr. Walter Kreinke of the University of Florida has experimented with running ribbons of tamarind pulp through vanilla ice cream as he has done so successfully with mango. In making fruit preserves, tamarind is sometimes combined with guava, papaya or banana. In the literature, there are a few, brief references to tamarind wine.

In India, some 230,000 tons of tamarind pulp are harvested annually. The pulp constitutes 55% of the fruit; the shell and fiber make up 11.1% and the seeds, 33.9%. The pulp has a notably high acid and sugar content. The acid usually predominates in the flavor though there is much variation in the fruit from seedling trees, some actually being referred to as "sweet", relatively speaking. Analyses of the pulp are many and varied. Roughly, they show 67.4% carbohydrates, 30 to 41% reducing sugars and 9.52-12.76% tartaric acid. The ripe pulp is reported in Hawaii to be rich in cal-



Foliage, whole and partly shelled fruits, and seeds of the tamarind (Tamarindus indica L.) and a dish of cooked, strained tamarind pulp.—(Photo by Kendal and Julia Morton.)

cium, phosphorus, vitamin B and riboflavin and is a good source of niacin and thiamine. No significant amounts of vitamin A or ascorbic acid have been recorded.

Indian scientists, in seeking new commercial uses for the pulp, are studying it as a source of tartaric acid, alcohol (12% yield) and pectin (2½% yield).

Tamarind Seed Jellose

Tamarind seeds have been used in a limited way as food. They contain approximately 63% starch, 14-18% albuminoids and 4.5-6.5% of a semi-drying oil. They may be roasted and soaked to remove the seed coat and then boiled or fried; or may be reduced to a flour or starch. However, the great bulk of the seeds available as a by-product, and estimated as amounting to 132,000 tons annually in India, have, in the past, gone to waste. In 1942, two Indian scientists, T. P. Ghose and S. Krishna, announced that the decorticated kernels contained 46-48% of a gel-forming substance and, as a result of their findings, a powder made from tamarind kernels has been adopted by the Indian textile industry as 300% more efficient and more economical than corn starch for sizing and finishing cotton, jute and spun viscose, as well as having other technical advantages. Other industrial uses include employment in color printing of textiles, paper sizing, leather treating, the manufacture of a structural plastic and a glue for wood. It is commonly used for dressing homemade blankets. Dr. G. R. Savur of the Pectin Manufacturing Company, Bombay, has patented a process for the production of a purified product, called "pectin", "polyose" or "jellose", which has been found superior to fruit pectin in the manufacture of jellies, jams and marmalades. It can be used in fruit preserving with or without acids and gelatinizes with sugar concentrates even in cold water or milk. It is recommended as a stabilizer in ice cream, mayonnaise and cheese and as an ingredient or agent in a number of pharmaceutical products.

Medicinal Uses

In primitive and modern medicine, the tamarind has long played a prominent role. The pulp is official in the British and American and most other pharmacopoeias and some 200,000 pounds of the shelled fruits are annually imported into the United States for the drug trade, primarily from the Lesser Antilles and Mexico. The European supply comes largely from Calcutta, Egypt and the British West Indies. Tamarind preparations are universally recognized as refrigerants in fevers and as laxatives and carminatives. Alone, or in combination with lime juice, honey, milk, dates, spices or camphor, the pulp is considered effective as a digestive, even for elephants, and as a remedy for biliousness and bile disorders, and as an antiscorbutic. In native practice, the pulp is applied to inflammations, is used in a gargle for sore throat and, mixed with salt, is used as a liniment for rheumatism. It is, further, administered to alleviate sunstroke, *Datura* poisoning and alcoholic intoxication. It is said to aid the restoration of sensation in cases of paralysis. In Colombia, an ointment made of tamarind pulp, butter, and other ingredients is used to rid domestic animals of vermin.

Tamarind leaves and flowers, dried or boiled, are used as poultices for swollen joints, sprains and boils. Lotions and extracts made from them are used in treating conjunctivitis, as antiseptics, as vermifuges, treatments for dysentery, jaundice, erysipelas and hemorrhoids and various other ailments. The fruit shells are burned and reduced to an alkaline ash which enters into medicinal formulas. The bark of the tree is regarded as an effective astringent, tonic and febrifuge. Fried with salt and pulverized to an ash, it is given as a remedy for indigestion and colic. A decoction is used in cases of gingivitis and asthma and eye inflammations, and lotions and poultices made from the bark are applied to open sores and to caterpillar rashes. The powdered seeds are made into a paste for drawing boils and, with or without cumin seeds and palm sugar, are prescribed for chronic diarrhea and dysentery. The seed coat, too, is astringent and it, also, is specified for the latter disorders. An infusion of the roots is believed to have curative value in chest complaints and is an ingredient in prescriptions for leprosy.

Miscellaneous Economic Uses

Tamarind twigs are sometimes used as "chewsticks" and the bark of the tree as a masticatory, alone or in place of lime with betel. The bark is often employed in tanning hides and in dyeing and is burned to make an ink.

The sapwood of the tamarind tree is pale-yellow. The heartwood is dark purplish-brown, heavy, durable and insect-resistant. It bends well and takes a good polish and, while hard to work, it is highly prized for furniture, wheels, axles, gears for mills, ploughs, planking for sides of boats, wells, mallets, tool handles, rice pounders, mortars and pestles. It has at times been sold on American markets as "Madeira mahogany". Wide boards are rare, despite the trunk dimensions of old trees, since they tend to become hollow-centered. The wood is valued for fuel, especially for brick kilns, for it gives off an intense heat, and it also yields a charcoal for the manufacture of gunpowder. The wood ashes are employed in tanning and in de-hairing goatskins. Young stems and also slender roots of the tamarind tree are fashioned into walking-sticks.

Tamarind leaves, flowers and fruits are useful as mordants in dyeing. A yellow dye derived from the leaves colors wool red and turns indigo-dyed silk to green. Tamarind leaves in boiling water are employed to bleach the leaves of the buri palm (*Corypha elata* Roxb.) to prepare them for hat-making. H. F. Macmillan records tamarind foliage as a common mulch for tobacco plantings.

The fruit pulp may be used as a fixative with turmeric or annato in dyeing and has served to coagulate rubber latex. The pulp, mixed with sea water, cleans silver, copper and brass.

Tamarind seeds yield an amber oil for varnish especially preferred for painting dolls and idols. The oil is said to be palatable and of culinary quality. The tannin-rich seed coat is under investigation as having some utility as

Tamarind balls from Jamaica; a patty of tamarind pulp from Havana; Blue Plate Barbecue Sauce containing tamarind; tamarind nectar from Puerto Rico and tamarind jam from Costa Rica. (Photo by Julia Morton.)

an adhesive for plywoods and in tanning and dyeing.

The tamarind tree is a host for certain lac insects and for a species of silkworm, the latter producing a fine silk considered superior for embroidery.

Season, Pests And Propagation

In Florida, Central America, and the West Indies, the flowers appear in summer, the green fruits are found in December and January and ripening takes place from April through June. In Florida and Hawaii, the pods, if left too long on the trees, are attacked by beetles (identified as *Calandra linearis* var. *striata* Thung. in Hawaii) and by molds. At the University of Florida's Subtropical Experiment Station in Homestead, it has been found that one or more sprayings with DDT prior to fruit-ripening lowers insect infestation.

Tamarind seeds remain viable for months; will germinate in a week after planting. In the past, propagation has been customarily by seed sown in position with thorny branches protecting the young seedlings. However, with intensified interest in the commercial possibilities of tamarind products, there is greater concern for vegetative propagation of selected varieties such as the reddish-fleshed types that are preferred in the Orient for preserving. Methods employed for increasing are the rooting of cuttings, shield-budding, side-veneer grafting and air-layering. Very young trees should be protected from cold but older trees are surprisingly hardy, no cold damage having been noted in South Florida following the low temperatures of the winter of 1957-1958 which had severe effects on many mango, avocado, lychee and lime trees. Dr. Henry Nehrling reported that a tamarind tree in his garden at Gotha, Florida, though damaged by freezes, always sprouted out again from the roots.

Among laymen unfamiliar with the true tamarind, the tree is sometimes confused with other leguminous species to which the terms "tamarind" and "wild tamarind" are colloquially applied. These include *Piptadenia peregrina* Benth., (syn. *Niopa peregrina* Britt. & Rose), *Albizzia lebbek* Benth., *Lysiloma latisiliqua* Benth., *L. bahamensis* Benth., *Cojoba arborea* Britt. & Rose (syn. *Pithecellobium arboreum* Urb.) and some species of *Leucaena* and *Acacia*. While most of these trees have somewhat tamarind-like foliage, their fruits are generally dry or seed-filled pods, quite unlike that of the tamarind in appearance, and none have any substance resembling the succulent, mineral-rich pulp which has given the tamarind its fame and which, with the tree's other useful products, invites further exploitation in the New World as in the Old.

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DEVELOPMENT OF TEMPERATE-CLIMATE FRUITS FOR FLORIDA

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The temperate-climate fruits emphasized in this paper are peaches, blackberries, and blueberries, since the authors have active breeding projects underway to produce adapted commercial varieties of these fruits for Florida. Other essentially temperate-climate fruits (apples, apricots, cherries, grapes, nectarines, pears, plums, and raspberries) are discussed

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