Volume 3, Issue 2, 2024, Page 803-816

International Journal of Pharma Research and Technology

Cactus as a Medicinal Plant: A Review

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Abstract

The Cactus is one of the most widely distributed plants in the xeric environment and has special characteristics. The major species of cacti used for livestock include opuntia ficus-indica Mill. opuntia lindheimeri Engelm, opuntia ellisiana, opuntia engelmannii Salm Dyck, opuntia chrysacantha Berg, opuntia amyclae, opuntia rastrera Weber, opuntia stricta Haw, and Nopalea cochenillifera Salm Dyck. Cactus species are plants that grow in the arid and semiarid regions of the world. Certain opuntia species are found in the wild, and while the fruit of these species is unfit for human consumption, the plants can serve as animal fodder. Its composition includes essential nutrients including taurine and betalains, as well as minerals, vitamins, and antioxidants. As a result, the food and nutraceutical industries can make great and diverse value-added products from it.

Keywords: Cactus, Opuntia, Cactus pear, Cactaceae, Antioxidant, Physico-chemical Composition, Pharmacological Properties

Introduction

Drylands occupy approximately 40 % of terrestrial surface and 2 billion people live in these areas. Furthermore, in certain parts of the world, climate change is raising temperatures as well as the frequency and intensity of droughts (FAO, 2019). A valuable source of fodder for dry and semiarid areas is cacti. The wild cactus population in Mexico determines the use of cacti as fodder. In other countries such as Brazil, Tunisia, South Africa, and Morocco, cactus fodder is produced in cultivated or-chards, which could have a multi-use purpose (fruit/forage/industrial processed products) or only fodder. For ruminants and other types of animals, it provides energy and water, especially during the dry season of the year. In semiarid areas, cacti serve as a reserve of live fodder and are a valuable resource for boosting food security (Ben Salem et al., 2002). Even in environments where other forms of fodder are limited, cacti yield a large quantity of succulent biomass with a good palatability (Ben Salem et al., 2002). Cacti use a photosynthetic process called cactus acid metabolism, or CAM (Leegood, 2013). Cacti often have lower dry matter concentrations (5–15% DM), crude protein, and fibre (ADF, acid detergent fibre, and NDF, neutral detergent fibre). They also typically have higher digestibility than other forages found in warm climates. (Batista et al.,

2009; Monteiro et al., 2018; In´Acio et al., 2020) .The term Cactus is derived from an ancient Greek word ‘kaktos’, which was used by Theophrastus to demarcate the spiny plants. Since cacti are the most common wild and ornamental plant in the Cactaceae family, they are very valuable economically. 'New world' plants is another name for them (Shetty et al., 2012). Because it contains 14% glucose, it is also regarded as an energy source (Salim et al., 2009).It displays CAM metabolism physiologically, which primarily has a mechanism to withstand environmental stress. Lack of access to water (Gibson and Nobel, 1986; Anderson, 2001; Bensadón et al., 2010). Cacti's stems undergo morphological modification to become fleshy, flat, cylindrical, or globular, and to form cladodes. Bats, birds, and insects assist in pollination and seed distribution (Gibson and Nobel, 1986; Godúnez-Alvarez et al., 2002; Godý´nez-Alvarez, 2004). Cacti, also known as cactuses or cactus, are a unique type of plant that is found in dry regions all over the world. The Cactaceae family, which includes 124 genera and 1438 species worldwide, is mostly found in tropical regions (Del Socorro Santos-Díaz and Camarena-Rangel, 2019). For example, even before Christopher Columbus arrived in America, cactus was used as food, medicine, and cosmetics (Lema-Rumińska and Kulus, 2014; Shetty, Rana, and Preetham, 2012). Some commercial items are made primarily from cactus species, like soaps and shampoos. De Lucena et al. (2013) suggest that food items such as cakes, biscuits, sweets, puddings, and candies can be obtained from cactus.

Table No.1: Scientific Classification

Kingdom	**Plantae**
Clade	Tracheophytes
Clade	Angiosperms
Clade	Eudicots
Order	Caryophyllales
Family	Cactaceae
Subfamilies	Cactoideae Maihuenioideae Opuntioideae pereskioideae

The History of Succulents and Cacti

The Name's Origin

The word "cactus" is derived from the Greek word "kaktos," which was a general term for the Native American Cactaceae and was used to refer to a species of thorny thistle in classical Greek. The remarkable capacity of succulent plants to hold onto water is why they got their name.

The Past Eternal

Since the time of the Incas in Peru and the Aztecs in Mexico, cacti and succulents have been known about. They saw them as a vital sign for divination, beauty items, healing, and feeling at one with their gods. Mexico City

was once known as Tenochtitlan, which translates to "place of the sacred cactus." They may have used plant representations as decorations on their structures, ceramics, and other uncovered artefacts.

European Discoveries

It wasn't until the 14th and 15th centuries that cacti garnered serious scientific attention. The first melocactus was introduced to Europe by Christopher Columbus. Since the plants he found are native to the Americas, they are referred to as "New World Plants." On the other hand, every continent that supports life has cacti and succulents. Aloes and other "Old World Plants" are present in Africa.

Various Uses of Cactus

Cactus Use as Fruit

The fruits of cactus vary in weight from 50 to 150 gm depending on the environmental conditions and its origin. It's an elongated, oval-shaped berry. The pulp is the edible portion of the extremely thick per carp. It is mostly composed of water (84–90%) and reducing sugar (10–15%). opuntia ficus indica fruits are consumed in many different ways. The fruit is often referred to as pitaya or "dragon fruit." Some cacti, like opuntia tuna, Opuntia streptacantha, and Opuntia cardona, are frequently farmed for their fruit. Because of their high pH (which ranges from 5.3 to 7.1) and low acidity, cactus fruits have a limited shelf life. (2012), Shetty et al. Fruits contain nutrients, vitamins, and amino acids. Typically, 54.18% of the fruit is edible (Bekir, 2004). Within cacti are betalains.

Cactus Use as Vegetables

The young or tender vegetative parts of wild cactus which lack glochids and spines are used as vegetables and salads (Russell and Felker, 1987)

Cactus Use as Fodder

In regions where there is a risk of drought, the spines are burned and fed to cattle. Despite having a low protein level, it is used as dairy cattle fodder in semi-arid climates. It imparts good flavour to milk and imparts good colour to butter (Salimetal, 2009).

Traditional Uses of Cactus Plant

Different parts of opuntia monacantha Haw. Can be used to treat different types of diseases. Its fruit is used to cure gonorrhoea and syphilis; its mucilage is used to treat piles, pox strains, rheumatism, and leprosy; its stem is used as a cathartic and to treat diarrhoea. Its latex is used to treat constipation (Arshad et al., 2014; Chetry et al., 2018). The fruit of opuntia ficus-indica is used in Italy as a diuretic, and for digestive disorders, while in Mexico it is used to treat wounds; in Morocco to treat stretch marks and wrinkles; in Turkey for joint dislocation, tonsillitis, and anemia; in India as an antispasmodic, diuretic, emollient, astringent, treatment for diarrhea, colitis, irritable bowel syndrome, and benign prostatic hypertrophy; (Ahmet Sargin, 2015; de la Cruz, Malpartida, Santiago, Jullian, and Bourdy0, 2014; Erbay, Anıl, and Melikoğlu, 2016; Khan and Ahmad, 2015; Maroyi, 2017; Messaoudi et al., 2015; Pandita, Pandita, and Pandita, 2013; T. Tuttolomondo et al., 2014). in Peru for liver and kidney inflammation. Only amoeba, catarrh, cough, and whooping cough were treated with melocactus bahiensis (Britton and

Rose) Luetzelb, a plant primarily found in northern and eastern Brazil (de Lucena et al., 2013). Opuntia engelmannii Salm- CTDyck ex Engelm is common in south-central and southwestern United States and northern Mexico. Its use as a medicinal plant for diabetes was only reported in Mexico (Estrada-Castillón et al., 2018).

Medicinal Uses

- **The Anti-cancer properties of cacti**

The cactus pear fruit extract demonstrated its anti-cancer properties by preventing the growth of in vitro cell lines that represent bladder, ovarian, and cervical cancer. (Camacho-Chab et al., 2016).

- **Antioxidant effect**

The fruits and vegetative parts of different varieties of cactus, largely opuntia contains many antioxidants Examples include taurine, cysteine, reduced glutathione, ascorbic acid, and flavonoids including isorhamnetin, kaempferol, and quercetin (Tesoriere et al., 2005)

- **Antiviral effect**

The cactus stem extract of Opuntia streptacantha has the ability to inhibit the intracellular replication of DNA and RNA viruses in both people and animals, including HIV, equine herpes virus, pseudorabies virus, influenza virus, and herpes simplex virus type 2 (Ahmad et al., 1996).

- **Anti-inflammatory effect**

Because of its analgesic and anti-inflammatory properties, genus opuntia has been employed. Opuntia dillenii fruit extract (Loro et al., 1999) and lyophilized cladodes have both been used for their anti-inflammatory properties**.**

- **Antidiabetic effect**

Italian herbalists are now employing species of Opuntia to lower blood sugar levels (Cicero et al., 2004). On non-diabetic rats, diabetic induced rats, and diabetic humans, the prickly pear extract has a hypoglycemic effect (Ibanez-Camacho et al., 1979; Ibanez-Camacho et al., 1983; Frati-Munari et al., 1988; Frati et al., 1990).

- **Anti-hyperlipidemic and hypercholesterolemic effect**

The consumption of cactus pear extract lowers cholesterol in humans and modifies low density lipoprotein (LDL) (Gurbachan and Felker, 1998; Fernandez et al., 1992; Frati, 1990; Stintzing et al., 2001; Stintzing and Carle, 2006)

Cholesterol

Both the cactus pad and the fruit of the cactus are high in fir, which can lower cholesterol levels in the blood.

Blood sugar

According to some research, individuals who regularly consumed cactus pads had lower blood sugar levels than those who did not. To ascertain the causes of this, more investigation is required.

Immune system

Vitamin C is one of the best things for boosting the immune system, and cactus fruits are a great source of it. Frequent vitamin C

dosages boost white blood cell synthesis, which aids in the body's ability to combat viruses.

Digestion

Cacti have high potassium and betalain content, which is beneficial for digestion. While betalains are anti-inflammatory and aid in the protection of your digestive tract, potassium aids in the body's absorption of nutrients.

Pharmacological Properties of Cactus Plant

- **Antimicrobial potential**

Opuntia ficus-indica cladode extract, both immature and mature, shown antibacterial efficacy against both Gram-negative (Escherichia coli, Salmonella enterica ser. Typhimurium Enterobacter aerogenes) and Gram-positive bacteria (Enterococcus faecalis, Staphylococcus aureus). (Blando, Russo, Negro, De Bellis, and Frassinetti, 2019). Seed oils from opuntia albicarpa and opuntia ficus-indica exhibited antibacterial activities against Escherichia coli, Staphylococcus aureus, Listeria monocytogenes, Pseudomonas aeruginosa and antifungal activity against Saccharomyces cerevisiae and Candida albicans (Ramírez-Moreno et al., 2017). The methanolic leaf extract of Pereskia grandifolia exhibited antibacterial activity against Pseudomonas aeruginosa, Staphylococcus aureus, and Philip et al. (2009) identified Bacillus subtilis.

- **Antiviral potential**

Opuntia streptacantha's cladode extract shown antiviral activity against human immunodeficiency virus, herpes simplex, horse herpes, pseudorabies, influenza, and respiratory syncytial viruses, as well as both DNA and RNA viruses. The extract rendered the extracellular virus inactive and prevented the production of the intracellular virus. (Ahmad, Davies, Randall, and Skinner, 1996).

- **Antioxidant Capacity**

The by-products obtained from cladodes and fruits of opuntia ficus-indica exhibited antioxidant potential as studied by ABTS and FRAP assays (Bensadón, Hervert-Hernández, Sáyago-Ayerdi, and Goñi, 2010). The antioxidant potential is attributed mainly to the existence of phenolic substances like as ferulic acid, rutin, and isorhamnetin, etc. that are effective radical scavengers Galati, Enza Maria, and others (2003).

- **Antidiabetic potential**

The effect of antidiabetes can be Assigned to the partial reduction of D-glucose intestinal absorption, free radicals quenching, and inhibition of pancreatic β-cells injuries. The aforementioned actions could be caused by the oil that contains oleic and linoleic acids. Similarly, a number of additional investigations have shown that opuntia ficus-indica crude extracts and cooked cactus stems can lower plasma, serum insulin, and postprandial glycemia. glucose-dependent insulinotropic peaks in the diabetic patient (López-Romero et al., 2014; Roman-Ramos, Flores-Saenz, and Alarcon-Aguilar, 1995).

- **Anti-Ulcer Potential**

The methanolic root extract of opuntia ficus-indica f. inermis demonstrated gastro protective ability against an ethanol-induced

ulcer in rats (Alimi et al., 2010). The lyophilized cladodes of opuntia ficus-indica were reported for their anti-ulcer potential in ethanol-induced ulcer in rats. The ultrastructural observations of gastric mucosa revealed the protective action of cladode against ethanol-induced ulcers opuntia ficus-indica's mucilage may have a protective effect (E. M. Galati, Monforte, Tripodo, d'Aquino, and Mondello, 2001).

- **Potential for Cardio protection**

Taking Opuntia ficus-indica ingestion dried leaves exhibited a rapid increase in HDL cholesterol levels concomitantly with a decrease in LDL cholesterol and triglycerides in women affected with metabolic syndrome, indicating the hypocholesterolemic As per Linarès, Thimonier, and Degre (2007), the herb has an effect. According to the results of the randomised clinical trials (RCT) study, opuntia ficus indica supplementation reduced blood pressure, total cholesterol, body fat percentage, and cardiovascular risk factors (Onakpoya, O'Sullivan, and Heneghan, 2015).

- **Neuroprotective potential**

The polysaccharide extracted from opuntia milpa also exhibited neuroprotective activity against cerebral cortex and hippocampal slices from H2O2-induced injury by normalization of neuroprotective biochemical markers like acetate dehydrogenase (LDH), superoxide dismutase (SOD), glutathione (GSH), and total antioxidant competence (T-AOC) level (Xianju Huang, Li, Guo, and Yan, 2008). The polysaccharides isolated from opuntia dillenii exhibited neuroprotective activities against brain ischemia-reperfusion injury in rats under in vivo conditions and. They reduced the oxidative stress-induced damage in the PC12 cells under in vitro conditions (X. Huang, Li, Li, and Guo, 2009). The methanol extract of opuntia ficus-indica furthermore induces neuronal changes in cultures of mouse cortical cells and has a neuroprotective effect against N-methyl-D-aspartate (NMDA), kainate (KA), and OGD oxygen deprivation oxygen (J. H. Kim et al., 2006).

Cactus's Nutritional Importance

Many names for the Opuntia species exist in the many countries where it is found. Nochtli is the original name in the Náhuatl language. Nevertheless, the fruit and shrub were renamed by the Spanish as higo de las Indias (now known as higo chumbo) and chumbera, respectively. It is referred to as ficod'India in Italy, figue de Barbarie in France, and prickly pear in Australia, South Africa, and the US. In an attempt to lessen the negative connotation of the word "prickly," which means "with spines," this is gradually changing into the moniker "cactus pear." It is referred to as sabras in Israel, which translates to "spiny outside but sweet inside." It is referred to as beles in Ethiopia and Eritrea. Depending on the location, it is referred known as nagphani, andatorra, or chapathi balli in various dialects around India. Because it is mostly used for animal feed, it is known as Palma forrageira in Brazil. Sudzuki et al., 1993.

Physico-Chemical Composition

Vitamin

The predominant components, comprising approximately 80% of the total vitamin E content present in fruit pulp, are the vitamin E

homologues, or isoforms gamma- and delta-tocopherol. Antioxidant properties of vitamin E are widely recognised for their potential to enhance the stability of fatty oils. The third main vitamin in cactus pears is ascorbic acid. (Stintzing and Other People, 2000).

Amino Acid

Proline, taurine, and serine are particularly abundant in cactus fruits (Uchoa and colleagues, 1998), while glutamine is the main amino acid found in cactus cladodes, followed by leucine, lysine, valine, arginine, phenylalanine, and isoleucine. Fruit pulp and seeds are excellent providers of proteins and amino acids (El-Mostafa and colleagues 2014).

Mineral Contents

Mineral content of cactus (mg/100g)

Table No.2: Source - El-Mostafa and others 2014

Mineral	Fruit pulp	cladode
Calcium	27.6	5.64 – 17.95
Calcium carbonate	--	11.5 - 14.3
Magnesium.	27.7.	8.80
Sodium.	0.8	0.3-0.4
Potassium.	161	2.35-55.20
Iron.	1.5.	0.09
Phosphorus.	--	0.15-2.59
Zinc.	--	0.08
Manganese	--	0.19-0.29

- **Nutrients per serving**
  A. 1-cup serving of raw, unsalted cactus contains:
- Calories: 24
- Protein: 1.98 grams
- Fat: 0.135 grams
- Carbohydrates: 5 grams
- Fiber: 3.3 grams
- Sugar: 1.72 grams
- (https://www.webmd.com/diet/health-benefits-cactus

Cultivation

- **propagation of Opuntia or cactus plants**

Pick edible Opuntia plants that are close to your field. Opuntia is simply plants that are edible cacti. Cut the Opuntia plant's leaf or a few flat leaves, and then put them in your cactus farm. It yields new plants in a matter of days, and as soon as the plant reaches the vegetative phase, flowering follows.

- **Harvesting in Cactus Farm**

The plant is harvested when it reaches a height of 4 to 6 metres. In order to preserve the cactus leaves' shelf life, gather the flattened leaves during certain times and pack the leaves right away. Cactus leaves do, however, have a longer shelf life than other crops.https://www.agrifarming.in/cactus-farming-cultivation-practices-of cactus#:~:text= The only thing you need is a certain amount of water and upkeep

.**Bioactive Extractable Substance**

Figure No.1: Bioactive Extractable Substance

The extensive body of research indicates that the most common methods for extracting bioactive compounds from cactus plants (fruit pulp and peel, seeds, cladodes, leaves, and flowers) are conventional extraction techniques using organic solvents. However, reports of the application of cutting-edge methods such as SFE (Fathordoobady et al., 2019; Sharif et al., 2015), ultrasound-assisted extraction (Espinosa Muñoz et al., 2017), and sonication (Mena et al., 2018; Moussa-Ayoub et al., 2014) have also been made. Many studies detailed the extraction of bioactive compounds, primarily phenolics and betalains, from Opuntia spp. fruits employing solvents such as acetone (Kıvrak et al., 2018), methanol: water (60:40), ethanol: formic acid: water (50:5:45 v/v/v) (Albano et al., 2015), and Among other things, methanol (80%) was acidified with 1% formic acid (Mena et al., 2018).

- **Various Cactus Types**
  1. Angel Wing
  2. Cacti of the African milk tree
  3. A plant of Christmas cactus
  4. Cactus ladyfinger
  5. Cactus Parado
  6. Rat tail cactus

Figure No. 2: Angel wing

Figure No. 3: African milk tree

Figure No. 4: Christmas cactus

Figure No. 5: Ladyfinger Cactus

Figure No. 6: Parodia cactus

Figure No.7: Rat tail cactus

Conclusion

A cactus is a multipurpose plant that can be used as a fruit, vegetable, fodder, and for traditional purposes as well as for industrial processing. It requires little water to thrive. The cactus' scientific categorization and name origin are also part of its history. The medicinal properties of cacti include their anti-inflammatory, antiviral, antioxidant, anti-cancer, and antidiabetic properties.

Additionally, cacti have an impact on immune system function, digestion, blood sugar, and cholesterol. Cacti's pharmacological qualities, including its antibacterial, antiviral, antioxidant, antiulcer, and neuroprotective potentials, are disclosed.

Cacti are a source of vitamins, amino acids, carbs, fibres, protein, and calories. There was also mention of cactus cultivation and extraction. The many cactus species were also introduced.

Acknoledgement

The authors would like to thank Matoshri Radha College of Pharmacy in Vigaon, Akole, for providing all necessary work facilities.

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