

Medicinal Plant Fact Sheet: *Opuntia*: prickly pear cactus

Common Name

prickly pear, nopal, cactus pear or tuna (fruit), nopales (mature pads) or nopalitos (immature pads).

Scientific Name

Opuntia spp. (Cactaceae: Cactus Family)

Description

Opuntia is a genus of fewer than 200 species of readily recognizable cacti growing as small ground-hugging plants to quite massive trees, with the majority as erect or trailing shrubs. These perennial plants are typically many branched with distinctive jointed, fleshy, flattened, often rounded stem-segments known as cladodes or phylloclades (commonly known as “pads”). As is diagnostic in the cacti, the stems of prickly pears have varying numbers of areoles—a specialized axillary or lateral bud, short shoot or branch—that produce spines and hairs, and can produce new stems, flowers or fruit. The areoles are irregularly distributed over the stem, usually elliptic, circular or obovate and produce white, gray or tan to brown hair and generally two types of spines; large, fixed spines and minute, barbed, hairlike spines called glochids that readily detach. The flowers are often showy, radially symmetric and vary in color from yellow, orange, pink, red, magenta and are sometimes whitish or bi-colored. The fruits can be club-shaped or cylindrical to ovoid or nearly spherical, spineless to spiny, fleshy or dry, and range in color from green to yellow, red, orange or purple in the fleshy types or tan to gray in the dry ones. The many seeds in each fruit have a hard, bony aril or funicular envelope surrounding them that is characteristic of the subfamily Opuntioideae to which *Opuntia* belongs (Anderson 2001, Benson 1982, Pinkava 2003, Stuppy 2002).

Distribution

Several genera have been segregated from the genus *Opuntia* during the past decades. Currently there are about 150 species in the genus *Opuntia* sensu stricto with 34 species in North America north of Mexico (Pinkava 2003). The genus as presented here occurs throughout much of the New World—Canada, USA, Mexico, the Caribbean, Central and South America and the Galápagos Islands. *Opuntia* is the most widely distributed genus of cacti, occurring from southern Canada to Argentina. Species of the genus are the most northern ranging of cacti, occurring to 56° North latitude in British Columbia and Alberta, Canada (Areces 2004) and are the only cacti ranging into the far eastern states of the USA. As such, they are also some of the most frost-tolerant cacti. Many species have been introduced into the Old World and some have become naturalized or seriously invasive in places such as South Africa, Australia and India. Around the Mediterranean, *Opuntia* were introduced shortly after Columbus’ first voyage to the New World and have been so thoroughly integrated into tradition and agriculture that local people frequently believe them to be native (Barbera et al. 1992).

Reproduction

Many studies of *Opuntia* blossoms demonstrate a remarkable variety of visitors to the flowers (Parfitt & Pickett 1980, Schlindwein & Wittmann 1997). Hymenoptera (bees, ants and wasps) constitute the richest assemblage of visitors to prickly pear flowers, followed by beetles, birds and lepidopterans. As is typical with many flowering plants, only some floral visitors are effective pollinators, however. For instance, though beetles can be common in *Opuntia* flowers, they are generally considered to have a limited role in the pollination of prickly pears. On the other hand, at least four *Opuntia* species in the Galapagos Islands and one species in Argentina are pollinated by birds (Reyes-Agüero et al. 2006).

Plants of the genus *Opuntia* have a long flowering season, large cyathiform flowers with attractive colors and sweet scent, highly nutritious pollen, stigma lobes that facilitate insect alighting and other characteristics that are consistent with a bee-flower pollination syndrome (Grant & Grant 1979, Grant et al. 1979, Grant & Hurd 1979). Some of the most common bees at *Opuntia* flowers belong to the Andrenidae (*Perdita*), Anthophoridae (*Anthophora*, *Diadasia*, *Melissodes*), Halictidae (*Agapostemon*, *Lasioglossum*), and Megachilidae (*Ashmeadiella*, *Lithurge*, *Megachile*). Generally, medium-size to large bees (1.0 to 1.6 cm) are effective pollinators of most *Opuntia* species (Grant & Hurd 1979), while smaller bees (0.2–0.7 cm) pollinate the flowers of smaller prickly pear species (Michener et al. 1994). Small bees in genera such as *Perdita* and *Dialictus* often act as pollen thieves (taking pollen without pollination). Many other bees of other genera are more casual visitors.

Prickly pear flowers are an extremely important resource for bees and it is perhaps not a coincidence that areas of high species diversity for *Opuntia* overlap areas richest in bee species (Linsley & MacSwain 1957, Ayala et al. 1993). The majority of the hymenopterans in North America that interact with *Opuntia* visit many pollen sources, but some are rather specialized, such as *Ashmeadiella*, *Diadasia*, *Melissodes*, *Lithurge*, and *Perdita*. The genera *Diadasia* and *Lithurge* may have coevolved with *Opuntia* (Linsley & MacSwain 1957, Michener et al. 1994, Mandujano et al. 1996, Schlindwein & Wittmann 1997). However, bee species exclusive to a single prickly pear species are unknown (Grant & Hurd 1979).

The stamens of *Opuntia* flowers are thigmotactic—when they are mechanically stimulated the filaments move towards the style. This movement is striking and quite rapid and when complete the anthers and filaments are tightly packed about the style. Stamen movement may have several effects, but the most important one may be to reduce pollen theft from non-pollinators and to guide pollination. The lower anthers, where about 80% of the pollen reward is located, are tightly shielded by the upper anthers after movement is complete. Certain bee species reach the lower layers of anthers by pushing their body downwards between the style and innermost stamens. These behaviors give these insects access to the main quantity of pollen and also effect pollination (Schlindwein & Wittmann 1997).

Opuntia exhibit a variety of breeding systems—self-compatibility (autogamy), cross-pollination (xenogamy), apomixis (production of seeds without fertilization) (Mondragón & Pimienta 1995), cleistogamy (self-pollination before anthesis) (Rosas & Pimienta 1986). Individual plants of some species are monoecious, others are dioecious or triecious (male plants, female plants and bisexual plants) and some are gynodioecious (female plants and bisexual plants) (Diaz & Cocucci 2003). While some species exhibit strict self-incompatibility (Piña et al. 2007) others are self-fertile. In at least some self-fertile species, the levels of cross- and self-pollination change through the season (Bianchi et al. 2000). Natural hybridization among *Opuntia* is common (Reyes-Agüero et al. 2006). All prickly pears can reproduce vegetatively, and some species appear to mostly forego sexual reproduction and reproduce mainly by this method (Anthony 1954, Bobich & Nobel 2001, Mandujano et al. 1996). The most important type of vegetative reproduction is the detachment and rooting of cladodes that subsequently develop into independent plants (Mandujano et al. 1998, Negrón-Ortiz 1998).

Medicinal Uses

Opuntia species have been used by humans for thousands of years (Smith 1967). Besides being consumed as food or beverages, most portions of the plants have been used as medicine and in modern times have also been commercially prepared as capsules, drinks, pills or powders. Preparations of prickly pear are variously considered anti-diabetic, anti-inflammatory, analgesic, galactagogue, hypoglycemic, antiviral and anti-oxidant. Preparations have been used to regulate weight, blood sugar, increase fiber intake and facilitate childbirth and are used in the treatment of asthma, fatigue, liver injury following alcohol abuse, corns, diarrhea, dysentery, dyspnea, gastritis, colitis and other gastrointestinal disorders, gonorrhea and syphilis, hypercholesterolemia, measles, nosebleed, obesity, snakebite, sore throat, vaginitis, and inflammation of the eyes, among other disorders. Heated poultices have been used to treat rheumatic disorders, erythema, chronic skin conditions, and applied to breasts to promote milk flow (Anderson 2001, Duke et al. 2002, Martínez 1989, Moerman 1998). The pulp of the pads has been used by many cultures as a dressing for burns, cuts, wounds, and fractures and is believed to deaden pain and promote healing. Glochids from the plant were rubbed into warts and moles to assist in their removal (Train et al. 1941). Decoctions of the fruit are taken as purgatives (Bean & Saubel 1972). The cladodes are used in the treatment of whooping cough, as "anti-infective agents" and in the treatment of gastric ulcer (Galati et al. 2001, Park et al. 2001). Recently preparations of prickly pear have been promoted as treatments for hyperglycemia, benign prostatic hyperplasia, alcohol hangover, acidosis, arteriosclerosis, diabetes and problems of the urinary system in women among other disorders (Feugang et al. 2006, Pittler et al. 2005, Rodriguez-Fragoso et al. 2007, Wiese et al. 2004).

Though usually well-tolerated and generally considered non-toxic when taken orally, prickly pear preparations have been reported to cause mild diarrhea, nausea, increased stool volume, increased stool frequency, abdominal fullness, and headache (Rodriguez-Fragoso et al. 2007).

Chemistry

Various species of *Opuntia* have yielded flavonoids (kaempferol, quercetin, narcissin, taxifolin and other phenolics); lactones known as alpha-pyrone (opuntiosides) (Qiu et al. 2007); terpenoids (lupenone, freideline, and others) and alkaloids (mescaline, hordenine, tyramine, and others) (Lee et al. 2003, Jiang et al. 2003). Betalain pigments (betanin, indicaxanthin) are at least found in the fruits (Butera et al. 2002) and act as anti-oxidants.

Trade

Prickly pears are cultivated and wild-harvested as fruit (tunas), vegetables (nopalitos—the young green cladodes or pads), and are used as forage for livestock in many countries, especially as a supplemental feed in times of drought (Stintzing & Carle 2005). The fruits are eaten fresh and are exported to the U.S., Canada, Japan, and some European countries or are used to make juice or confections, pigments, pectin and fructose. *Opuntia* products are used in cosmetics, lotions, soaps, and shampoos (Anderson 2001, Pinkava 2003, Reyes-Agüero et al. 2006). In Mexico and other places in the world, at least a part of commercial production has been devoted to cochineal scale insect (*Dactylopius coccus*). These insects are harvested from the plants to yield a red dye that has been used as a coloring for foods, cosmetics and fabrics (Portillo 1999). In addition there are many local uses for prickly pear, as for instance the addition of juice of the stems to plaster or whitewash as a binding agent (Stintzing & Carle 2005).

Prickly pears are grown in more than 30 countries (Stintzing & Carle 2005) and in Mexico alone there are at least 144 variants of *Opuntia* with differing levels of domestication (Reyes-Agüero et al. 2005). Commercial cultivation is carried out in Spain, Italy, Mexico, Brazil, Chile, Argentina and in the USA, notably California. At least Mexico, California and Chile have commercial production lines with product produced for export. No country's production approaches that of Mexico, however. Some estimates place the total area in Mexico with significant prickly pear production—both wild and cultivated—at over 3,000,000 hectares of which about 218,000 hectares consist of commercial production (Vigueras & Portillo 2001). The 1996 production in Mexico of nopalitos (young cladodes as a green vegetable) was estimated at over a half-million tons (Flores 1997). Prickly pear products have been estimated to constitute close to 2.5% of the value of Mexican agricultural products, generating about US\$50 million per year in income with an export market of *Opuntia* products valued at roughly the same amount annually (Soberon et al. 2001). Prickly pear cultivation has been especially important in marginal and subsistence economies where the plants are used in a variety of ways, several not related to food production.

Legal Protection and Conservation Status

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) currently lists all *Opuntia* species under CITES Appendix II. International trade in specimens of Appendix-II species may be authorized by the granting of an export permit or re-export certificate. Artificially propagated specimens of *Opuntia microdasys*

and cultivars are not subject to the provisions of the Convention and provisions are made to exempt parts (“stem joints (pads) and parts and derivatives thereof”) of plants of the “genus *Opuntia* subgenus *Opuntia*” (CITES 2007).

Differing implementation and views of the taxonomy of the cacti in the subfamily Opuntioideae (Stuppy 2002) may cause differences in the conservation listings of different agencies or organizations. For instance, the Florida semaphore cactus, formerly known as *Opuntia spinosissima*, is known only from the Florida Keys and is critically imperiled. The Center for Plant Conservation still lists this plant as an *Opuntia* as do many texts and websites. However, the best current treatment of these cacti uses the name *Consolea corallicola* (Pinkava 2003). The Bakersfield cactus, Kern beavertail prickly pear, or Trelease’s beavertail prickly pear (*Opuntia treleasei*), is listed as endangered in the National Master List of Proposed, Threatened and Endangered Species (USDAFS 2007). However, it is considered a variety of the beavertail prickly pear, *Opuntia basilaris*, in other treatments (Pinkava 2003). *Opuntia aggeria* and *O. kunzei*, both listed as “vulnerable” by NatureServe (2007), are now placed in the genus *Grusonia*.

The following *Opuntia* species of the United States are considered as being vulnerable or imperiled (NatureServe 2007). Some may be listed under different names or not considered as having valid taxonomic status by some authorities and there may be disagreement over their conservation status. *Opuntia superbospina*, listed as “possibly extinct” on the NatureServe website is listed in Pinkava’s work (2003) as a synonym of *O. phaeacantha*. For a number of taxa in the genus *Opuntia*, Pinkava states that “morphologic and genetic analyses of the populations are needed before correct names can be assigned to many of these plants with confidence.” Putative hybrids are not listed here. Taxa that are not listed as valid in Pinkava (2003) are denoted with a *.

For more information on specific USA state and Canadian province conservation rankings and explanations supporting these rankings, see the NatureServe website: <http://www.natureserve.org/> and state and federal databases.

Vulnerable (NatureServe rank of G3 or the like)

Golden prickly pear (*O. aurea*). Arizona, Utah.

Chisos Mountain prickly pear (*O. chisosensis*). Texas, probably adjacent Mexico.

Cactus-apple (*O. engelmannii* var. *flavispina*). Arizona.

*Brittle prickly pear (*Opuntia fragilis* var. *brachyarthra*). Arizona, Colorado, New Mexico, Utah.

*Violet prickly pear (*O. gosseliniana*). Arizona and Sonora, Mexico.

Purple prickly pear (*O. macrocentra* var. *macrocentra*). Arizona, New Mexico, Texas, Mexico.

Chaparral prickly pear (*O. oricola*). California, Mexico.

*New Mexico prickly pear (*O. phaeacantha* var. *camanchica*). Colorado, New Mexico, Oklahoma, Texas.

*New Mexico prickly pear (*O. phaeacantha* var. *laevis*). Arizona.

*New Mexico prickly pear (*O. phaeacantha* var. *wootonii*). New Mexico.

Bullrush Canyon prickly pear (*O. pinkavae*). Arizona, Utah.

*Panhandle prickly pear (*O. polyacantha* var. *juniperina*). Arizona, Colorado, New Mexico, Utah, Wyoming.

Big Pine Key prickly pear (*O. triacantha*). Florida, Caribbean.

*San Antonio prickly pear (*O. valida*). New Mexico, Texas.

Imperiled (NatureServe rank of G2 or the like)

*Sand prickly pear (*O. arenaria*). New Mexico, western Texas, and adjacent Mexico.

*Beavertail prickly pear (*O. basilaris* var. *heilii*). Utah

Beavertail prickly pear (*O. basilaris* var. *longiareolata*). Arizona, Utah.

Bakersfield cactus, Kern beavertail prickly pear, or Trelease's beavertail prickly pear (*O. basilaris* var. *treleasei*). California.

*Old-man prickly pear (*O. erinacea* var. *ursina*). Arizona, California, Nevada, Utah.

*Heacock's prickly pear (*O. heacockiae*). Colorado, Arkansas.

*Coastal prickly pear (*O. littoralis* var. *austrocalifornica*). California.

Coastal prickly pear (*O. littoralis* var. *littoralis*). California.

Critically Imperiled (NatureServe rank of G1 or the like)

Golden-spined prickly pear (*O. aureispina*). Texas.

Short joint beavertail (*O. basilaris* var. *brachyclada*). California.

*Big Bend prickly pear (*O. densispina*). Texas.

Few-spined marble-fruited prickly pear (*O. engelmannii* var. *flexispina*). Texas.

Cow-tongue prickly pear (*O. engelmannii* var. *linguiformis*). Texas.

*Coastal prickly pear (*O. littoralis* var. *piercei*). California.

*Coastal prickly pear (*O. littoralis* var. *vaseyi*). California.

*Seashore cactus (*O. martiniana*). Arizona.

Sustainable Use and Conservation

Prickly pear species that are considered vulnerable or imperiled are generally populations that are small and localized. In these cases, agriculture, urbanization, mining, hobbyist or landscape trade collecting, grazing, road building and vehicle activity, among other causes are considered threats (Anderson 2001, Benson 1982). Direct competition from introduced species as well as brush fires caused by increases in fuel load from them can be very hazardous for succulents. The introduced cactus moth, *Cactoblastis cactorum*, is causing much concern for its potential for destroying *Opuntia* (Vigueras & Portillo 2001). Species that have been used by herbalists for medicinal purposes are usually species that are cultivated or are wild species that are not vulnerable to over harvesting (Anderson 2001).

[BOX]Sustainable Actions

- Wild-harvesters: Collection of wild material should follow certain procedures that allow sustainable harvest (Medicinal Plant Specialist Group 2007). Avoid species or populations that are of conservation concern.
- Growers: Prickly pear cacti are already commonly cultivated in many places in the world and it is generally these species that are used medicinally.

- Practitioners and Consumers: No cautions should be necessary for *Opuntia* products since the cultivated varieties are not of conservation concern.
- Suppliers and manufacturers: No cautions should be necessary for *Opuntia* products since the cultivated varieties are not of conservation concern.

Disclaimer

The information contained in this article is not intended nor implied to be a substitute for professional medical advice relative to your specific medical condition or question. All medical and other healthcare information that is given here should be carefully reviewed by the individual reader and their qualified healthcare professional.

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