

Opuntia ficus-indica

Opuntia ficus-indica, the Indian fig opuntia, fig opuntia, or prickly pear, is a species of cactus that has long been a domesticated crop plant grown in agricultural economies throughout arid and semiarid parts of the world.[3] *O. ficus-indica* is the most widespread and most commercially important cactus.[2][3] It is grown primarily as a fruit crop, and also for the vegetable nopales and other uses. Cacti are good crops for dry areas because they efficiently convert water into biomass. *O. ficus-indica*, as the most widespread of the long-domesticated cactuses, is as economically important as maize and blue agave in Mexico. *Opuntia* species hybridize easily, but the wild origin of *O. ficus-indica* is likely to have been in central Mexico, where its closest genetic relatives are found.[4]

Most culinary references to the "prickly pear" refer to this species. The Spanish name *tuna* is also used for the fruit of this cactus and for *Opuntia* in general; according to Alexander von Humboldt, it was a word of Taino origin taken into the Spanish language around 1500.[5]

Common English names for the plant and its fruit are Indian fig opuntia, Barbary fig, cactus pear, prickly pear, and spineless cactus, among many others.[3] In Mexican Spanish, the plant is called *nopal*, a name that may be used in American English as culinary terms. Peninsular Spanish mostly uses *higo chumbo* for the fruit and *chumbera* for the plant.[6]

O. ficus-indica is polyploid, hermaphroditic, and autogamous.[7] As *Opuntia* species grow in semiarid environments, the main limiting factor in their environment is water. They have developed several adaptations to dry conditions, notably succulence.[8]

A perennial shrub, *O. ficus-indica* can grow up to 5 m in height, with thick, succulent, and oblong to spatulate stems called cladodes. It has a water-repellent and sun-reflecting waxy epidermis. Cladodes 1–2 years old produce flowers, with the fruit's colours ranging from pale green to deep red.[7]

The plants flower in three distinct colours: white, yellow, and red. The flowers first appear in early May through the early summer in the Northern Hemisphere, and the fruits ripen from August through October.[citation needed] The fruits are typically eaten, minus the thick outer skin, after chilling in a refrigerator for a few hours. They have a taste similar to sweet watermelon. The bright red/purple or white/yellowish flesh contains many tiny hard seeds that are usually swallowed but should be avoided by those who have problems digesting seeds.

O. ficus-indica is consumed widely as food.[3] The fruits are commercialized in many parts of the world, eaten raw, and have one of the highest concentrations of vitamin C of any fruit.[3] The young "leaves" (actually cladodes, which technically are stems) are cooked and eaten as a vegetable known as *nopalitos*. [3] They are sliced into strips, skinned or unskinned, and fried with eggs and jalapeños, served as a breakfast treat. They have a texture and flavor like green beans. The fruits or leaves can be boiled, used raw, or blended with fruit juice, cooked on a frying pan, used as a side dish with chicken, or added to tacos. Jams and jellies are produced from the fruit, which resemble strawberries and figs in color and flavor.[3] Mexicans may use *Opuntia* fruit to make an alcoholic drink called *colonche*. [9]

In Sicily, a prickly pear-flavored liqueur called *ficodi* is produced, flavored somewhat like a medicinal aperitif. In Malta, a liqueur called *bajtra* (the Maltese name for prickly pear) is made

from this fruit, which grows wild in almost every field. On the island of Saint Helena, the prickly pear also gives its name to locally distilled liqueur, Tungi Spirit.

The cattle industry of the Southwest United States has begun to cultivate *O. ficus-indica*,^{[3][10]} both as a feed source for cattle and a boundary fence. Cattle are normally fed a spineless variety of the cactus.^[10] The cactus pads are low in dry matter and crude protein but useful as a supplement in drought conditions. In addition to the food value, the moisture content adequately eliminates watering the cattle during drought.^[10] Numerous wildlife species use the prickly pear for food.^[10] In severe drought years, the spines of wild prickly pear are sometimes burned off for emergency feed.

O. ficus-indica is planted in hedges to provide a cheap but effective erosion control in the Mediterranean basin. Under those hedges and adjacent areas, soil physical properties, nitrogen, and organic matter are considerably improved. The structural stability of the soil is enhanced, runoff and erosion are reduced, and water storage capacity and permeability are enhanced.^[11]

Prickly pear plantations also positively impact the plant growth of other species by improving severe environmental conditions, which facilitate the colonization and development of herbaceous species.^[12]

O. ficus-indica is being advantageously used in Tunisia and Algeria to slow and direct sand movement and enhance the restoration of vegetative cover, thus minimizing deterioration of built terraces with its deep and strong rooting system.^[13]

The plant may be used as an ingredient in adobe to bind and waterproof roofs.^[4] *O. ficus-indica* (as well as other species in *Opuntia* and *Nopalea*) is cultivated in nopalries to serve as a host plant for cochineal insects, which produce desirable red and purple dyes,^[3] a practice dating to the pre-Columbian era.^[14]

Mucilage from prickly pear may work as a natural, non-toxic dispersant for oil spills.^[15]

Mexico has a semicommercial pilot plant for biofuel production from *Opuntia* biomass, in operation since 2016.^[16]

Commercial use for *O. ficus-indica* is for the large, sweet fruits called tunas. An area with a significant tuna-growing cultivation is Mexico.^[17] The cactus grows wild and cultivated to heights of 12–16 feet (3.7–4.9 m). In Namibia, *O. ficus-indica* is a common drought-resistant fodder plant.^[18] *O. ficus-indica* grows in many frost-free areas of the world, including the Southern United States.^[19] It is naturalized with widespread distribution in Greece.^[20]

Prickly pears are a massive weed problem for some parts of Australia, especially southeast Queensland, some inland parts of New South Wales, Victoria, and south-eastern and eastern South Australia.^{[21][22][23][24]}

The plant is considered an invasive species in northern Africa.^{[3][25]}

Factors that limit the growth of prickly pear are rainfall, soil, atmospheric humidity, and temperature.^[26] Its minimum rainfall requirement is 200 mm per year as long as the soils are sandy and deep. The ideal growth conditions regarding rainfall are 200–400 mm (7.9–15.7 in) per year.^[11]

O. ficus-indica is sensitive to lack of oxygen in the root zone, requiring well-drained soils.[11] It is similar to crassulacean acid metabolism species, which are not salt-tolerant in their root zone, and growth may cease under high salt concentration.[11] *O. ficus-indica* usually grows in regions where relative humidity is above 60%, and saturation deficit[*further explanation needed*] occurs.[11] It is absent in regions where less than 40% humidity occurs for more than a month.[26] Mean daily temperature required to develop is at least 1.5–2.0 °C. At –10 to –12 °C, prickly pear growth is inhibited even if it is exposed to these temperatures only for a few minutes. The maximum temperature limit of prickly pear is above 50 °C.[11]

As the fruits of *O. ficus-indica* are delicate, they need to be carefully harvested by hand. The small spines on the fruits are removed by rubbing them on an abrasive surface or sweeping them through the grass. Before consumption, they are peeled.[27]

The pads of the plant (mainly used as fodder) also must be harvested by hand. The pads are cut with a knife, detaching the pad from the plant in the joint. If *O. ficus-indica* is cultivated for forage production, spineless cultivars are preferred, but wild plants are also used as fodder. In these cases, the spines must be removed from the pads to avoid animal damage. Primarily, this is achieved by burning the spines off the pads.[8]

O. ficus-indica for human and animal consumption is valuable for its water content in an arid environment, containing about 85% water as a water source for wildlife.[8] The seeds contain 3–10% protein and 6–13% of fatty acids, mainly linoleic acid.[7][28] However, the seeds contained in the fruits can be unpleasant to chew because of their hardness and can lead to constipation.[29][30][31] For this reason, some agronomic studies in Italy and Mexico have focused on decreasing the seed content of *Opuntia ficus-indica* fruits.[32][33]

As the fruit contains vitamin C (containing 25–30 mg per 100 g),[7][34] it was once used to mitigate scurvy.[35] *Opuntia* contains selenium.[36]

The red color of the fruit and juice is due to betalains, (betanin and indicaxanthin).[37] The plant also contains flavonoids, such as quercetin, isorhamnetin,[38] and kaempferol.[39]

DNA analysis indicated *O. ficus-indica* was domesticated from *Opuntia* species native to central Mexico.[4] The Codex Mendoza, and other early sources, show *Opuntia* cladodes, as well as cochineal dye (which must be cultivated on *Opuntia*), in Aztec tribute rolls.[*citation needed*] The plant spread to many parts of the Americas in pre-Columbian times. Since Columbus, it has spread to many parts of the world, especially the Mediterranean, where it has become naturalized.

