

## Plant *Opuntia dillenii*: A Review on It's Traditional Uses, Phytochemical and Pharmacological Properties

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### Abstract

*Opuntia dillenii* (Cactaceae) is an important medicinal shrub growing under desert and dry conditions. Though almost all of its parts are used in traditional systems of medicines, stem, flower and roots are the most important parts which are used medicinally. This review article gives an account of updated information on its phytochemical and pharmacological properties and reveals that wide numbers of phytochemical constituents have been isolated from the plant which possesses activities like anti-inflammatory, anti-oxidant, Anti Diabetic, Immunomodulatory Effect, Anti-Depressant, Hypotensive Activity, In Acute Liver Injury, Low-density lipoprotein peroxidation, Anti hyperlipidemia Activity, in-vitro Antimicrobial Synergistic, Anti-Tb and various other important medicinal properties. It contains phytoconstituents like flavonoids, phenolic, ascorbic acid, betanin and many other chemical constituents have been isolated.

**Keywords:** *Opuntia dillenii*; Pharmacological activity; Low- density lipoprotein; Betanin

### Introduction

In ancient times, peoples used to inquire the medicinal plants of their living environment for curing sickness and acquired knowledge about the use of plants through trial and error, the people looked for drugs in nature [1]. The medicinal plants have been utilized hundreds to thousands of years to conserve food, cure health ailment and inhibit primary diseases as well as fatal diseases. There was many plants used to the treatment of prophylaxis in 16<sup>th</sup> century [2]. Medicinal plants are also in great demand in the developed countries for primary health care because of their efficacy, safety and lesser side effect. From the previous literature, more than 3.3 billion people in the less residential countries consume medicinal plants on a regular basis [3]. Approximately, 2000 ethnic groups are founded in the world, have the either different medicinal value or chemical composition [4,5].

### *Opuntia dillenii*

Members of the Cactaceae, a family from the Americas, are well known as ornamental plants in all temperate zones of the earth. Many species also show features of practical interest. They have been used in a number of directions, particularly by the inhabitants of their areas of basis for thousands of years [6].

*Opuntia dillenii* (Cactus) common name used to prickly pear and belongs to the family Cactaceae. *chopathi balli* is the common name of plant used in Tamil Nadu. Family Cactaceae is reported to contain about 130 genera and nearly 1500 species, which were originally native to the New World. Cacti have a special carbon dioxide fixation pathway known as Crassulacean acid metabolism (CAM) and are ideally suited to water-scarce dry zones of the world as an alternate source of food and fodder [7-9].

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### Taxonomic Classification [10]

Kingdom	- Plantae (Plants)
Subkingdom	- Tracheobionta (Vascular plants)
Superdivision	- Spermatophyta (Seed plants)
Division	- Magnoliophyta (Flowering plants)
Class	- Magnoliopsida (Dicotyledons)
Subclass	- Caryophyllidae
Order	- Caryophyllales
Family	- Cactaceae (Cactus family)
Species	- <i>Opuntia dillenii</i> (Ker Gawl.) (erect pricklypear)
Genus	- <i>Opuntia</i> Mill. (pricklypear)

### Description [11]

#### Synonyms

AndhraPradesh	-	Nagajemudu, Nagadali
Bengal	-	Nagphana
Gujrat	-	Chorhathalo Nagphan
Himachal Pradesh	-	Chhittarthor
Hindi	-	Hathhathoria, Naghana
Karnatka	-	Papaskalli, Chappatigalli
Kerala	-	Palakakkali
Maharashtra	-	Nagamullu chapal
Orissa	-	Nagophenia
Punjab	-	Chittarthohar
Sanskrit	-	Mahavriksha, Vajrakantaka
Tamilnadu	-	Nagathali, Sappathikalli

#### Geographical source

*Opuntia dillenii* is found wild in abundance in the Himalayas up to 1,500 metres. Roxburgh (1832) considered this plant to be a native of India, whereas Watt (1891) believed it to be of American origin *Opuntia dillenii* originates from south eastern parts of North America, the east coast of Mexico, the Bermudas, the West Indies and from the north of South America. Wild populations are nowadays reported in the same areas [12,13] and additionally at the Gulf Coast of Texas the south eastern coastal margin of Brazil [14] and in Ecuador. The native locations of *O. dillenii* are mostly at an altitude near sea level in sand dunes, at edges of maritime forests or associated with tropical plants [15]. It is found around the Mediterranean [16], on the Canary Islands [17-19], on Madagascar and Mauritius, in North Yemen [20], in India [21,22] in the southeast of Asia and in Australia [12, 20].

#### Morphology [11]

*O. dillenii* is a shrubby, branched from the base, about 1.5m high leaves 3.8 mm long, pale green, conical from a broad base. Joints 30-40 by 15-20 cm, broadly obovate, indulate, not very thick, dull bluish green. Leaves are modified into spines, and their function is taken up by the leaf-like stem; the modified leaves aggregate to form groups of fine bristles, called areoles; the areoles are prickly, the largest one is very stout, sharp and about 2 cm in length; there are about 35 areoles per internode. Flowers, yellow, complete, hermaphrodite, cyclic, epigynous, actinomorphic, 5 to 6 cm in diameter epicalyx with 4 sepals, green, 1.7 cm long, 1.8 cm broad calyx, polysepalous with 4 sepals, yellowish green, 8 mm long, 1.2 cm broad; corolla, polypetalous with 12 petals, regular, superior; Chinese yellow 606, 3.2 cm

long, 1.5 cm broad androecium polyandrous, infinite (with 380 to 450 stamens); versatile, stamens unequal in length (each 8 to 13 mm) gynoecium having an eight-lobed stigma, each lobe about 6 mm long, style 2 cm long; ovary, inferior ovules, numerous. There are around 15 flowers on the topmost internode. Each flower arising from the axil of a scale leaf which falls off earlier, leaving behind a scar at the base. Mature fruits obovoid, bright red-purple to pinkish red, usually extremely juicy, areoles with slender spines or spineless [23].



**Figure 1:** *Opuntia dillenii*.

### Traditional Uses

The fruit is considered a refrigerant, and is said to be useful in gonorrhoeas. In the Deccan, the baked fruit is given in whooping cough. A syrup of the fruit appears to increase the secretion of bile when given in teaspoonful doses three or four times a day and to control spasmodic cough and expectoration. In Dacca, the milky juice is given as a purgative in doses of ten drops mixed in a little sugar. The leaves mashed up and applied as a poultice are said to allay heat and inflammation. The hot leaf applied to boils hastens suppuration, the leaf made into a pulp is applied to the eyes in cases of ophthalmia [11]. The plant enters into the composition of Sushruta's Ksharagada, snake remedy, but no part of the plant is an antidote to snake venom. According to literature, cacti and especially members of the genus *Opuntia* are manifold used [6-25].

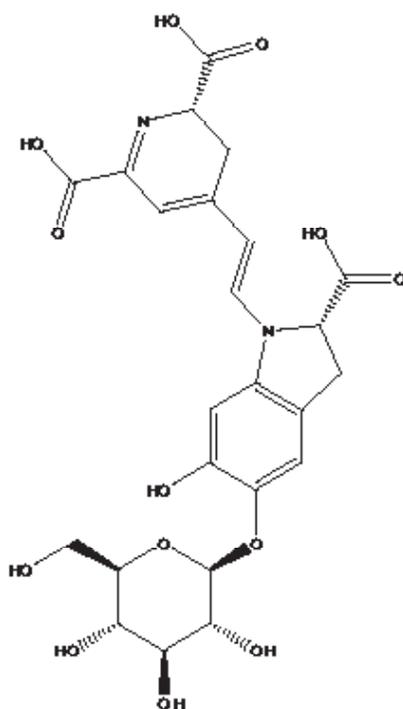
### Phytochemistry

Sciuto, S., *et al.* [26] studied <sup>14</sup>C-labelled betanidin was incorporated into betanin (5-O- $\beta$ -D-glucoside of betanidin) from fruit of *Opuntia dillenii*. This result shows that glucosylation occurs late in the biosynthesis of the pigment and is possibly the last step.

Srivastava, B K, and Pande, C S. [27] isolated polysaccharide in 0.5% yield (based on the weight of the fresh material). The polysaccharide is composed of arabinose and galactose in the molar ratio 1:3. On the basis of the results of oxidation and characterization and estimation of the methylated sugars in the methylated polysaccharide, a probable structure has been suggested for the arabinogalactan.

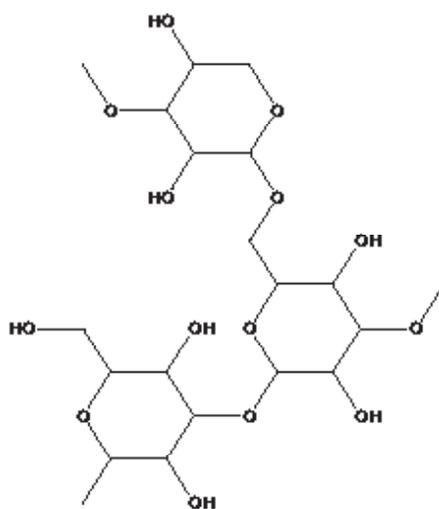
Qiu, Yingkun., *et al.* [28] isolated Six compounds from the stems of *Opuntia dillenii* (Ker-Gawl.) were identified as 3-O-methyl quercetin, kaempferol, kaempferide, quercetin, isorhamnetin and  $\beta$ -sitosterol on the basis of the chemical evidence and spectral analysis. Kaempferol, kaempferide and 3-O-methyl quercetin were isolated from the *Opuntia dillenii* for the first time.

Qiu, Y K., *et al.* [29] isolated from the 80% ethanolic extract of the stems. a new compound 4-ethoxyl-6-hydroxymethyl-alpha-pyrone.

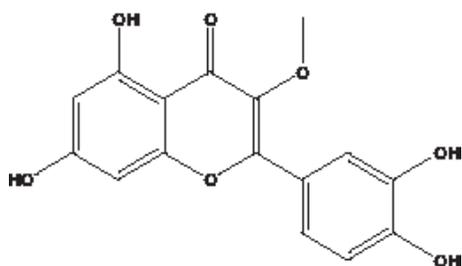


4-(2-(2-carboxy-5-(beta-D-glucopyranosyloxy)-2,3-dihydro-6-hydroxy-1H-indol-1-yl)ethenyl)-2,3-dihydro-(S-(R\*,R\*)))-2,6-pyridinedicarboxylic acid

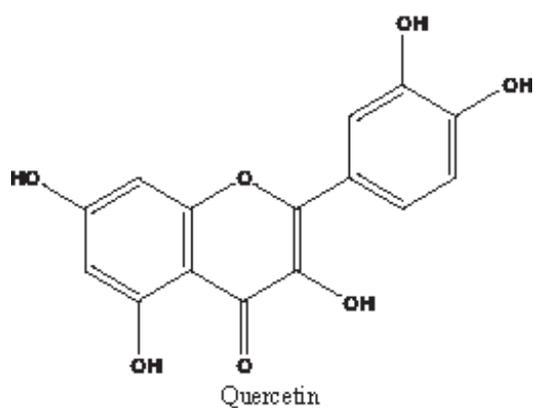
Betanin



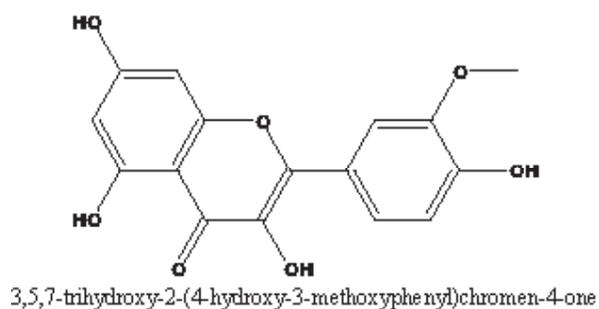
2-[3,5-dihydroxy-2-(hydroxymethyl)-6-methoxyoxan-4-yl]oxy-6-[[3,5-dihydroxy-4-methoxyoxan-2-yl]oxymethyl]-4-methoxyoxane-3,5-diol Arabingalactan



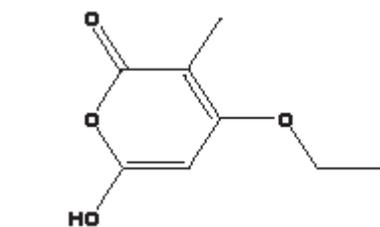
3-o-Methyl Quercetin



Quercetin

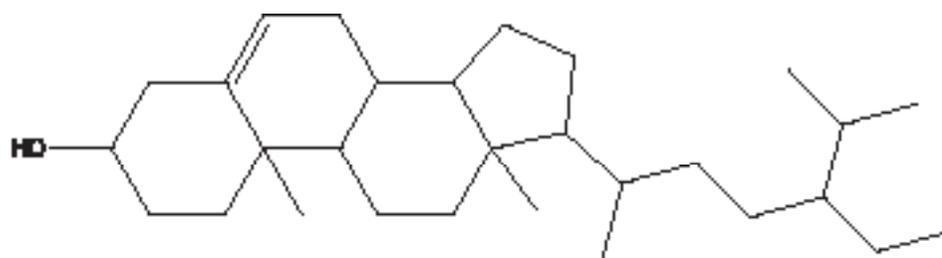


Isorhamnetin

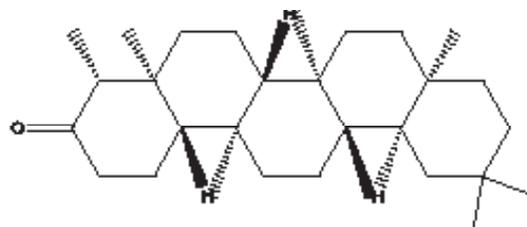


4-ethoxyl-6-hydroxymethyl alpha pyrone

Jianqin, Jiang, *et al.* [30] in their previous phytochemical studies on the plant revealed the presence of polysaccharides, flavonoids, alkaloids and pyranoids were isolated. In this study two new compounds C29-5 $\beta$ -sterols, opuntisterol [(24R)-24-ethyl-5 $\beta$ -cholest-9-ene-6 $\beta$ ,12 $\alpha$ -diol] and opuntisteroside [(24R)-24-ethyl-6 $\beta$ -[( $\beta$ -D glucopyranosyl)oxy]-5 $\beta$ -cholest-9-ene-12 $\alpha$ -ol] together with nine known compounds,  $\beta$ -sitosterol, taraxerol, friedelin, methyl linoleate, 7-oxositosterol, 6 $\beta$ -hydroxystigmast-4-ene-3-one, daucosterol, methyl eucomate, eucomic acid, were isolated from the stems of *Opuntia dillenii* collected in Guizhou Province, China. Their structures were elucidated mainly by spectroscopic analysis. The absolute configuration of opuntisterol deduced from comparative <sup>1</sup>H NMR data of the (S)- and (R)-methoxyphenyl acetate derivatives. Compounds methyl linoleate, 7-oxositosterol, 6 $\beta$ -hydroxystigmast-4-ene-3-one and eucomic acid were isolated from *O. dillenii* for the first time [26,31-35].

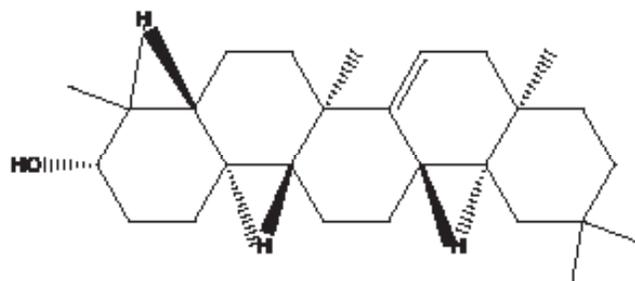


17-(5-Ethyl-6-methylheptan-2-yl)-10,13-dimethyl-2,3,4,7,8,9,11,12,14,15,16,17-dodecahydro-1H-cyclopenta[a]phenanthren-3-ol



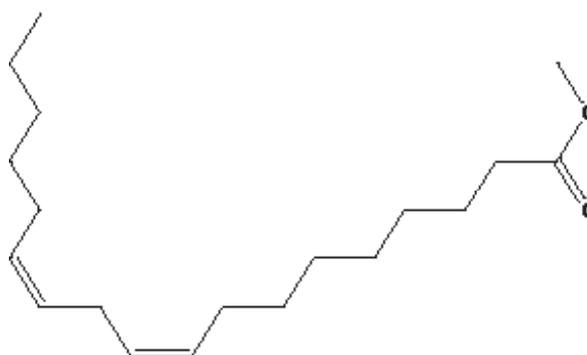
(4R,4aS,6aS,6bR,8aR,12aR,12bS,14aS,14bS)-4,4a,6b,8a,11,11,12b,14a-octamethylcosahydropicen-3(2H)-one

Friedelin



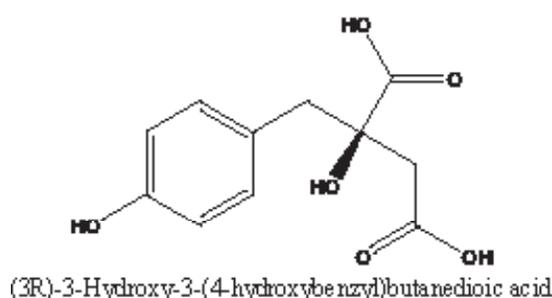
(3S,4aR,6aR,8aR,12aR,12bS,14aR,14bR)-4,4,6a,8a,11,11,12b,14b-octamethyl-1,2,3,4,4a,5,6,6a,8,8a,9,10,11,12,12a,12b,13,14,14a,14b-icosahydropicen-3-ol

Taraxerol



methyl (9Z,12Z)-octadeca-9,12-dienoate

Methyl linoleate



(3R)-3-Hydroxy-3-(4-hydroxybenzyl)butanedioic acid

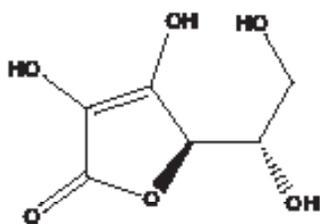
Methyl eucomic acid

Ying, Kun, Qiu., *et al.* [36] revealed two new  $\alpha$ -pyrones, named opuntioside II and opuntioside III, were isolated from the extract together with six known compounds. The structures of the new compounds were determined on the basis of chemical and physico-chemical evidence [37].

Diaz, Medina, E M., *et al.* [17] determined chemical compositions (moisture, Brix, total fibre, protein, fat, ash, pH, acidity, ascorbic acid, total phenolics, Na, K,Ca, Mg, Fe, Cu, Zn, Mn, Ni and Cr) in fruit of *Opuntia dillenii*, from Tenerife Island. Nitrogen concentration was obtained by applying the Kjeldahl method [38], and the protein concentration was estimated using a nitrogen factor of 6.25. Fat was measured by extraction with petroleum ether using a Soxhlet apparatus. The pH was determined by potentiometric measurement at 20°C with a pH meter. The acidity was determined by titration with 0.1 N NaOH to pH 8.1, expressing the results in g of anhydrous citric acid/100g [39].

Yang, Jun-heng., *et al.* [40] isolated, purify and identify the *Opuntia dillenii* Polysaccharide (ODP).

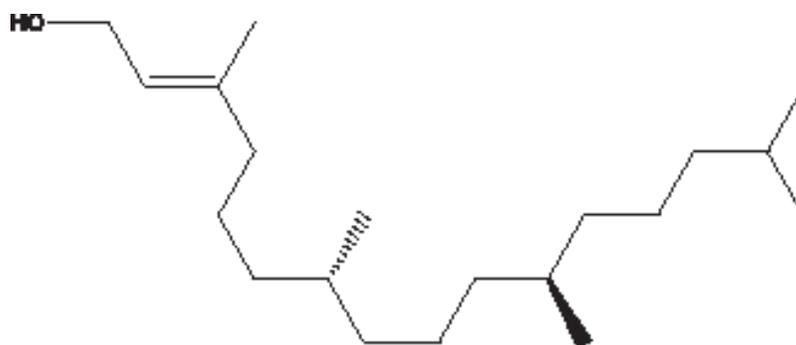
Amira, Touil., *et al.* [41] reported the chemical composition (moisture, Brix, protein, acidity, saccharose, fructose, glucose and minerals), the physical properties (Linear dimensions, mass, density, shrinkage and porosity) and equilibrium properties (sorption isotherms, enthalpy and entropy) of *Opuntia dillenii* fruit were determined. This fruit is characterized by an important value of water content, minerals and acidity. Cactus pear has total soluble solids (12-17%), acidity (0.03-0.12%), and pH (6.0-6.6), and ascorbic acid contents (20-40 mg/100 g fresh weight). Composition and nutritional value are: energy (172 kJ), vitamin C (14 mg), protein (0.7g), fats (0.5g), glucose (7.8g), fibre (1.8g), potassium (220 mg), magnesium (85 mg), calcium (56 mg), phosphorous (24 mg) for 100g edible portion. Dehydration is an age-old process of preserving food. Several authors mentioned dried prickly pear as another edible form of the product [42,43].



(5R)-[(1S)-1,2-dihydroxyethyl]-3,4-dihydroxyfuran-2(5H)-one

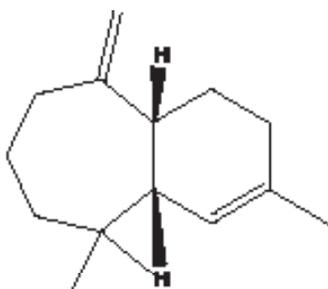
### Ascorbic acid

Jin, Hua, *et al.* [44] reported scientific evidence for the rational development and comprehensive utilization of *Opuntia dillenii*. The volatile oil was extracted from *Opuntia dillenii* by steam distillation. The main constituents are Phytol (36.57%), Himachalene(10.89%), Spathulenol (8.35%), Aromadendrene (7.24%), Caryophyllene (5.90%), Hexadecanoicnal (2.36%).



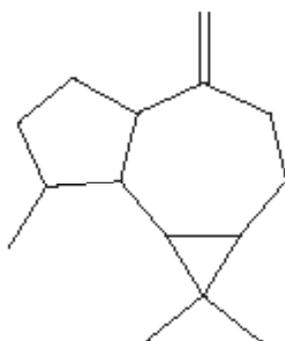
(2E,7R,11R)-3,7,11,15-tetramethyl-2-hexadecen-1-ol

### Phytol



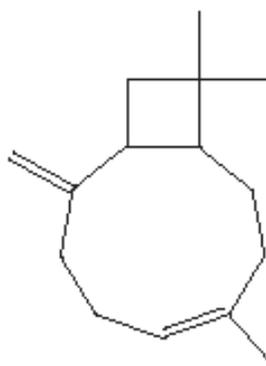
(4aS,9aR)-3,5,5-Trimethyl-9-methylene-2,4a,5,6,7,8,9,9a-octahydro-1H-benzo[7]annulene

### Himachalene



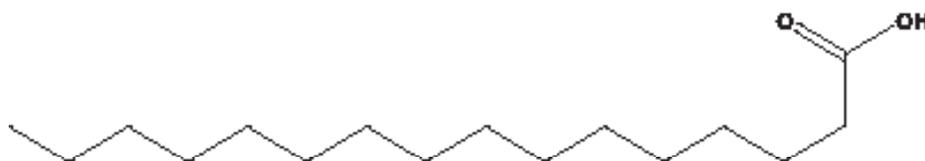
1,1,7- Trimethyl-4-methylenedecahydro-1H-cyclopropr opa[e]azulene

Aromadendrene



4,11,11-trimethyl-8-methylene-  
bicyclo[7.2.0]undec-4-ene

Caryophyllene



hexadecanoic acid

Zhao, L Y, Lan., *et al.* [45] investigated the natural plant-derived drugs provide several potential options for the control of diabetes [46]. These plant-derived agents may be less toxic and have fewer side effects than synthetic agents. Recent studies on polysaccharides derived from *Opuntia* spp. have shown that these polysaccharides contain arabinose, xylose, fructose, glucose, galacturonic acid, and rhamnose units and isolated three kinds of ODPs - ODP-Ia, ODP-Ib, and ODP-II' - were isolated by using an ultrasonic extraction method and diethylaminoethyl (DEAE)-Sephacrose fast-flow column chromatography [47].

## Pharmacological activity

### Anti diabetic activity

Marina perfumi and Rosalia Tacconi (1996) determined whether or not there is a scientific basis for this popular use, the effects of the fruit's red palatable juice on blood glucose levels were assessed in normoglycemic and alloxan-induced diabetes rabbits. These data suggest that *O. dillenii* produces hypoglycemia mainly by reducing intestinal absorption of glucose, but other different mechanisms of action cannot be excluded, for example the presence of an orally active insulin-like compound. During the oral toxicity study of the crude drug, rats given doses up to 50 ml/kg exhibited no symptoms of toxicity [15,48,49]. In the Canary Islands, the ripe fresh fruit of *O. dillenii* is used in folk medicine as an Antidiabetic crude drug [50]. Furthermore, various species of the genus *Opuntia* have been cited as hypoglycemic drugs in several reviews [51,52]. Zhao, Xiang, *et al.* [52] reported *Opuntia dillenii* tablet from *Opuntia dillenii*, to make a four week clinical observation on thirty type 2 Diabetes Mellitus (DM) patients, the study proved that this medicine could improve the glycometabolism of DM patients effectivity and avoid the early impairment of renal function of diabetic neuropathy.

Abdallah, Inas, Z A. [53] evaluated the possible curative role of *O. dillenii* fruit juice using the streptozotocin (STZ)-induced diabetic rats. The nutritive value of the edible portion of the fruit was also assessed. Diabetes mellitus, a metabolic hyperglycemia, altered metabolism of lipids, carbohydrates and proteins with an increased risk of complications of vascular diseases [54]. Chronic hyperglycemia during diabetes causes permanent tissue damage, not able to the retinas, kidneys and nerve endings [55]. The increasing number of aging population, consumption in the number of diabetic worldwide [56]. Pharmacological evaluation of *Opuntia* has shown its efficacy as antihyperlipidemic, antiatherosclerotic [57], antiviral, anti-inflammatory, antidiabetic, antioxidant and antiulcerogenic agent [58]. Presence of mineral contents [57], Vitamins B1, B2, C,  $\beta$  - carotene, E and D3 [59].

Tao, Mei-hua, *et al.* [60] observed the hypoglycemic activity of *Opuntia dillenii* polysaccharides, mice were injected with streptozotocin 120 mg/kg, 40 mg/kg in turn to induce diabetic model [61,62].

### Anti-depressant activity

Ismail, Owais, M., *et al.* [63] reported the antidepressant like actions of butanol fraction from methanol extract of *Opuntia dillenii* in rodents. The flowers of this plant are being used for the treatment of bronchitis and asthma [64]. However, there is no scientific information regarding its antidepressant activities. It is well established that animal models such as forced swimming test and tail suspension test are useful tools for the assessment of potential antidepressants [65,66].

### Hypotensive activity

Saleem R., *et al.* [67] reported methanolic extract of *Opuntia dillenii* cladodes and its pure compound  $\alpha$ -pyrone glycoside, opuntioside-I showed potent hypotensive activity in normotensive rats [39]. *Opuntia dillenii* (Nagphana), the specie under investigation, is not much explored. However, its analgesic, anti-inflammatory radical scavenging activity [20] and antispermatic effect [68] have so far been reported. Its cladodes are used in the treatment of scorbutic ulcers and ophthalmia [69]. Chemical constituents isolated so far include glycosides of quercetin, rhamnetin [69,70] and kaempferol, opuntiol and its glucoside.

### In acute liver injury

Yu, Ning-hua, *et al.* [71] investigated the protective effect of *Opuntia dillenii* Polysaccharides (OPS) on carbon tetrachloride (CCl<sub>4</sub>)-induced liver injury in mice.

### Immunomodulatory effect

Zhao, L Y, *et al.* [72] investigated the specific immune modulation of *Opuntia dillenii* polysaccharides (ODPs) on mice (body fluid and cells).

### Anti-inflammatory activity

Ahmed, M S., *et al.* [73] reported the alcoholic extracts of the flowers, fruits and stems of the *Opuntia dillenii* have anti-inflammatory activity. The lyophilized aqueous extract of the fruits has been shown to have analgesic properties associated with anti-inflammatory effects. Anti-inflammatory effect was evaluated by the carrageenan-induced rat paw oedema test [16].

Loro, J F., *et al.* [16] studied the lyophilized aqueous extract of the fruits of the plant, used in Canarian traditional medicine for gastrointestinal and bronchial troubles, was evaluated for analgesic and anti-inflammatory properties in rats and mice [74,75].

### In-Vitro antimicrobial synergistic and anti-tubercular (Tb)

Debnath, Subal., *et al.* [76] investigated the synergistic antimicrobial and anti-tubercular activities of *Opuntia dillenii* aqueous & methanolic extract.

### Low-density lipoprotein peroxidation

Chang, Su-Feng., *et al.* [77] investigated the antioxidant activity and inhibitory effect of extracts from *Opuntia dillenii* fruit and its active compounds on low-density lipoprotein (LDL) peroxidation were investigated. Researchers have shown that atherosclerosis has an intimate relationship with the oxidative modification of LDL cholesterol [78].

### Conclusion

Both its history and its present appearance justify that *O. dillenii* keeps an independent taxonomic position [79]. There are, first of all, the fruits: spineless, palatable, attractively coloured, with edible seeds and many health-promoting components. They would certainly meet with a market, for 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 [60].

A prerequisite for the more intensive work with and the cultivation of the well-growing, adaptable *O.dillenii* plants is the reduction or even removal of the stout spines. The absence of spines will also favour the use of cladodes as vegetable and for medicinal purposes. Consequently, *O. Dillenii* is a highly promising candidate of programmes directed to the development of *Opuntia* species into crop plants [7].

It is seen from the literature that *Opuntia dillenii* is a very important plant for its large number of medicinal properties as well as medicinally important chemicals like betanin, polysaccharide composition of arabinose and galactose, 3-O-methyl quercetin, kaempferol, kaempferide, quercetin, isorhamnetin, beta-sitosterol, 4-ethoxyl-6-hydroxymethyl-alpha-pyrone, opuntisterol, opuntisteroside, taraxerol, friedelin, methyl linoleate, 7-oxositosterol, 6 $\beta$ -hydroxystigmast-4-ene-3-one, daucosterol, methyl eucomate, eucomic acid and also with moisture, Brix, protein, acidity, saccharose, fructose, glucose and minerals. The plant shows many pharmacological activities like anti-inflammatory, anti-oxidant, antidiabetic activity, immunomodulatory effect, anti-depressant activity, hypotensive activity, in acute liver injury, low-density lipoprotein peroxidation, anti hyperlipidemia activity, *in-vitro* antimicrobial synergistic, anti-tb., *Opuntia dillenii* is quite promising as a multipurpose medicinal agent so further clinical trials should be performed to prove its efficacy.

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