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Opuntia: Medicinal Plant

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Abstract: Opuntia stricta with high water use efficiency produces forage for animals, vegetables, and fruits with glucose. Traditionally cactus used as a valuable health supporting nutrient and it also has applications in pharmaceutical industries. Opuntia stricta is belonging to the Cactaceae family and comprises from 200 to 300 species. Its fruit is composed of around 69% peels, 21% pulp, and 10% seeds. Opuntia stricta fruit juice is a potential source of betacyanin pigments which can be used as a natural red-purple food colorant and The fruits of O. stricta contain water (92%), carbohydrates (4-6%), protein (1-2%), minerals (1%) and a moderate amount of vitamins, mainly A and C (Cantwell, 1991, and Neri, 1991, cited by Pimienta, 1993). According to these figures, its fruits are high in carbohydrates (50-75% of DM) and moderate in protein content (12.5-25% of DM), minerals and vitamins.

Keywords: Opuntia Stricta, Cactaceae, Betacyanin, Food Colorant, Nutrient.

I. INTRODUCTION

It is well known that none of the dosage forms either for internal use or external use can be manufactured without excipients. Excipients play an important role in formulating a dosage form. These are the ingredients which along with Active Pharmaceutical Ingredients make up the dosage forms. Herbal excipients are non-toxic, freely available, and less expensive compared to their synthetic excipients. Opuntia stricta is belonging to the Cactaceae family and comprises from 200 to 300 species. Its fruit is composed of around 69% peels, 21% pulp, and 10% seeds. Opuntia stricta fruit juice is a potential source of betacyanin pigments which can be used as a natural red purple Food colorant. Opuntia stricta fruits have a high level of betalains (80 mg/100 g fresh fruit) with betanin and isobetanin as the main colorant components. Opuntia stricta juice was obtained and it presents a vivid red-purple color which is clearly distinguishable from the colors shown by other commercialized natural red food colorant. The juice contains sugar moiety so it can be used as a sweetening agent as well as sugar coating in tablet formulation. The chemical composition of the peels, pulp and seeds of the opuntia stricta fruit indicating that seeds have a highly significant level of proteins, oil, fiber and carotenoids as compared to the pulp and peel. In addition to the major food constituents such as proteins, fat, carbohydrates and micronutrients, *opuntia* fruits contain other components that may have positive effect on human health as nutritive health drink

Opuntia stricta is a shrubby, low-spreading, evergreen cactus, sometimes forming large, wide clumps that are seldom more than 80cm tall, though occasional forms with definite trunks are known to grow 2 - 3 meters tall. The plant varies considerably in degrees of spininess, ranging from forms that are completely free of spines up to forms with relatively abundant spines.The plant has been cultivated through much of the tropics, subtropics and warm temperate zone as a hedge plant and living fence, and also for sand dune fixation The fruits are occasionally eaten.

IMPORTANCE

In India, an important part of the population is settled in rain fed dry areas which need perennial vegetation to protect them from erosion using drought hardy and economically viable plants. Cacti seem to be an option to sustain a livelihood, reduce poverty and generate employment opportunities. Cactus is drought tolerant due to its CO2 fixation capacity (CAM); it is well suited to dry areas, where it can be used as an alternative food and fodder, as well as a live fence to protect agricultural fields. In the seventh century, the British introduced the cactus to India for cochineal dye production but these plantations gradually disappeared due to pests and flooding of the

areas. Recent attempts to introduce cultivated cactus pear started late in the 1980's (Singh 2006). Pitaya (*Stenocereus griseus*) is a cactus fruit used as a complementary part of diet since ancient times in Southern Mexico. In this region approximately 30 types of Pitayas like Amarilla, Jarra, Melon, Crema, and Olla have been identified. Olla and Jarra showed the best quality attributes for the fresh and processed market (Yanez et al. 2005). Some countries, such as Australia, have water restrictions in many cities, so drought-resistant plants are increasing in popularity.

II. NATURALIZED DISTRIBUTION (GLOBAL)

Locations within which *Opuntia stricta* is naturalized include Australia, east and south Asia, the Middle East, Spain, northern, southern and eastern Africa and India.

HABITAT

The natural range of the two recognized varieties of *O. stricta* spans a large area with varying climates, habitats, and soils. Within the centre of its natural distribution, *O. stricta* var. *stricta* is confined mainly along the Florida coast on sandy soils (Benson, 1982) whereas in Australia and South Africa the same species has invaded millions of hectares and can be found in many soil types, habitats and climates (Mann, 1970; Henderson, 2001). An invasion is always enhanced by disturbances and in particular by overgrazing, and neither variety has ever invaded the well-grassed downs in Australia and high altitude grasslands in the cooler parts of South Africa. Invasions were particularly common in low-lying wooded areas in Australia and savanna bushveld in South Africa (Wells et al., 1986; Malan, 1989). It would appear as if nursery plants are important for the initial establishment of the delicate seedlings. Although *O. stricta* is frost-tolerant, it thrives best in hot and humid conditions. The species is also drought tolerant, and invading populations can be found within annual rainfall regimes of 300-1200 mm which may include an 8-month dry spell.

HISTORY

Prickly pear is widely cultivated and used in juices, jellies, candies, teas, and alcoholic drinks. The fruits and flowers of the plant are used as natural food colorants. Cactus gum is used to stiffen cloth. Essential oils from the flowers are used to make perfumes, and the seeds are a source of oil. Prickly pear has also been used as a source of animal feed and dye. There are numerous medicinal uses of the plant. American Indians used prickly pear juice to treat burns. Often a cone of plant material would be burned on the skin to treat irritation or infection, a process known as moxabustion in Chinese medicine. The Lakota tribe used prickly pear in a tea to assist mothers during childbirth. Prickly pear has a long history of traditional Mexican folk medicine use, particularly as a treatment for diabetes. Prickly pear pads have been used as a poultice for rheumatism. The fruit has been used for treating diarrhea, asthma, and gonorrhea. The fleshy stems or cladodes have been used to treat high cholesterol, blood pressure, gastric acidity, ulcers, fatigue, dyspnea, glaucoma, liver conditions, and wounds. In South Korea, the plant has been used to treat abdominal pain, bronchial asthma, burns, diabetes, and indigestion. In Sicily, a flower decoction of prickly pear has been used as a diuretic; the cladodes were valued for their anti-inflammatory activity in treating edema, arthrosis, and whooping cough, and for preventing wound infection. Prickly pear has also been planted on steep slopes to control erosion

III. DESCRIPTION

Cotyledons: Two.

Leaves: Several, purplish to pink, conical and scale-like, 5-7 mm long, sometimes very small, below the 'warts' on young stems. They fall off with age.

Stems: Erect, up to 3000 mm tall and usually 1000 mm tall, made up of the oval to egg-shaped, flattened, spiny. Dull green to blue-green, fleshy segments 100-250 mm long x 70-160 mm wide and 10-20 mm thick. Branches from near the ground with no definite trunk and forms large clumps. Hairless. Has 'warts' or areoles, 12-100 mm diameter, in the leaf axils, 35-50 mm apart in 2-3 diagonal lines, sometimes, with tufts of finely barbed, yellow bristles and may have 1-11, slightly curved, spines 20-60 mm long or spineless. Each 'wart' may produce a flower, new stem segment or roots.

Flower head: Usually several flowers on the edges of the stem segments.

Flowers: Pale yellow, no stalk. Floral tube narrowly egg-shaped, 50-65 mm long.
Ovary - One style, yellow. Several stigmas.
Sepals - Difficult to distinguish from the petals.
Petals - Many, overlapping, yellow with green or pink markings on the back, 60-80 mm wide when fully open. Outer lobes, sepal-like, abruptly pointed on the tip. Middle lobes kidney shaped and abruptly pointed or triangular or with a point where the midrib projects. Innermost 8-10 lobes petal-like, yellow, egg-shaped or cut off at the top. More correctly termed petaloid.

Stamens - Many.
Anthers - Yellow.

Fruit: Pear shaped to globular berry, red-purple when ripe with red flesh, 38-75 mm long x 25-40 mm wide, with a circular depression or flat at the top. Has warts with fine barbed bristles.

Seeds: Many, smooth, yellow to light brown or black, hard coated, globular seeds about 5 mm wide in the pulp in the middle of the fruit.

Roots: Fibrous. Shallow.

CHEMISTRY

The medicinal components of the plant are found in the flowers, leaves or pads, and fruit.Isorhamnetin-glucoside, kaempferol, luteolin, penduletin, piscidic acids, quercetrin, rutin, and β-sitosterol have been found in the flowers of prickly pear. The leaves or pads are rich in mucilage and consist primarily of polysaccharides that contain galactose, arabinose, xylose, and rhamnose. Prickly pear fruit is high in nutritional value. Ethanol-soluble carbohydrates are the most abundant components of prickly pear fruit pulp and skin, making up 50% of the pulp and 30% of the skin. The betalain compounds are responsible for the various colors of the fruit. The skin contains calcium, iron, potassium, magnesium, manganese, sodium, and selenium. The edible pulp contains biothiols, taurine, flavonols, tocopherols, and carotenoids. However, industrial processing of juice components results in some loss of vitamins A, E, and C the seeds are rich in phosphorus and zinc. The oils from the seeds and peel are a good source of polyunsaturated fatty acids. Several older chemical analyses of enzymes from *Opuntia* species are available. Other studies discuss the chemistry of prickly pear, including isolation of albumin, the amino acid composition in the fruits, and fatty acids of the seeds.

BIOLOGY

Life cycle: Perennial. Seed germinates at any time of the year, producing a delicate bristly seedling that normally dies. Survivors grow slowly and make new segments on the edges of their small stem segments. After 3 years they may flower. Plants are very long lived and most new plants arise from stem segments that fall to the ground or are broken off. Roots form from the areoles (warts) in contact with the soil and new stem segments are produced from the areoles on top. Segments are often broken off and carried by floods.

Physiology: Drought tolerant. Crassulacean acid metabolism (CAM) plant helps preserve water. Detached stem segments can remain viable indoors for 3 years.

Reproduction: By seed and stem fragments.

Flowering times:
November in western NSW.
September to October in Perth.
Spring and early summer in WA.

Seed Biology and Germination: Seed may remain viable for 20 years.

Vegetative Propagules: Stem segments.

Climate: Grows in tropical regions through to semi-arid savannas. Semi-arid, warm temperate, subtropical and tropical regions. The most severe infestations occurred in the 500-750 mm rainfall zone in Australia.

DOSING

Prickly pear is commercially available in numerous dose forms, including capsules, tablets, powders, and juices, and as food. Follow manufacturers' suggested guidelines if using commercial products. Typical dosage regimens are two 250 mg capsules by mouth 3 times a day or every 8 hours.

CONTRAINDICATIONS

Hypersensitivity to any components of prickly pear.

PREGNANCY/LACTATION

Avoid use during pregnancy and lactation because of the lack of clinical studies.

ADVERSE REACTIONS

Dermatitis is the most common adverse reaction to prickly pear.

USES

- Prickly pear is widely cultivated and commercially used in juices, jellies, candies, teas, and alcoholic drinks.
- American Indians used prickly pear juice to treat burns, and prickly pear has a long history in traditional Mexican folk medicine for treating diabetes.
- Used as a red colorant is used in certain dairy products such as yogurts and also in the production of jams and juices.
- Other uses include preparations of mock-gherkins, jams and syrups, soap from its leaves, alcoholic drinks, and seeds for honey and cheese production.
- Cactus pears from *Opuntia stricta* are considered as a potential source natural red colourants (Casteller et al. 2003).
- A study about the use of prickly pear cactus mucilage as an edible coating to extend the shelf life of strawberries revealed that use of mucilage coatings leads to increased strawberry shelf life (Del-Valle et al. 2005).
- Opuntia genus is widely known for its mucilage production. Mucilage, a complex carbohydrate with a great capacity to absorb water, should be considered a potential source of industrial hydrocolloid. Mucilage contains varying proportions of L-arabinose, D-galactose, L-rhamnose, and D-xylose, as well as galacturonic acid. The mucilage content found in the cactus cladodes is influenced not only by the management of the crop but also on the temperature, irrigation and the rain.
- In some countries, small farmers use cactus mucilage to purify drinking water.
- Another traditional use is for improving house paint. Recently, a cactus cladode extract was tested to improve water infiltration in soil (Saenz et al. 2004).
- Cactus mucilage can be used as a natural thickener. All these components could be used as natural ingredients in foods to enhance their healthy properties.
- Cacti are commonly used for fencing material where there is a lack of either natural resources or financial means to construct a permanent fence.
- In spite of considerable research on its nutritional importance, medicinal uses and food value, cacti remains to be an underutilized and unexploited crop. Cactus with a number of uses has immense potential to be the food of future.
- One benefit of Opuntia ficus-indica for human and animal consumption is its water content in an arid environment, containing about 85% water as an important source for wildlife.

PHARMACOLOGY

Diabetes

A mechanism of action remains to be discovered in diabetes; however, polysaccharides may be responsible for the plant's hypoglycemic activity.

Animal

An extract of O. fulginosa prickly pear maintained normal blood glucose and glycated hemoglobin levels in streptozotocin-induced diabetic rats after insulin was withdrawn.Similar results were obtained with O. megacantha in reducing blood glucose in normal and streptozocin-induced diabetic rats. However, O. megacantha was nephrotoxic as shown by elevated plasma urea and creatinine concentrations and reduced plasma sodium concentrations.

Clinical

The hypoglycemic effects of Opuntia species are documented in numerous studies. One open-label study of 14 patients found that O. streptacantha decreased glucose and insulin levels in patients with noninsulin-dependent diabetes mellitus; however, the plant had no effect on glucose or insulin levels in healthy volunteers. Another open-label study involving 32 patients with type 2 diabetes treated with O. streptacantha also resulted in decreased glucose and insulin levels.

Hyperlipidemia

Animal Data

Two animal studies examined the effect of prickly pear seed oil on serum and lipid parameters in rats.An increase in high-density lipoprotein cholesterol and a reduction in serum cholesterol was observed in rats treated with seed oil. Raw O. ficus-indica had beneficial effects on hypercholesterolemia.

Clinical Data

In one small study of 29 patients, prickly pear significantly reduced cholesterol levels. Prickly pear may have antiplatelet activity, which may be useful in patients with prothrombotic conditions such as diabetes and hyperlipidemia. Eight healthy volunteers and 8 patients with familial heterozygous hypercholesterolemia were treated with prickly pear 250 mg for 2 months. Significant (**P** > 0.01) decreases in total and LDL-cholesterol and reduced platelet proteins were found. Opuntia capsules in a human trial had marginally beneficial effects on cholesterol and glucose levels.

Inflammation

The mechanism of action is associated with the anti-inflammatory principle β-sitosterol.

Animal Data

Anti-inflammatory actions were demonstrated in Opuntia dillenii in an induced rat paw edema model. β-sitosterol from the fresh stems of prickly pear had potent anti-inflammatory activity in an adjuvant-induced chronic inflammation model in mice.

Clinical Data

Prickly pear may inhibit the production of inflammatory mediators associated with the symptoms of alcohol hangover. In a double-blind, placebo-controlled, crossover trial, 55 healthy volunteers received placebo or 1,600 units of prickly pear 5 hours before consuming alcohol. Patients consumed 1.75 g alcohol/kg of body weight over 4 hours. C-reactive protein and symptoms such as nausea, dry mouth, and anorexia were reduced in patients treated with prickly pear.

Ulcers

A cytoprotective mechanism is associated with an interaction between the mucilage monosaccharides from prickly pear and membrane phospholipids.

Animal Data

Histological evidence supports the efficacy of prickly pear cladodes against the formation of ethanol-induced ulcers.

Clinical Data

No clinical trials could be found.

Orthopharmacological

Antioxidant

Opuntia species have antioxidant activity that may be associated with their phenolic content. Short-term supplementation with 250 g of fresh fruit pulp in a comparative study and a study of patients with familial isolated hypercholesterolemia reduced oxidative damage to lipids and improved oxidative stress status of treated patients.

Diuretic

Prickly pear cladode, fruit, and flower infusions increased diuresis in a rat model.

Neuro-Protective Effects

Animal models in rats demonstrated that the flavonoids isolated from O. ficus-indica var. saboten species had neuroprotective activity against oxidative injury induced in cortical cell cultures and neuronal damage induced by global ischemia.

Nutrition

Prickly pear fruit liquid has been studied as a natural sweetener. Opuntia has been studied as a source of dietary fiber.

Wound Healing

Histological evidence documents that topical application of polysaccharide extracts from prickly pear cladodes enhanced cutaneous repair and healing of large, full-thickness wounds in a rat model. The polysaccharides from prickly pear cladodes have been studied for their chondro protective effects in treating joint diseases.

CONCLUSION

Both its history and its present appearance justify that O. stricta keeps an independent taxonomic position like that recommended by Benson (1969). Its name should not be eliminated since it stands for some characteristics. There are, first of all, the fruits: spineless, palatable, and attractively colored, with edible seeds and many health-promoting components. They would certainly meet with a market, for instance in Europe, and offer a rich source of red food dye. Fruits and cladodes of O.stricta have shown remarkable effects against several diseases which could partly be confirmed by recent investigations and may be of special interest with respect to the rapidly increasing prevalence of diabetes type 2 in many parts of the world (Wild et al 2004).

A prerequisite for the more intensive work with and the cultivation of the well-growing, adaptable O. stricta plants is the reduction or even removal of the stout spines. They should be attainable through the propagation of respective mutants occurring in nature or in experiments with established in vitro methods. Then, the completely or nearly spineless O. stricta plants can be bred in order to enlarge fruit size and to lower pulp sourness or to improve relevant properties. The absence of spines will also favour the use of cladodes as vegetable and for medicinal purposes.

Consequently, O. sticta is a highly promising candidate of programmes directed to the development of Opuntia species into crop plants (Mohamed-Yasseen et al. 1996), and it is surprising that this cactus has been neglected in the areas of origin (Pimienta-Barrios 1994, Scheinvar 1995) whereas it has found attention in other parts of the world.

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