

Prickly Pear (*Opuntia ficus indica*)

SPECIFICATION SHEET

DESCRIPTION Prickly pear powder is an ingredient obtained from the selection, washing, cutting, dehydration and milling of *Opuntia* spp.

The drying process is particularly designed to keep the bioactive properties of Prickly pear.

The ingredient is GMO free, allergens free and is not an irradiated product.

SPECIFICATIONS: Organoleptic

attributes Appearance _____ Fine Powder

Color Creamy green Olor

Characteristic

Flavor Characteristic **Physical**

and chemical data Moisture < 10.0%

Dry matter \geq 90%

Ash \leq 25% Mesh size

< 10 % On US# 40 Lead

< 3 ppm —

Cadmium \leq 0.5 ppm

Arsenic \leq 1 ppm

Microbiological Total Plate Count < 10

000 CFU/g Molds < 150

CFU/g Yeast < 150 CFU/g E.

coli < 10 CFU/g Salmonella

Negative S. aureus

Negative

Typical Nutrition Profile

Ash	17.0-22.0 %
Protein	4.5-6 %
Reducing Sugars	6.0 – 12.0 %
Dietary fiber	40 – 48 %
Potassium	1.8 %

APPLICATIONS

- Food supplements: weight management, diabetes, hypercolesterolemia.
- Food and beverages
- Cosmetic products

STORAGE:

PACKAGING

Multilayer kraft paper bag with inner plastic bag. Net Weight : 25 kg

STORAGE CONDITIONS

Recommended storage is a cool (below 25°C) and dry area.

SHELF LIFE

2 years keeping under recommended storage conditions and handling GMP practices.

Prickly Pear (*Opuntia ficus indica*)

PRODUCT HIGHLIGHTS



- Natural concentrate of *Opuntia* spp.
- It has low glycemic index
- Rich in soluble and insoluble fiber
- **Hypoglycemic properties:** Blood glucose levels was reduced up to 42% after postprandial (after meal) consumption of an extract of *Opuntia* spp. This is because it reduces the intestinal absorption of glucose (soluble fiber effect) or due to the existence of hypoglycemic substances ³⁷, presumably a saponin. ⁵
- **Anti-hyperlipidemic and anti-hypercholesterolemic effect:** It was reported a reduction of total cholesterol, LDL, apolipoprotein levels, triglycerides, fibrinogen, blood glucose, insulin and urate. The anti-hyperlipidemic effects were ascribed to the pulp pectin, by means of reducing lipid absorption and increased fecal sterol excretion due to its binding bile acid capacity. ⁴⁸⁻⁵¹ The pectin was attributed as responsible for decreasing lipid absorption, blood lipid levels, and finally weight reduction. ⁵³
- **Antioxidant Capacity and atherogenic properties :** It has demonstrated antioxidant capacity by inhibiting some oxidant enzymes.

Opuntia robusta pulp broiled was responsible for an antiatherogenic effect decreasing isoprostane levels in urine, serum and plasma as an indicator for oxidative stress and generally improved blood parameters levels. ^{15,17}

- **Satiety:** A prolonged period of satiety was registered after cladode consumption. ⁴⁹⁻⁵¹

Metabolic Syndrome X is a group of conditions that put you at risk for heart disease and diabetes. These conditions are: High blood sugar levels, high levels of triglycerides, a type of fat, in your blood Low levels of HDL in blood (the good cholesterol) and too much fat around waist. (U.S. National Library of Medicine and National Institutes of Health)

According to its definition we can conclude that prickly pear has multiple benefits that can improve Metabolic Syndrome X conditions.

- **Diuretic effect and impact on uric acid metabolism:** *O. ficus indica* cladode, fruit and flower infusions significantly increase diuresis.⁵⁶
A study to determine the effects of feeding spineless *Opuntia ficus-indica* Mill cladodes on diuresis and urinary electrolyte excretion conclude that plasma urea concentration decreased linearly ($P < 0.05$) as *Opuntia ficus-indica* Mill cladode level in the diet increased. A tendency for a linear decrease ($P = 0.06$) in uric acid concentration was also noted as a result of *Opuntia ficus-indica* Mill cladode inclusion.¹⁸
Diuretic properties of *Opuntia ficus-indica* Mill can partly be attributed to the effects its high K concentration exerts on renal epithelia (Galati et al., 2002).³⁸
- **Antiulcerogenic Effect :** Antiulcerogenic effect of the cladode or fruit powder from *O. ficus indica* var. *saboten* Makino. Stomach lesions triggered by hydrochloric acid/ethanol or hydrochloric acid/acetylsalicylic acid were reduced. The protective effect was ascribed to the cladodes' hydrocolloid acting as a buffer, spreading out on the gastric mucosa and increasing mucus production by enhancing the number of secretory cells.¹⁹⁻²²
- **Antiinflammatory Properties:** Extracts of cladodes demonstrated a fast regeneration of the tissue that was ascribed to inflammation inhibition, stimulation of the fibroblast migration with accelerated collagen synthesis and faster healing process. This effect is presumably ascribed to a polysaccharide fraction of cladodes.^{23-25, 55}

Prickly Pear (*Opuntia ficus indica*)

RESEARCH OVERVIEW



Scientific Name of Species : *Opuntia ficus-indica* L. Miller., *Opuntia streptacantha* Lem.

Common Names: Prickly pear cactus, Nopal.

Family: Cactaceae

Origin: Mexico

General Description: Belongs to the genus *Opuntia*, family Cactaceae and subfamily Opuntioideae which comprises over 300 species. All of them are native from Americas, from USA to Argentina. This species grow in arid (less than 250 mm annual precipitation) and semi-arid areas (250 to 450 mm annual precipitation). This plant is highly adaptable and therefore, can be found in wide variety of weather.^{1, 2}

Botanical Characteristics:

Opuntia spp. cactus are up to 16.4 feet with flattened cladodes (pads) with very few quantity of spines. Its flowers are yellow to orange from 2.8 to 3.937 inches. The fruits are called prickly pear fruit or "tuna" .

Primary Uses: Traditionally and nowadays, cladodes and fruits are used for different functional purposes in foods, beverages, cosmetics and as a source of natural colors. Several investigations reveal its broad functional properties for foods.

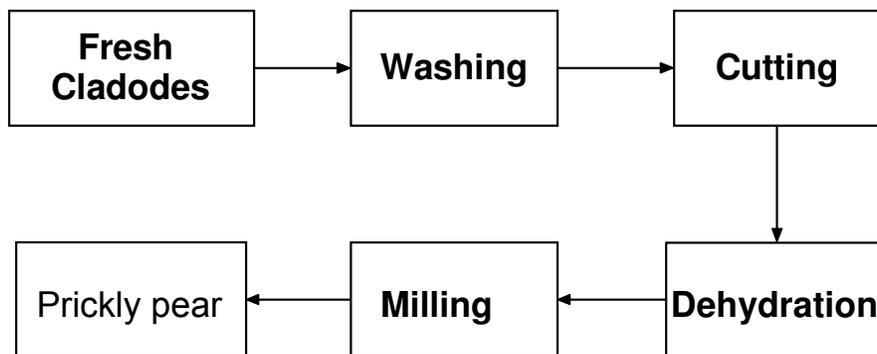
Process Description

Prickly pear was particularly developed as a suitable product for its application in wide variety of products.

Prickly pear is a concentrate of dehydrated *Opuntia* spp. that is obtained by selection, washing, cutting, dehydration and milling of prickly pear cactus cladodes.

The dehydration process of prickly pear is designed to keep the bioactivity of compounds from *Opuntia* spp. of that are responsible for its multiple health benefits.

Concentration rate: 1 kg of prickly pear is obtained from 12.5 –15 kg from fresh *Opuntia* spp. cladodes.



Flow Sheet for production of Prickly pear

General Characteristics

The rate of absorption of water is an important parameter because as its water retention capacity increases the size of the bolus and satiety effect increase. Generally, as the particle size decrease, water retention increase. This parameter depends mainly on the particle size and it can be set in the milling process.

The low water content in dehydrated Prickly pear powder makes it suitable for mixing with other flours such as wheat. Either way, the amount of water in the dried powder may be modified during the drying process. (Lecaros, 1997)

The ash content of prickly pear powder consists mainly in calcium and potassium in considerable amounts. Few foods have high levels of potassium, so the dried *Opuntia* spp. powder is a good source of this mineral to the diet. The low sodium content is especially important for application in wide variety of products. (Saenz et al., 1997)

The color of prickly pear is pale green, not very intense and therefore is easy to change with the addition of natural colors contained in chocolate or caramel when it is added to other food products such as desserts, biscuits, supplements, etc.

The rheological behavior of this ingredient when added to a liquid is affected by the quantity of powder in the suspension.

The viscosity properties of prickly pear can be modified in the drying process for particular needs in a great variety of products.

Typical dietary fiber profile of dehydrated Opuntia spp. Opuntia spp. are an excellent source of dietary fiber both soluble and insoluble. To obtain its benefits. For this reason, prickly pear powder could be added to unlimited food and food supplements.¹² The presence of both types of fiber in the ingredient makes healthy and balanced products according to the soluble and insoluble fiber profile, which different properties.

Table 4 . Typical dietary fiber profile dehydrated Opuntia spp. (Saenz et al. (1997))

Fiber Type	Quantity (%)
Insoluble Fiber	28.45
Soluble Fiber	14.54
Total Dietary Fiber	42.9

By means of its composition analysis, it was determined the great potential of prickly pear for its application in food, pharmaceutical and cosmetic products.

Table 1: Typical Chemical composition of Opuntia spp. ^{1,2}

Components	Dry Basis (g / 100g total)	Wet Basis (g / 100g total)
Water	-	88-95
Carbohydrates	64-71	3-7
Ash	19-23	1-2
Fiber	18	1-2
Protein	4-10	0.5-1
Lipids	1-4	0.2

Table 2: Typical Composition of Opuntia spp. (Muñoz de Chavez et al, 1996) ⁴

Item	Content /100 g
Energetic Content (kcal)	27
Proteins (g)	1.70
Fat (g)	0.30
Carbohydrates (g)	5.60
Sodium (mg)	2.0
Potassium (mg)	166.0
Calcium (mg)	93.0
Iron (mg)	1.60
Thiamine (mg)	0.03
Riboflavin (mg)	0.06
Niacin (mg)	0.30
Ascorbic Acid (mg)	8.00
Retinol (mcg)	260.00

The composition varies depending on cultivation area, season and age of the plant. The above typical compositions is referred to average and spineless Opuntia spp. cladodes.

Table 3: Chemical Composition: *In terms of isolated compounds from Opuntia ficus-indica.*

Isolated Compounds from Opuntia ficus-indica			
Name	Compound Type	Part of the Plant	References
	Mucilage	Cladodes	32, 35
Rhamnose	Monosaccharides	Cladodes and Fruits	34, 36
Galactose	Monosaccharides	Cladodes and Fruit	34, 36
Xylose	Monosaccharides	Cladodes and Fruits	34, 36
	Glucans	Cladodes	34
	Glicoprotein	Cladodes	34
Pectin		Fruits	26, 32
Galacturonic Acid		Fruits	26, 34
Saccharose	Disaccharide	Fruits	27, 33, 36
Glucose	Monosaccharides	Fruits	27, 33, 36
Fructose	Monosaccharides	Fruits	27, 33, 36
	Aldehydes	Fruits	28
	Alcohols	Fruits	28
	Lactones	Fruits	28
	Esters	Fruits	28
Beta-Fructofuranosidase	Enzyme	Fruits	29
Betalaine	Alcaloid		30
Indicaxantine	Betaxantin		30
Betanine	Betaxantin		30
Isobetanine	Betaxantin		30
Glycoside betalainic	Betaxantin	Fruits	30
Betaine	Betaxantin	Fruits	31
Isobetaine	Betaxantin	Fruits	31
Sorbitol	Polisaccharides	Fruits and Seeds	33
Linoleic Acid	Fatty Acid	Fruits and Seeds	33
Oxalic Acid	Acid	Fruits	36
Tartáric Acid	Acid	Fruits	36
Cítric Acid	Acid	Fruits	36

Compounds Isolated from Opuntia ficus-indica. Carmen Alonso. Plantas Medicinales de México II. ⁵⁸



Functional Properties

Hypoglycemic properties

Human studies in the 80es demonstrated glucose and insulin levels in healthy fasting subjects were stable when eating *Opuntia cladodes*. The positive contribution to overall health in diabetes mellitus type II (non-insulin-dependent diabetes) patients was assumed to be due to a reduced postprandial sugar absorption. Following a glucose challenge test, the increase in insulin and glucose were retarded. Also, the glucose and insulin plasma levels were reduced. After 10 days of cladode ingestion prior to meals, a significant reduction of the serum glucose level was noticed.^{40, 14}

Since these effects did not depend on glucagon, cortisone, and human growth hormone levels, which are closely interrelated with glucose metabolism, a gastric enterohormone was held responsible for the hypoglycemic effect.⁴⁰ Although the responsible principle could not be elucidated by^{39,41-42} the hypoglycemic effect stayed away when the pancreatic tissue was removed from the animals prior to *O. streptacantha* ingestion.⁴² In an earlier report, the unidentified anti-diabetic factor was assumed to be of steroidal nature, presumably a saponin.⁵

At present, two species are the most frequently used: *Opuntia ficus-indica* (L.) Mill., popularly named "nopal" or "nopal de Castilla", and *Opuntia streptacantha* Lem, popularly known as "nopal" or "nopal xoconoxtle". Both species are also the Mexican anti-diabetic plants most clinically and experimentally studied. Traditional preparations from both species have been evaluated in temporarily hyperglycemic rabbits, in alloxan-diabetic rabbits, normal volunteers and type II diabetic patients. In these studies, results suggest that the hypoglycemic effect produced by *O. ficus-indica* could be explained by a mechanism that reduces the intestinal absorption of glucose (fiber effect). On the other hand, the hypoglycemic activity suggested for *O. streptacantha*, predominantly has been associated with the existence of hypoglycemic substances producing activity after their absorption.³⁷

The efficiency of cladode preparations was underlined by who investigated the hypoglycemic potential of *O. ficus-indica* cladodes on non-insulin-dependent diabetics. Both fried and and raw despined cladodes showed this therapeutic effect.³⁹

The application of an ethanol extract from ground *O. megacantha* cladodes (20 mg/100g body weight over the period of 5 weeks) resulted in a weight decrease in diabetic animals, which could not be observed in healthy individuals. In both groups, the plasma glucose levels were decreased by about 20%.³⁸



In feeding trials with pigs, diabetic individuals exhibited reduced blood glucose levels 1 h after ingestion of an extract from *O. lindheimeri* Engelm. When 250 mg extract per kg body weight were applied, a 24% glucose decline was registered while at a 500 mg dose, even a reduction by 42% was noted. Since diabetic pigs develop the same secondary injuries as humans such as microvascular eye and kidney damage as well as proliferating nonresponsiveness to insulin, this model should be preferred to tests.⁴³

The soluble dietary fiber is associated with control of glucose concentrations and therefore diabetes. (Periago et al, 1993; McPherson, 1992).¹²

These effects deserve special attention since the populations of developed countries are increasingly suffering from obesity and diabetes symptoms urgently requiring effective countermeasures.⁴³⁻⁴⁷

Anti-hyperlipidemic and anti-hypercolesterolemic effect

The anti-hyperlipidemic effect after cladode ingestion was investigated only in recent studies⁴⁸⁻⁵². In general, a prolonged period of satiety was registered after cladode consumption. In a series of studies with Guinea pigs, Fernández et al.⁴⁹⁻⁵¹ demonstrated that the reduction of blood lipids was attributed to a pectin from *Opuntia* due to its binding bile acid capacity. It was concluded that bile absorption in the colon was also reduced.⁴⁹⁻⁵⁰

The pectin was attributed as responsible for decreasing lipid absorption, blood lipid levels, and finally weight reduction.⁵³

Wolfram et al.⁴⁸ reported a reduction of total cholesterol, LDL, apolipoprotein levels, triglycerides, fibrinogen, blood glucose, insulin and urate. The anti-hyperlipidemic effects were ascribed to the pulp pectin, by means of reducing lipid absorption and increased fecal sterol excretion.

Increase consumption of dietary fiber in the diet (as contained in *Opuntia* spp.) is associated with lower cholesterol levels because apparently dietary fiber causes and accelerates the secretion of bile acids and cholesterol. They bind to the fiber and are eliminated in the feces, reducing the possibility of its reabsorption. (Badui, 2006)⁵⁹

Antioxidant Capacity and atherogenic properties

The total phenols in an ethanolic cladode extract from lyophilized *ficus-indica* var. *saboten* were held responsible for the radical scavenging activity towards superoxide and hydroxyl anions. In addition, a cell growthregulating activity was noted.¹⁵

Decreasing isoprostane levels in urine, serum and plasma as an indicator for oxidative stress and generally improved blood parameters levels were held responsible for the antiatherogenic effect of broiled *O. robusta* pulp.¹⁶

Besides catecholmethyltransferases, the monoamino-oxidases (MAOs) are usually involved in the catabolism of catecholamines, (hormones or neurotransmitters) thus regulating the overall amine pool⁵⁴. In cladodes, methyl esters derived from organic acids were identified as MAO inhibitors¹⁷.

Diuretic effect and impact on uric acid metabolism

A study determined the diuretic activity of *Opuntia ficus indica* (L.) Mill. (Cactaceae) waste matter in rat. Acute and chronic diuretic activity of 15% infusion of cladodes, flowers and fruits were assayed. The results show that *O. ficus indica* cladode, fruit and flower infusions significantly increase diuresis.⁵⁶

A study was conducted to determine the effects of feeding spineless *Opuntia* spp. cladodes on diuresis and urinary electrolyte excretion in goats. Potassium intake increased quadratically (P<0.05) while Na intake decreased quadratically (P<0.05) as the level of *Opuntia* spp. cladodes in the diet increased. Water intake from feed and urine output increased linearly (P<0.05) as the level of *Opuntia* spp. cladodes in the diet increased. Plasma urea concentration decreased linearly (P<0.05) as *Opuntia* spp. cladode level in the diet increased urinary concentrations of creatinine, urea and K decreased linearly (P<0.05) as the level of *Opuntia* spp. cladodes in the diet increased. A tendency for a linear decrease (P=0.06) in uric acid concentration was also noted as a result of *Opuntia* spp. cladode inclusion.

Similar effects have also been reported for *O. megacantha* leaves' extract (Bwititi et al., 2001a). Ingestion of *O. megacantha* increased water intake and urine volume (Bwititi et al., 2001b)³⁸.

Diuretic properties of *Opuntia* spp. can partly be attributed to the effects its high K concentration exerts on renal epithelia (Galati et al., 2002).³⁸ Drugs and plants with diuretic activities are characterized by high K:Na ratio (Szentmihalyi et al., 1998). The K:Na ratio for dietary treatments in our study ranged between 19:1 and 26:1 which is within the range reported for diuretic drugs and plants (i.e. 5:1 to 615:1) (Szentmihalyi et al., 1998).⁵⁷

Antiulcerogenic Effect

Furthermore, Lee et al.¹⁹⁻²⁰ postulated an antiulcerogenic effect of the cladode or fruit powder from *O. ficus indica* var. *saboten* Makino. Stomach lesions triggered by hydrochloric acid/ethanol or hydrochloric acid/acetylsalicylic acid were reduced. The secretion rate of both gastric juice as well as the pH value remained constant. Galati et al.²² confirmed these results. However, the protective effect was ascribed to the cladodes' hydrocolloid



acting as a buffer, spreading out on the gastric mucosa and increasing mucus production by enhancing the number of secretory cells.¹⁹⁻²²

Antiinflammatory Properties

An ethanolic extract of the cladodes demonstrated a fast regeneration of the tissue was attributed to inflammation inhibition, stimulation of the fibroblast migration with accelerated collagen formation and faster healing process.²³⁻²⁵

A base cream containing 15% lyophilized cladodes and a commercial ointment on the wound produced on the backs of rats was studied. The treatment was carried out for 3 and 5 days.

After three days of treatment, the scar tissue is evident, both fibers and fibroblasts in the derma are properly arranged. The dermal vessels are reduced in lumen and the keratinocytes show proliferation areas. In the 5 days' treatment, the wound healing process is almost completed and the piliferous bulbs are recovering. Complete epithelization occurs. Evidently, the *O. ficus-indica* treatment accelerates wound healing, probably by involving the proliferation and migration of the keratinocytes in the healing process.

Results of experiments show, it is evident that in animals with nontreated wounds, the cutaneous layers show typical characteristics of the healed scars. Indeed, veins with a dilated lumen and the presence of inflammatory cells are very evident; in the superficial area underneath the scar no keratinocytes can be detected.

In samples treated with the commercial preparation, the veins are wide with a good organization of the collagen fibres. A thin layer of migrated keratinocytes can be seen underneath the scar. In the more advanced stages of healing (5 days' treatment) a reorganization of piliferous bulbs occurs.

Treatment with the preparation containing the lyophilized *Opuntia ficus-indica* cladodes produces a better and more organized tissue reconstruction due to an improved organization of the dermal constituents.

Indeed, from the first stage of the healing process, an ordered disposition of the collagen fibres can be seen, as well as the vascular neo-formations, which are characterized by the presence of smaller, and more numerous dermal veins than those in the control animals (Brown et al., 1992; Norris et al., 1982).

Opuntia ficus-indica cladodes contain a polysaccharide fraction (Karawya et al., 1980), and various reports show that polysaccharides from different plants can be responsible for the effects associated with the healing of wounds. Some polysaccharides have an influence on the immune system and the polysaccharides, all coming from plants used for wound healing in folk medicine, can influence the complement system (Tomoda et al., 1981; Yamada et al., 1991 a,b,c).

Besides the angiogenesis is an essential process in wound healing (Brown, et al., 1992; Norris, et al., 1982), and it is known that some angiogenic activators have been shown to promote wound healing. These activators could be a low-molecular-weight component of

cladodes (Lee et al., 1998) as monosaccharide residues, polyphenols or β -sitosterol, that is the predominant sterol in Cactaceae (Salt et al., 1987).

This study demonstrates that the treatment accelerates wound healing. Probably, *Opuntia ficusindica* cladode components are capable of maintaining high humidity of the wound-dressing interface, but perhaps they also could influence inflammation, fibroplasias, and collagen synthesis.⁵⁵

References:

1. Mohamed-Yasseen, Y., Barringer, S. A., Splittstoesser, W. E.,. A note on the uses of *Opuntia* spp. in Central/North America. *J. Arid Environ.* 1996, 32, 347 –353.
2. Nobel, P. S., *Environmental Biology*, in: Barbera, G., Inglese, P., Pimienta-Barrios, E. (Eds.), *Agro-ecology, Cultivation and Uses of Cactus Pear*, FAO-Plant Production and Protection Paper, Rome 1995, 132, pp. 36–48.
3. Saravia, T.P. 2004. Cluster del nopal. Programa Fundamental para el Desarrollo Económico del Estado de México hacia el 2005 y de Competitividad Visión 2020.
4. Muñoz de Chávez, Miriam; *Tablas de valor nutritivo de los alimentos de mayor consumo en México*; Editorial Pax México; 1996; Primera reimpresión; Pág.92.
5. Cruse, R. R., *Desert Plant Chemurgy: a current review.* *Econ.Bot.* 1973, 27, 210–230.
6. Domínguez López, A., *Revisión: Empleo de los frutos y de los cladodios de la chumbera (Opuntia spp.) en la alimentación humana.* *Food Sci. Technol. Int.* 1995, 1, 65–74.
7. Hamdi, M., *Prickly pear cladodes and fruits as a potential raw material for the bioindustries.* *Bioprocess Engineer.* 1997, 17, 387–391.
8. Meyer, B. N., McLaughlin, J. L., *Economic uses of Opuntia.* *Cactus Succulent J.* 1981, 53, 107–112.
9. Viguera, G. A. L., Portillo, L., *Uses of Opuntia species and the potential impact of Cactoblastis cactorum (Lewpidoptera:Pyralidae) in Mexico.* *Florida Entomol.* 2001, 84, 493 –498.
10. C.Sáenz, et al. *Cactus pear fruit: A new source for a natural sweetener.* Kluwer academic Publishers. *Plant Foods for Human Nutrition* 52: 141–149, 1998.

11. Florian C. Stintzing and Reinhold Carle. Cactus stems (*Opuntia* spp.): A review on their chemistry, technology, and uses. N Hohenheim University, Institute of Food Technology. November 12, 2004
12. Sáenz.C; Cladodes: A source of dietary fiber. Facultad de Ciencias Agrarias y Forestales.Universidad de Chile. 117-122. 1997.
13. Pimienta-Barrios, E., Vegetable cactus (*Opuntia*), in: Williams,J. T. (Ed.), Pulses and Vegetables, Chapman & Hall, London 1993, pp. 177 –191.
14. Meckes-Lozyoa, M., Roman-Ram_s, R., *Opuntia streptacantha*,a coadjutor in the treatment of Diabetes mellitus. Am. J. Chinese Med. 1986, 14, 116–118.
15. Lee, J.-C., Kim, H. R., Kim, J., Jang, Y.-S., Antioxidant property of an ethanol extract of the stem of *Opuntia ficusindica* var. *saboten*. J. Agric. Food Chem. 2002, 50, 6490 –6496.
16. Budinsky, A.,Wolfram, R., Oguogho, A., Efthimiou, Y., Stamatopoulos,Y., Sinziger, H., Regular ingestion of *Opuntiarobusta* lowers oxidation injury. Prostagland. Leukotr. Ess. Fatty Acids 2001, 65, 45 –50.
17. Han, Y. N., Choo, Y., Lee, Y.-C., Moon, Y.-I., Kim, S.-D.,Choi, J.-W., Monoamine oxidase B inhibitors from the fruitsof *Opuntia ficus-indica* var. *saboten*. Arch. Pharmacol Res.2001, 24, 51–54.
18. Vieira, L., Batista, A.M., Mustafa, A.F., Effects of feeding high levels of cactus (*Opuntia Ficus-indica* Mill) cladodes on urinary output and electrolyte excretion on goats. Livestock Science 2007, 1-4.
19. Lee, E. B., Hyun, J. E., Li, D. W., Moon, Y. I., The effect of *Opuntia ficus-indica* var. *saboten* fruit on gastric lesion and ulcer in rats. Nat. Prod. Sci. 2001, 7, 90–93.
20. Lee, E. B., Hyun, J. E., Li, D. W., Moon, Y. I., Effects of *Opuntia ficus-indica* var. *saboten* stem on gastric damage in rats. Arch. Pharmacol Res. 2002, 25, 67–70.
21. Galati, E. M., Monforte, M. T., Tripodo, M. M., D’Aquino, A., Mondello, M. R., Antiulcer activity of *Opuntia ficusindica* (L.) Mill. (Cactaceae): ultrastructural study. J. Ethnopharmacol. 2001, 76, 1–9.
22. Galati, E. M., Pergolizzi, S., Miceli, N., Monforte, M. T.,Tripodo, M. M., Study on the increment of the production of gastric mucus in rats treated with *Opuntia ficus indica* (L.) Mill. cladodes. J. Ethnopharmacol. 2002, 83, 229 –233.

23. Park, E.-H., Kahng, J.-H., Paek, E.-A., Studies on the pharmacological actions of cactus: Identification of its anti-inflammatory effect. *Arch. Pharmacol Res.* 1998, 21, 30–34.
24. Park, E.-H., Kahng, J.-H., Lee, S. H., Shin, K.-H., An anti-inflammatory principle from cactus. *Fitoterapia* 2001, 72, 288–290.
25. Galati, E. M., Mondello, M. R., Monforte, M. T., Galluzo, M., Miceli, N., Tripodo, M. M., Effect of *Opuntia ficus indica* (L.) Mill. cladodes in the wound-healing process. *J. Profess. Assoc. Cactus Develop.* 2003, 5, 1–16.
26. Forni, E. et al., *Carbohidrat Polym.* 23 (4) 231, 1994.
27. Kutti, J. O. et al., *J. Food Sci.* 59 (2) 3878, 1994.
28. Di Cesare, L.F. et al., *Fluess. Obst.* 59 (1) 6, 1992.
29. Ouelhazi, n.k. et al, *Phytochemistry* 31 (1) 59, 1992.
30. Forni, E. et al., *J. Chromatogr.* 593(1-2) 177, 1992.
31. Piatelli, M. et al., *Phytochemistry* 3 (5) 511, 1964.
32. Karawya, M. S. et al., *Planta (Suppl)* 68, 1980.
33. Lercher, G. et al., *Riv. Ital. Sostanze Grasse* 53 (10) 250, 1976.
34. Paulsen, B.S., *Phytochemistry* 18 (4) 569, 1979.
35. Mc. Garvie, D. et al., *Carbohydr. Res.* 88 (2) 305, 1981.
36. Shalaby, A. F. et al., *Egypt J. Chem.* 24 (4-6) 295, 1981.
37. Roman-Ramos, et al., Hypoglycemic Activity of Two Polysaccharides Isolated from *Opuntia ficus-indica* and *O. streptacantha*. Health & Biological Sciences Division, Health Sciences Department, Metropolitan Autonomous University, Iztapalapa Campus, 1999.
38. Bwititi, P. T., Machakaire, T., Nhachi, C. B., Musabayane, C. T., Effects of *Opuntia megacantha* leaves extract on renal electrolyte and fluid handling in streptozotocin (STZ)-diabetic rats. *Renal Failure* 2001, 23, 149–158.
39. Frati, A. C., Gordillo, B. E., Altamirano, P., Ariza, C. R., Cortes-Franco, R., Chavez-Negrete, A., Acute hypoglycemic effect of *Opuntia streptacantha* Lemaire in NIDDM. *Diabet. Care* 1990, 13, 455–456.
40. Muñoz de Chávez, M., Chávez, A., Valles, V., Roldán, J. A., The nopal: a plant of manifold qualities. *World Rev. Nutr. Dietetics* 1995, 77, 109–134.
41. Frati, A. C., Jimenez, E., Raffil Ariza, C., Hypoglycemic effect of *Opuntia ficus indica* in non insulin-dependent Diabetes mellitus patients. *Phytother. Res.* 1990, 4, 195 – 197.
42. Ibañez-Camacho, R., Meckes-Lozoya, M., Mellado-Campos, V., The hypoglycemic effect of *Opuntia streptacantha* studied in different animal experimental models. *J. Ethnopharmacol.* 1983, 7, 175–181.
43. Campbell, R. K., White, J. R. jr., Insulin therapy in type 2 diabetes. *J. Am. Pharmaceut. Assoc.* 2002, 42, 602–611.

44. Costacou, T., Mayer-Davis, E. J., Nutrition and prevention of Type 2 diabetes. *Ann. Rev. Nutr.* 2003, 23, 147–170.
45. Jones, R., Insulin resistance, diet and cardiovascular disease: a review. *Food Agric. Environ.* 2003, 1, 26–29.
46. Nourparvar, A., Bulotta, A., Di Mario, U., Perfetti, R., Novel strategies for the pharmacological management of type 2 diabetes. *Trends Pharmacol. Sci.* 2004, 25, 86–91.
47. Yeh, G. Y., Eisenberg, D. M., Kaptchuk, T. D., Phillips, R. S., Systematic review of herbs and dietary supplements for glycemic control in diabetes. *Diab. Care* 2003, 26, 1277–1294.
48. Wolfram, R. M., Kritz, H., Efthimiou, Y., Stomatopoulos, J., Sinzinger, H., Effect of prickly pear (*Opuntia robusta*) on glucose- and lipid-metabolism in non-diabetics with hyperlipidemia – a pilot study. *Wiener Klin. Wochenschr.* 2002, 114, 840–846.
49. Fernández, M. L., Trejo, A., McNamara, D. J., Pectin isolated from prickly pear (*Opuntia* sp.) modifies low density lipoprotein metabolism in cholesterol-fed guinea pigs. *J. Nutr.* 1990, 120, 1283–1290.
50. Fernández, M. L., Lin, E. C. K., Trejo, A., McNamara, D. J., Prickly pear (*Opuntia* sp.) pectin reverses low density lipoprotein receptor suppression induced by a hypercholesterolemic diet in guinea pigs. *J. Nutr.* 1992, 122, 2330–2340.
51. Fernández, M. L., Lin, E. C. K., Trejo, A., McNamara, D. J., Prickly pear (*Opuntia* sp.) pectin alters hepatic cholesterol metabolism without affecting cholesterol absorption in guinea pigs fed a hypercholesterolemic diet. *J. Nutr.* 1994, 124, 817–824.
52. Palumbo, B., Efthimiou, Y., Stamatopoulos, J., Oguogho, A., Budinsky, A., Palumbo, R., Sinzinger, H., Prickly pear induces upregulation of liver LDL binding in familial heterozygous hypercholesterolemia. *Nuclear Med. Rev.* 2003, 6, 35–39.
53. Shapiro, K., Gong, W. C., Natural products used for diabetes. *J. Am. Pharmaceut. Assoc.* 2002, 42, 217–226.
54. Eisenhofer, G., Kopin, I. J., Goldstein, D. S., Catecholamine metabolism: a contemporary view with implications for physiology and medicine. *Pharmacol. Rev.* 2004, 56, 331–349.
55. Galati., Mondello., Monforte., Galluzzo., Miceli., Tripodo. Effect of *Opuntia ficus-indica* (L.) Mill. Cladodes in the Wound-Healing Process . Department of Organic and Biological Chemistry, University of Messina., 2003.
56. E.M. Galati, M.M. Tripodo, A. Trovato, Miceli, M.T. Monforte. Biological effect of *Opuntia ficus indica* (L.) Mill. (Cactaceae) waste matter Note I: diuretic activity; *Department of Organic and Biological Chemistry and Pharmaco-Biological Department* ,University of Messina. 2002.
57. Szentmihalyi, K., Kery, A., Then, M., Lakatos, M., Sandor, Z., Vinkler, P., 1998. Potassium sodium ratio for the characterization of medicinal plants with diuretic activity. *Phytother. Res.* 12, 163–166.
58. Alonso, Carmen; Ochoa, Francisco; Rodríguez, Baldomero; Essayag, Rachel. *Plantas Medicinales de México II Primera Edición.* Dirección General de Publicaciones y Fomento Editorial 1999. Nopal de Castilla Páginas 121-122.



59. Badui, Salvador. Química de los Alimentos. Cuarta Edición. Pearson Educación de México, 2006. Fibra Página 108.