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Opuntia plants nutritive and medicinal value: a review

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Abstract

The scientific name *Opuntia* identifies a succulent plant native to Mexico. It is now widespread in the United States, South America and the Mediterranean basin, where it has found a suitable terrain for naturalization. It is a species of cactus popularly known as Nopal in Mexico and "Fico d'India" in Italy. Cladodes, the branched leaves of the plant, are paddle shaped and covered in short spines that enable it to absorb even the tiniest drop of water. A specific and well known type of *Opuntia*, called *Opuntia ficus-indica*, can be recognized by its typical yellow flowers and is appreciated for its fleshy fruit with a pleasant taste, rich in nutrients but low in calories. It is used as a foodstuff and in particular to produce juices, jellies and other edible products. The *O. ficus-indica* is also well known as a source of vitamins, especially vitamin C, calcium and phosphorus and in smaller quantities of other minerals and various essential nutrients, including antioxidants. The cladodes are the part of the plant from which the extract is used to aid weight control and as a cosmetic ingredient with an emollient and soothing action. The spongy tissues of the cladodes contain high concentrations of high molecular weight polysaccharides, which are relevant for the specific properties commonly attributed to this common succulent plant. This review presents several medicinal benefits, which can be obtained using cladodes, fruits and flowers of the different *Opuntia* species.

Keywords**:** *antimicrobial activities; cactus; medicinal fruits; Opuntia; sustainable agriculture; therapeutic uses.*

1. Introduction

The Cactaceae family, among the 350 families of flowering plants, is one of the newest and, precisely because of its flowers, is believed to be descended from the rose family. However, the rough, spiny surface makes it difficult to see the resemblance. Although, when cacti are in full bloom, the kinship with roses is more prominent. Based on plant form, cacti are, in turn, subdivided into three subfamilies, including the *Opuntia* genus, which is further classified into species (Akacha, Badraoui, Rebai, & Zourgui, 2022; Zhao, Lan, Huang, Ouyang, & Zeng, 2011). As a whole, around 2000 species of cactus get classified. Cacti are succulent plants, as they are capable of retaining and storing water for long periods. Since they grow in arid habitats, they must be able to draw on their reserves when water is scarce. Cacti absorb water through a pervasive surface root system and are, also able to capture surface moisture (Aliscioni, Delbón, & Gurvich, 2021; Zaedi, Karimi, & Venditti, 2021). In the hostile desert habitat, it is essential that the plant can replenish its water reserve quickly and effectively. Once absorbed, the moisture is attracted to the plant's storage cells, chemically transforming into mucilage, which evaporates less quickly than watery sap (Aragona, Lauriano, Pergolizzi, & Faggio, 2018; Attanzio et al., 2018). In addition, the stem of the cacti is covered with a waxy layer that seals the moisture inside, preventing it from evaporating. At the same time, the branches swell to retain excess liquid and

contract during dry periods when the plant draws on its reserves. Most cacti that have colonised desert environments have turned their leaves into spines, to have structures adapted to the environment, in particular to reduce transpiration and lose less water, and with the function of deterring animals that might feed on the vegetative structures to obtain water (Aliscioni et al., 2021). The spines also create considerable shade and act as heat dispersal points, protecting the body of the plant, which causes an internal temperature 10 °C lower than that of a plant without spines (Ávila-Gómez, Meléndez-Ramírez, Castellanos, Zuria, & Moreno, 2019; Babitha, Bindu, Nageena, & Veerapur, 2019).

The prickly pear cactus, (*Opuntia ficus-indica* (L.) Mill.), is one of the main species of the genus *Opuntia*, plants belonging to the Cactaceae family, native to the Americas, where they are widespread in arid tropical and subtropical areas (Wright, & William, 2014). The prickly pear now grows wild throughout the Mediterranean basin, including Italy, and is the only species naturalized in Europe. Opuntias have a rare characteristic in the plant kingdom: not only do they have edible flowers and fruit, but also part of the stem can be eaten, and they can also be used to make protective fencing, paper and handicrafts (Benattia, Arrar, Dergal, & Khabbal, 2019; Berrabah, Taïbi, Abderrahim, & Boussaid, 2019; Blando, Russo, Negro, De Bellis, & Frassinetti, 2019; Sottile et al., 2021). For this reason, and because of their extraordinary ability to thrive in some of the most hostile habitats on Earth, opuntias have been a dietary staple of the native people of the Southwestern United States, those who later settled in Central and South America, as well as inhabitants of parts of Europe and the Middle East (Contino et al., 2022). In many varieties, *Opuntia* was not only enjoyed as a food but also as a medicine (Bouhrim et al., 2019; Chakale, Asong, Struwig, Mwanza, & Aremu, 2022; de Wit, du Toit, Osthoff, & Hugo, 2019). The Spanish conquerors of Mexico were the first Europeans to experience opuntias' benefits in treating sailors suffering from scurvy, the terrible disease caused by vitamin C deficiency. Nowadays, scientific research confirms what ancestral cultures have always known: opuntias can heal (Saroj, Singh, & Kumar, 2018).

Opuntias can be found in mountainous areas, even at considerable heights, in jungles, along the sea, in subtropical areas, and arid and semi-arid regions (Griffith, 2004). The native habitat of the prickly pear is the desert, rarely exceeding twenty years. They propagate quickly, efficiently regenerating leaves, root calluses and seeds throughout the year because they are perennial plants. Some botanists consider them the most tenacious and adaptable of the cacti (Aruwa, Amoo, & Kudanga, 2018; Elkady. Bishr, Abdel-Aziz, & Salama, 2020). It is no coincidence, therefore, that opuntias have rapidly naturalized and spread in numerous territories: in Africa, where they are cultivated from Morocco to South Africa, in Italy, Israel, Spain, the United States, Mexico, Colombia, Brazil, Peru, Bolivia, Chile and Argentina.

In the Cactaceae family, *Opuntia* spp. (Figure 1) is the wealthiest genus in terms of subgenera, variety of shapes, sizes and colours, and is the one that grows most easily because the plants do not need to be cultivated or irrigated and can withstand the harshest climatic changes. The two main branches of the *Opuntia* are the *Platyopuntia*, to which the prickly pear belongs, and the *Cylindropuntia*. The *Platyopuntia* are recognizable by their flat stems, also called blades or nodes, which grow apart. The main difference between the two *Opuntia* families is the way the stems are structured: the *Platyopuntia*, in order to support the blades, develop a network of fibres that can be easily cut; the *Cylindropuntia*, on the other hand, branch out into a woody stem that is very difficult to cut. Another difference is the goodness of the fruit: the fruit of the *Platyopuntia* is a delicacy with a taste very similar to watermelon, although pulpier and dotted with tiny black seeds; the fruit of the *Cylindropuntia*, instead, tastes so bad as to be inedible. A further difference between these two families is related to all that lies inside the blades. By exerting light pressure on the trunk of the *Platyopuntia*, a bitter, sticky juice can be extracted, which can be drunk in times of emergency as a water and mineral resource; this type of drink is used by various South American populations also as a medicinal source due to the presence of metabolites such as flavonoids and carotenoids. On the other hand, the *Cylindropuntia* has a much more complex trunk, rich in thorns and with tissues lacking mucilage, from which water and mineral sources are difficult to obtain. Plants are not classified by their traits but rather by the elements, each has in common with others in the same family. A common feature of opuntias is that each species has small tufts of bristles, called glochids, growing

at the top of each wart. Opuntias may not be thorny, but they are always covered with glochids, tiny protuberances ending in hooked teeth, sometimes as thin as peach fuzz, but very irritating and difficult to remove, often causing more significant problems than thorns.

The main objective of this review is to describe the botany of *Opuntia* genus, emphasizing the medicinal capacities of the flowers and fruits of this plant, as information in the literature is often false or inaccurate (Escobedo-Hinojosa et al., 2018; Figueroa-Pérez, Pérez-Ramírez, Paredes-López, Mondragón-Jacobo, & Reynoso-Camacho, 2018; Githae, 2018; Gouws, Mortazavi, Mellor, McKune, & Naumovski, 2020; Guerrero, Majure, Cornejo-Romero, & Hernández-Hernández, 2019; Stintzing, & Carle, 2005).

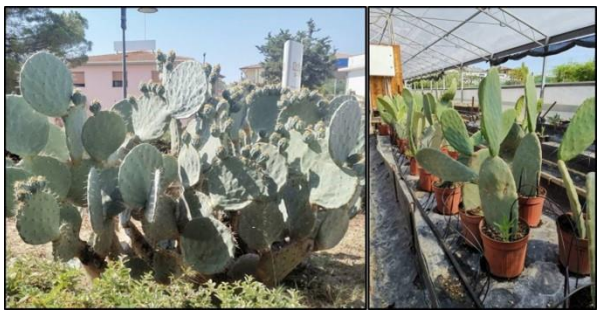

Figure 1 *O. ficus-indica* in an ornamental garden and cultivation greenhouse

2. Medicinal properties of prickly pears and other *opuntias*

In the *Opuntia* spp. paddles are a storehouse of nutrients: they contain a good amount of minerals such as potassium, magnesium, calcium and iron. Furthermore, they are rich in antioxidant vitamins, such as pro-vitamin A, in the form of β-carotene, found in quantities similar to spinach, as well as vitamin C in high amounts (Table 1-2) (Izuegbuna, Otunola, Bradley, 2019; Khazdair, Anaeigoudari, Hashemzehi, & Mohebbati, 2019). In addition, shovels contain the full range of amino acids and elements necessary for protein formation, including the eight essential amino acids the human body cannot produce but must take in with food (Table 3) (Kim, & Lim, 2019; Koshak et al., 2021). The benefits of consuming amino acids are far-reaching: proteins are involved in the interactions of many chemicals within the body. It is sporadic for a plant to provide a variety of amino acids, such as that found in opuntias. This extraordinary feature multiplies the benefits of a nutritious, fibre-rich, low-fat food. Vegetarians can find a high quality source of protein in the blades (nopales) (Figure 2) (Li et al., 2020; López-Romero et al., 2018; Madrigal-Santillán et al., 2022).

Table 1 Nutritive value of prickly pears (100g) (Knishinsky, 2004).

Minerals	mg	Vitamins	mg
Ca	56	Vitamin C	14
Fe	0,3	Thiamine	0,01
Mg	85	Riboflavin	0,06
P	24	Niacin	0,5
K	220	Vitamin B6	0,06
Na	5	Folates	6
Cu	0,08	Vitamin B12	0
Se	0,6	Pro-vitamin A	51
Zn	0,12	Vitamin E	0,01
Calories	40		
Lipid (g)	0,5		
Cholesterol (mg)	0		
Carbohydrates (g)	9,6		
Dietary fibres (g)	3,6		
Protein (g)	0,7		

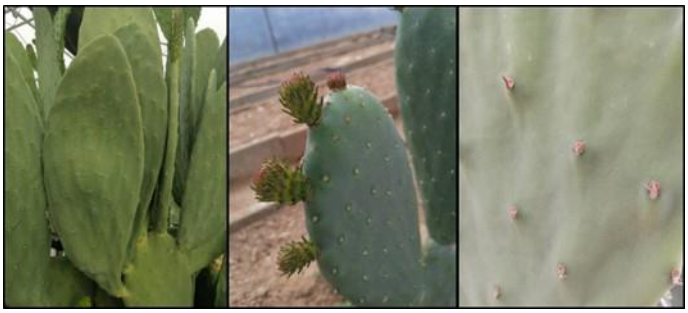

Figure 2 Paddles, glochids and thorns of *O. ficus-indica*

Table 2 Nutritional value of *Opuntia* spp. paddles (100 g) (Knishinsky, 2004).

Minerals	mg	Vitamins	mg
Ca	163	Vitamin C	13
Fe	0,7	Thiamine	0,01
Mg	58	Riboflavin	0,04
P	17	Niacin	0,5
K	319	Vitamin B6	0,07
Na	22	Folates	3
Cu	0,06	Vitamin B12	0
Se	0,7	Pro-vitamin A	415
Zn	0,3	Vitamin E	0,002
Calories	16		
Lipid (g)	0		
Cholesterol (mg)	0		
Carbohydrates (g)	3,3		
Dietary fibres (g)	2,3		
Protein (g)	1,2		

Table 3 Amino acid content of *Opuntia* spp. paddles (Knishinsky, 2004).

Essential amino acids	mg/g	Non-Essential amino acids	mg/g
Histidine	0,08	Alanine	3,95
Isoleucine	2,53	Arginine	1,26
Leucine	5,14	Aspartic acid	0,32
Lysine	4,50	Cystine	0,16
Methionine	0,80	Glutamic acid	1,66
Phenylalanine	2,88	Glycine	4,50
Threonine	1,38	Proline	3,48
Valine	4,31	Serine	0,36
		Thyrosine	2,05

The stem of Opuntia spp. is composed of cladodes, commonly referred to as blades: these are modified stems, flattened and oval-shaped, 30 to 40 cm long, 15 to 25 cm wide and 1.5 to 3.0 cm thick, which, when joined together, form branches. The cladodes ensure chlorophyll photosynthesis, vicariating the function of the leaves. They are covered with a waxy cuticle that limits transpiration and provides a barrier against predators. The basal cladodes, around the fourth year of growth, undergo lignification to form a true stem. The true leaves have a conical shape and are only a few millimetres long. They appear on the young cladodes and are ephemeral. At the base of the leaves are the areoles (about 150 per cladode) which are modified axils, typical of the Cactaceae. The meristematic tissue of the areola can be differentiated into spines and glochids as appropriate, it can give rise to adventitious roots, new cladodes or flowers. Nopales, or cactus blades/paddles, are the pads of the prickly pear cactus.

In 2022, the Journal of the American Pharmaceutical Association published a study on using herbal products by Latin American

populations. The authors report that Opuntia spp., besides being a typical food in Latin American people, is one of the most studied hypoglycaemics (Medina-Pérez et al., 2019). Patients, who were asked whether they used nopal for its hypoglycaemic properties, as a food or for both purposes, answered in most cases that they used it both as a food and as a remedy; only a low percentage of respondents used it exclusively as a food (Mouhaddach, El-hadi, Taghzouti, Bendaou, & Hassikou, 2018; Prisa, 2020). Furthermore, they generally stated that they use nopal regularly, once every two days, as part of their diet or when they notice high sugar levels. Recent studies on Opuntia spp. have investigated its properties as an anti-diabetic remedy, and several published studies have documented the effectiveness of using Opuntia spp. blades in treating type II diabetes. The studies have provided positive results, showing a significant hypoglycaemic effect in patients with non-insulin-dependent diabetes mellitus. Research has also shown a reduction in glucose assimilation and an improvement in insulin response, subsequently demonstrating that the blades' high flavonoid content helps reduce undesirable low-density lipids. An essential component of opuntias appears to be soluble fibre, mainly in mucilage and pectins. Mucilages are the sticky liquid, scientifically named mucilaginous polysaccharides that come out of the cut blade.

3. Opuntia fruits and flowers: a concentrate of vitamins and minerals

At the end of summer, the fruits ripen, depending on the species, in colour (green, red or purplish) and size (5 to 6 cm in length and 2 to 3 cm in diameter). The fruits are kiwi-like shape and are sold in their spiny skin or already peeled in sealed trays. The fruit contains few calories and is one of the tastiest parts of the Opuntia spp., ideal for those who want to keep their weight under control (Kuti, 2004). In Italy, the prickly pear can be found in supermarkets and exotic fruit shops. It is cultivated, sold and exported, both fresh and dried, in many countries: Mexico, Colombia, Chile, Honduras, Israel, Nicaragua and Italy. In Israel, which successfully exports prickly pears, the fruit is called sabra, a word that also refers to Jews born in Israel (Quiroz, Varnero, Cuevas, & Sierra, 2021). The Opuntia spp. fruit is rich in cofactors that strengthen the immune system. It contains significant amounts of calcium, magnesium, potassium, and a considerable percentage of antioxidant compounds, including flavonoids (Li et al., 2020; López-Romero et al., 2018; Madrigal-Santillán et al., 2022; Kuti, 2004; Atiya et al., 2021). Like blades, the fruit has a high content of pro-vitamin A in the form of β-carotene and vitamin C (Stintzing, & Carle, 2005). In recent years, Opuntia spp. fruits have been received careful interest in research showing positive correlations between their consumption and lower blood sugar levels (Guevara-Figueroa et al., 2010). Several studies have confirmed that daily intake of Opuntia spp. fruits produces positive effects. For instance, Opuntia dillenii (Ker. Gawl.) has been shown to have an anti-diabetic effect on laboratory rabbits, lowering blood glucose, mainly by reducing glucose absorption from the intestine (Guevara-Figueroa et al., 2010). Studies conducted in Arizona show significant effects on cholesterol metabolism, with a reduction in plasma, mainly due to a decrease in low-density lipoproteins (Stintzing, Herbach, & Mosshammer, 2005). These findings suggest that Opuntia spp. pectin may reduce the body's response to glucose. In spring, yellow, orange or pink flowers grow from the fruit body of the Opuntia. Like the blades and fruits, the petals of the flowers also contain active substances rich in healing properties, mainly flavonoids. Like the rose hips, Opuntia flower petals are harvested, dried and sold, either loose or in sachets, in the form of capsules or liquid extracts.

4. Medicinal uses of the *Opuntia* plant

Opuntia spp. is mainly used for topical applications (Zito et al., 2013). The mucopolysaccharide gel of *Opuntia* pulp is very hydrophilic and hypertonic; part of the exuded fluid formed in the wound is absorbed osmotically by the *Opuntia* spp. (Stintzing et al., 2005) through the skin, while the gel softens the skin, reducing tension and pain in the injured area. Several species can be used with therapeutic activities (Da Silva, de Sousa, Silva, Flach, & Fernandes de Moura, 2022). *Nopalea cochenillifera* (L.) Salm-Dyck (1850) is found in southern Mexico; this Cactaceae has a long tradition of splitting its stems and using the mucilaginous pulp as a poultice for toothache and earache against rheumatism and eye inflammation (Quinto et al., 2019). In Trinidad, it is used as an emollient on burns and inflamed skin. *Opuntia elatior* Mill is native to Costa Rica and Panama. Of this plant, the stem without the bark is used, which

is tied to the sole and seems to have an antipyretic effect. Studies on the application of *O. ficus-indica* have shown that this plant can improve the symptoms of benign hypertrophy of the prostate (Fernández-López, Almela, Obón, & Castellar, 2010). A high percentage of subjects reported a decreased urge to urinate, while the feeling of fullness in the bladder and urine leakage subsided. The mucilaginous pulp of the stems of the *Opuntia stricta* (Haw.) and *O. dillenii* (Ker Gawl.) species is used to relieve the burning sensation when urinating. Other applications including the treatment of gastric ulcers and anti-inflammatory activity (Reda, & Atsbha, 2019; Medina, Rodríguez, & Romero, 2007). An aqueous extract of *Opuntia streptacantha* (Lem.) was found to be effective in inhibiting intracellular replication and inactivating extracellular viruses. Inhibition of virus replication also occurred in the treatment of preinfection, an exciting finding for the in vivo limitation of viral diseases (Ahmad, Davies, Randall, & Skinner, 1996). In addition, virus DNA and RNA were inhibited in simple herpes, equine herpes, pseudomonas herpes, influenza, respiratory syncytial virus and human immunodeficiency virus while maintaining normal protein synthesis in uninfected cells (Ahmad et al., 1996). The components in *Opuntia* with inhibitory activity against viruses and bacteria appear to be natural proteins located in the plant wall rather than in the cuticle or internal sap; this is important because, in this case, the blades do not have to be peeled before use (Ahmad et al., 1996). While the mechanisms of action of the extract's active components remain unknown, the researchers believe that the active component could be the protein, thus distinct from the flavonoid alkaloid group of viral inhibitors (Remes-Troche et al., 2021). For the treatment of diabetes or controlling blood sugar levels, blades of the varieties *O. streptacantha* and *O. ficus-indica* are often indicated (Table 4) (Ibanez-Camacho, Meckes-Lozoya, & Mellado-Campos, 1983). In order to achieve an anti-diabetic effect, it is necessary to heat the extracts or the entire stem before administration; however, based on positive tests, some studies have shown the effectiveness of using fresh, raw blades (Zhao et al, 2011). A daily dose of 5 to 9 g per day of pectin from the *Opuntia* spp. fruit may be effective in preventing or reversing hypercholesterolaemia (Table 5). Studies have shown that even lower doses of pectin, such as 2.50 g per day, have proven effective.

5. Other pharmacological activities of *Opuntia* spp.

In southern Italy, the *Opuntia* plant is frequently used for gastrointestinal problems. Some experiments on mice have shown significant effects in treating gastric ulcers. The application of freeze-dried *Opuntia* protects the gastric mucosa due to the action of the mucilage contained in the cladodes. In addition, mucilage prevents necrosis formation (Shirazinia et al., 2021; Silva et al., 2021; Smeriglio, De Francesco, Denaro, & Trombetta, 2021; Tahir, Xiaobo, Komla, & Adam Mariod, 2019).

Table 4 Effect of *O. streptacantha* (250 mg per day) after eight weeks of treatment on fasting glucose and insulin (Ibanez-Camacho et al., 1983).

Week	Glucose mg/dl	Week	Insulin mg/dl
Control	204	Control	99
1	146	1	73
2	122	2	36
4	118	4	8
6	135	6	50
8	105	8	38

Table 5 Effect of *O. dillenii* on plasma cholesterol in rats (Lim, & Lee, 2000)

Cholesterol (mg/dl)	Control	Aqueous extract	Ethanol extract
Triglycerides	130,80±5,67	113,40±7,83	116,80±5,72
Total plasma cholesterol	197,60±3,05	186,80±6,05	187,60±3,51
HDL lipoproteins	35,40±4,04	40,0±1,58	41,40±2,07
LDL lipoproteins	136,04±4,23	123,92±4,17	122.84±4,17
VLDL lipoproteins	26,16±2,16	22,28±0,96	23,36±1,14

The presence of pectin can undoubtedly influence the regeneration of the gastric mucosa by regenerating a gastrointestinal tissue. Furthermore, research shows an increase in protective gastric mucus (Tranquilino-Rodríguez, Martínez-Flores, Rodiles-López, Dios Figueroa-Cárdenas, & Pérez-Sánchez, 2020). Treatment with cladodes of *O. ficus-indica* may block the agents that cause stomach damage. Some research has shown that Opuntia's analgesic and anti-inflammatory activity after using fruit extracts or lyophilized cladodes (Figure 3). The active ingredient β-sitosterol is commonly suggested as the primary anti-inflammatory, although its action is usually weaker than cortisone (Cárdenas, Arguelles, & Goycoolea, 1998). *O. ficus-indica* is also used for its protective activity of neural cells due to flavonoids, which can protect the neural system (Tsafantakis et al., 2019). Some flavonoids, such as quercetin, may exert neuroprotective activity against N-methyl-d-aspartate and kainate in rat and gerbil cortical cells (Ibanez-Camacho et al., 1983). Effects have also been shown in neural lesions in gerbils. Prickly pear fruit extracts are being studied to reduce cancer proliferation in the human reproductive system, particularly in the cervix, ovary and bladder (Stintzing, & Carle, 2005; Veeramani kandan et al., 2021). Experiments demonstrate the inhibition of prickly pears on cancer cells influenced by dose and time of application (Valero-Galván et al., 2020; Welegerima, Zemene, & Tilahun, 2018). In animals, the use of *Opuntia* has not resulted in contraindications. Inhibition of cancer cell development in vitro is associated with an increase in apoptotic cells and a cell cycle arrest. The application of betaine extracted from *Opuntia* fruits decreased k562 cell proliferation in human chronic myeloid leukaemia (Guevara-Figueroa et al., 2010). All these studies suggest that the use of *Opuntia* extracts may influence: (i) the reduction of cell proliferation, which plays an essential role in the metastatic invasiveness of tumours; (ii) the induction of apoptosis; (iii) intervention in metabolic activity that produces carcinogens by scavenging ROS (Zeghbib, Boudjouan, Vasconcelos, & Lopes, 2022; Hernández-Urbiola, Pérez-Torrero, & Rodríguez-García, 2011). The use of extracts derived from *Opuntia* also seems to have an effect in reducing the symptoms of alcohol hangovers by reducing symptoms such as nausea, headache or dry mouth. The continued use of freeze-dried cladodes also appears to affect liver problems related to organophosphorus insecticides in mice (Astello-García et al., 2015). Studies have shown that using *Opuntia* can lead to a recovery of liver activity, protecting the liver and decreasing pesticide-related toxicity. Some extracts of *Opuntia dejecta* (Salm-Dyck) have been evaluated for their antioxidant activity (Zouaoui et al., 2021). The extracts showed dose-dependent antioxidant activity against free and hydroxyl radicals. In addition, protection against plasma DNA against strand breakage and reduction of glucose-mediated cytotoxidase are shown. The high amount of phenols present in this plant appears responsible for its antioxidant activity (El-Mostafa et al. 2014). A summary of the main antioxidants contained in the different *Opuntia* spp. species is described in (Table 6).

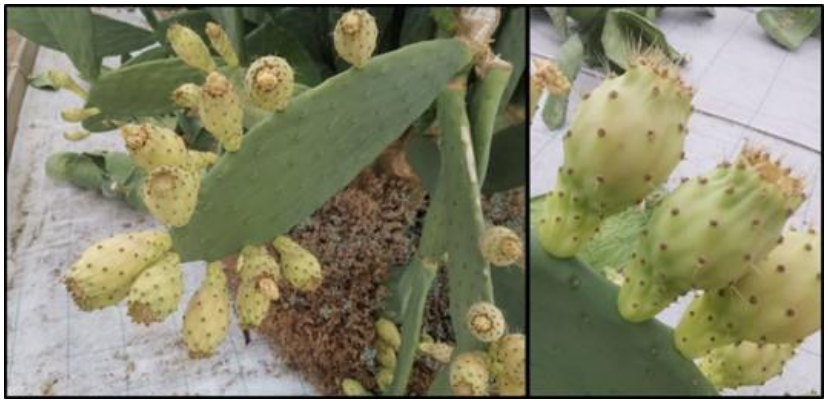

Figure 3 *O. ficus-indica* fruits

Table 6 Antioxidants compounds present in *Opuntia* species (Díaz, de La Rosa, Héliès-Toussaint, Guéraud, & Nègre-Salvayre, 2017).

Species	Region	Chemical and Natural compounds
O. albicapa	Mexico	Phenolic acid Flavonoids Betalains Ascorbic acid
O. ficus indica	Mexico Spain Italy Portugal	Phenolic acid Flavonoids Quercetin Betacyanins glucoside Piscidic acid
O. atropes	Mexico	Phenolic acid Flavonoids
O. hyptiacantha	Mexico	Phenolic acid Flavonoids
O. dillenii	Spain Taiwan Egypt	Phenolic acids Ascorbic acid Flavonoids Catechin Epicatechin Quercetin Betacyanins Isoramnetin-3-*O*-rutinoside
O. leucotricha	Mexico	Phenolic acid Flavonoids
O. lindheimeri	Mexico USA	Phenolic acid Kaempferol Quercetin Isorhamnetin Ascorbic acid
O. megacantha	Mexico Argentina Marocco	Phenolic acids Flavonoid Betalains
O. rastrera	Mexico	Phenolic acids Kaempferol Isorhamnetin
O. robusta	Mexico	Phenolic acids Flavonoids Betalains Ascorbic acid Kaempferol Isorhamnetin
O. streptacantha	Mexico USA	Phenolic acids Flavonoids Kaempferol Isorhamnetin Betalains Ascorbic acid
O. stricta	Spain USA	Phenolic acids Betalains Ascorbic acid
O. violacea	Mexico	Phenolic acids Flavonoids
O. elatior	Mexico	Phenolic acids Flavonoids Ascorbic acid
O. dejecta	Mexico	Phenolic acid Betalains Flavonoids

6. Conclusions

The results highlighted in this review demonstrate the medicinal properties of the paddles, fruits and flowers of *Opuntia* plants. Several studies have shown that the use of *Opuntia* fruits and mucilage can have beneficial effects on human health. Fascinating studies are related to the benefits that extracts of this plant can provide for gastric, neurological, inflammatory, reproductive, glycaemic and weight-related problems. The data presented shows that *Opuntia* spp. can have long-term beneficial effects on gastric, neurological, tumour, inflammatory, reproductive, glycaemic and weight-loss issues.

Improved cultivation techniques and analytical approaches will undoubtedly improve the promotion of prickly pear stems, fruits and blades for food, medicinal and cosmetic purposes. An increase in demand would encourage growers to increase the cultivation areas dedicated to this plant, with increased benefits in terms of soil protection and reduction of CO_2 in the atmosphere. Further studies are underway in the medicinal and industrial fields to make the most of the structure and fruits of this plant, which still does not seem to be fully exploited.

7. Acknowledgements

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