Review Article

A Review of *Cactus Opuntia dillenii* and It's Value for Human Health Benefits

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ABSTRACT

Opuntia dillenii, also known as the prickly pear cactus, are indigenous to the arid and semi- arid regions of Mexico and the southern United States, thriving across diverse climatic conditions. It is one of the most traditionally used medicinal plants in the region of Mexico. They possess numerous beneficial properties and is widely utilized as a medicinal plant in various parts of the world. It is known for its antioxidant, anti-inflammatory, antimicrobial, and antidiabetic properties and they are also known for its wound healing properties. The plant contains important bioactive compounds like flavonoids, alkaloids, and polysaccharides, which contribute to its medicinal effects. The presence of the secondary metabolites is the reason for its medical properties. Several studies have been conducted and they suggest that *Opuntia dillenii* may help in managing conditions like diabetes, hyperlipidemia and liver diseases. This review provides an overview of the plant's botanical description, chemical composition and pharmacological properties.

Keywords: *Opuntia dillenii*, medicinal plant, Anti- oxidant, Antihyperglycemic, Antihyperlipidemic.

INTRODUCTION

Opuntia dillenii (OD) a plant form Cactacea growing in dry and desert environments is a great medicinal herb, a shrub grows in desert and dry conditions with a height of about 1 to 1.8 meters. Additionally, OD has very beautiful flowers with amazing coloration due to betalain and possess important chemicals including betanin, polysaccharide like galactose and arabinose, 3-O-methyl quercetin, kaempferide, kaempferol, isorhamnetin and also with moisture, protein, brix, acidity, glucose, fructose, saccharose and minerals.[1]

For years, health benefits associated with the *Opuntia* genus have been documented in folk medicine, and this traditional knowledge remains highly relevant in many indigenous communities to this day. From the scientific point of view, it has been observed that extracts of opuntioid cacti, obtained from fruits, cladodes or flowers, can exert beneficial properties for the prevention and treatment of certain disorders, such as obesity, type-2 diabetes, cardiovascular diseases, non-alcoholic fatty liver disease and several types of cancer.[2]

The flowers of *Opuntia dillenii* are yellowish-orange to lemon-yellow, and the flowering period is from April to July. The stems are green, branched, flat, and fleshy and are known as cladodes. The leaves are tiny and shaped like cylindrical spines; the fruits are green but turn red when mature; and the cladode and fruits have glochids on their surfaces. *Opuntia dillenii* flowers have anti-inflammatory, analgesic, antioxidant, antiviral, and antimicrobial effects. The fresh fruit of *Opuntia dillenii* has antihyperglycemic effects, and its lyophilized aqueous fruit extract has anti-inflammatory properties. The cladodes of *Opuntia dillenii* possess anti-inflammatory properties by inhibiting arachidonic acid metabolites and cytokines and have potent hypotensive and antihyperglycemic effects. *Opuntia dillenii* seed oil has antidiabetogenic and antihyperlipidemic activities that are correlated with phenolic content and antioxidant activity.[3]

This review focuses on the botanical characteristics, phytochemical composition and its medicinal properties.

REVIEW METHODS

This review presents a comprehensive analysis of the available literature on the morphology, phytochemical composition, and pharmacological properties of *Opuntia dillenii*. Relevant in- formation was retrieved from scientific databases, including **PubMed, ScienceDirect and Google scholar**. The literature search was performed using specific keywords such as *Opuntia*, *Opuntia dillenii*, pharmacological activities, antioxidant, anti-inflammatory, hypotensive, anti- diabetic, and chemical composition.

PLANT CONSTITUENTS

Fruit:

The prickly pears of O. dillenii are berries composing of a thick pericarp containing a few small clefts of prickles, and reddish-purple in colour. The pulp is intermixed with numerous small rounded seeds, and has an acidic taste. Despite there are multiple studies on the physical and chemical characteristics of several species of cactus pear, the investigations *on O. dillenii* species are scarce. There is also insufficient data on the physio-chemical properties of fruit growing in Morocco. The identification of these characteristics would assist in the characterization, valorization, and promotion of future use of this species. The exceptional red-purple hue of the

O. dillenii pulp is due to the high betacyanin's content.[4]

The study by Loukili et al revealed that the extracts

produced from seeds, juice, and peel of O. dillenii fruits have an interesting chemical composition, including the presence of high polyphenol quantities (193.73 ± 81.44 to 341.12 ± 78.90 gallic acid eq [g/100 g dry weight]). Notably, gallic acid, vanillic acid, quercetin 3-O-*β*-D-glucoside, kaempferol, and syringic acid, which were the dominant constituents, are well known for their remarkable biological activities, including ant-diabetic, antibacterial, and antifungal properties. Results also showed that the yield, chemical composition, and biological activity of O. dillenii seeds, juice, and peel extracts varied according to the plant organ and extraction solvent, with the highest yields being obtained with ethanol extracts (8.41 ± 5.19%). In this study, a noteworthy anti-diabetic effect was highlighted for *Opuntia* extracts, in both *in vitro* and *in silico* assays, suggesting that they could potentially be used as a phytomedicine in healthy and diabetic subjects to prevent the incidence of diabetes and delay the development of complications in diabetics.[5]

Stem:

The stems are much-branched and consist of a series of flattened fleshy (i.e. succulent) segments, which are sometimes confused for leaves. These segments (10-40 cm long, 5-20 cm wide and 1-2 cm thick) are green or bluish-green in colour and longer than they are broad (i.e. elliptic or obovate in shape). They are hairless (i.e. glabrous) and covered in small raised bumps (i.e. areoles) which bear tiny spiny bristles (i.e. glochids). Most of these small raised bumps (i.e. areoles) also have 1-7 larger sharp spines (2-4 cm long).[6]

The stems of *Opuntia dillenii* have been found to contain a variety of bioactive compounds. Notably, two novel C29-5β-sterols, opuntisterol and opuntisteroside, have been isolated from the stems. Additionally, nine known compounds, including β-sitosterol, taraxerol, and friedelin, were identified. Flavonoids such as kaempferol, kaempferide, and quercetin have also been extracted from the stem tissues. These findings suggest that the stem of *Opuntia dillenii* is a rich source of phytochemicals with potential pharmacological applications.[7]

Flowers:

The ethanolic extract of O. dillenii flowers contains three flavonoid glycosides (kaempferol 3- *O*-α-arabinoside, isorhamnetin-3-*O*-glucoside, and isorhamnetin-3-*O*-rutinoside) and shows potent anti-inflammatory and analgesic effects at a dose of 200 mg/kg. The methanolic extract of O. dillenii flowers exhibited potent antioxidant abilities, with an IC_{50} of 58.7µg/ml. This extract possesses strong antiviral activity against herpes simplex 1 and 2 and the vaccinia virus while exhibiting cytotoxicity above 100µg/ml. These studies indicate that O. dillenii flowers are suitable as natural antioxidants.[8]

Cladodes:

The cladodes (pads) of *Opuntia dillenii* are rich in bioactive compounds. Studies have shown that mucilage extracted from the cladodes yields approximately 6.2% in aqueous medium. The neutral sugar composition of this mucilage includes arabinose (38.80%), rhamnose (15.70%), galactose (33.00%), xylose (5.10%), and glucose (5.10%). Additionally, two novel α-pyrones, opuntioside II and opuntioside III, along with six known compounds, have been isolated from the cladode and stem extracts. These findings highlight the potential of O. dillenii cladodes as a source of valuable phytochemicals.[9]

PHARMACOLOGICAL PROPERTIES

Antihyperglycemia Activity:

The Alpha amylase inhibitory activity of *Opuntia dillenii* ethanol concentrate was compared to that of the widely used alpha amylase inhibitor acarbose with IC50values. The IC50estimations of ethanol extract of *Opuntia dillenii* was 106.027µg/ml which was the better on contrasted and standard acarbose 101.235µg/ml. Alpha amylase is an enzyme accountable for digestion of carbohydrates to give diverse products of glucose units which may be responsible for hyperglycemia and evolution of type 2 diabetes mellitus. The ethanol extract of *Opuntia dillenii* was inhibits the alpha amylase activity and decreases the raised blood glucose levels. The ethanol extract of *Opuntia dillenii* was more potent on contrasted with that of standard acarbose. The plant-based α-amylase inhibitor offers a forthcoming helpful methodology for the management of diabetes.[10]

In the study conducted by Inas Z.A. Abdallah the *Opuntia dillenii* ripe fruit juices has significant effect on the rats which are diabetic due to the injection of streptozotocin which caused highly significant reduction in body weight gain%, highly significant elevation in blood glucose concentration accompanied by significant reduction in liver glycogen. The oral administration of fruit juices in normal rats showed no effect but, in the diabetes, induced rats there was significant improvement in in body weight gain % and lipid profile, it reduced significantly blood glucose and MDA levels as compared with nontreated diabetic group. They concluded that O. dillenii fruit juice had a potent hypoglycemic activity, this effect may be attributed to its antioxidant activity and its high content of chromium which was proved in this study.[11]

Anti-inflammatory Activity:

Ahmed et al. conducted studies demonstrating that various parts of O. dillenii, particularly the flowers, exhibit significant anti-inflammatory properties. The isolation of compounds such as kaempferol 3-O-α-arabinoside, isorhamnetin-3-O-β-d-glucopyranoside, and isorhamnetin-3- O-β-d-rutinoside from the flowers was associated with a notable reduction in carrageenan- induced paw edema in albino rats, suggesting these flavonoids play a crucial role in the plant's anti-inflammatory activity.[12]

Siddiqui et al. found that the specific compounds in O. dillenii cladodes like opuntiol and opuntioside which calms inflammation by modulating cytokines and eicosanoids. These compounds were found to inhibit both

cyclooxygenase (COX) and lipoxygenase (LOX) pathways leading to reduced levels of pro-inflammatory mediators such as prostaglandin E_2 (PGE_2), leukotriene B_4 (LTB_4), reactive oxygen species (ROS), tumor necrosis factor-alpha (TNF-α), interleukin- 1β (IL-1β), and interleukin-6 (IL-6). This dual inhibition underscores the potential of *Opuntia dillenii* constituents in managing inflammation through multiple biochemical pathways.[13]

Antihyperlipidemia Activity:

Bouhrim et al conducted test for hypolipidemic activity of *Opuntia dillenii* on albino mice by giving high fat diet daily prepared based on the method by Harnafi et al[15]for 30days and they are fasted for 14hours and blood sample for taken for analysis and their cholesterol, HDL cholesterol/total cholesterol (%), triglycerides were noted and They were feed *Opuntia dillenii* oil daily has significantly attuned the increase in the cholesterol, HDL cholesterol/total cholesterol (%), triglycerides, and the atherogenic index levels and did not affect the HDL cholesterol (g/L) level compared to the high-fat-diet group which were only given high fat diet. ODSO has shown a significant antihyperlipidemic effect in mice and this effect could be linked to its rich- ness in polyunsaturated fatty acids, phytosterols, vitamin *E*, and phenolic compounds.[14]

Iván Gómez-López et al researched the triglyceride-lowering effect of green extracts, obtained from Opuntia stricta var. dillenii fruit (whole fruit, pulp, peel, and industrial by-products (by-gases)) in 3T3-L1 mature adipocytes. They obtained the extracts rich in betalains and phenolic compounds from freeze-dried samples of tissue under reduced light conditions, as previously documented by Gómez-López et al.[15] They grew 3T3-L1 pre-adipocytes in mature adipocyte cell experiment and placed it in 6-well plates and incubated it with whole fruit, peel, pulp, or bagasse (BA) extracts from O. stricta var. dillenii at 10, 25, 50, or 100 µg/mL (diluted in milli- Q water), on day 12 after differentiation, for 24 h. Subsequently, cells were collected for tri- glyceride assessment. The lipid quantification assay substantiated a significant decrease ($p < 0.05$) in intracellular triglyceride levels in mature 3T3-L1 adipocytes treated with 50 µg/mL or 100 µg/mL of the whole fruit, peel, and pulp extracts from O.dillenii prickly pear. They found out that the extracts from whole fruit, peel, and pulp are effective in reducing triglyceride accumulation in murine mature adipocytes at doses of 50µg/mL or higher.[16]

Antioxidant Activity:

Heng Li et al extracted polysaccharides from the *Opuntia dillenii* cladodes based on the method by Cuesta G. et al[17] and research on these polysaccharides extracted from O. dillenii (ODP) revealed notable antioxidant activities. Among the fractions tested, ODP-I exhibited significant scavenging activities against DPPH (58.44%), hydroxyl (45.69%), and superoxide radicals (43.71%) at a concentration of 6.4 mg/ml. These findings suggest *that O. dillenii* polysaccharide- rides could serve as natural antioxidants. [18]

Elouazkiti et al analyzed the extracts from the *Opuntia dillenii* flower and found out about the anti-oxidant properties. The ethanol extract demonstrated the highest total phenolic content (34.45 ± 0.42 mg GAE/g) and exhibited potent antioxidant activity in DPPH and FRAP assays. Notably, the butanol extract showed the strongest DPPH radical scavenging activity, with an EC50 value of 58.7µg/ml. These antioxidant effects are attributed to the presence of methylated flavonoids, such as quercetin 3-O-rutinoside and isorhamnetin-3-O-rutinoside.[19]

CONCLUSION

Opuntia dillenii is a promising medicinal plant with diverse medicinal properties like antioxidant, antidiabetic, anti-inflammatory, and antihyperlipidemic activities. Among these pharmacological activities anti-oxidant was the most well researched and proven activity. The various parts of the plants like cladode, fruits, seeds and flower are rich in secondary metabolites. Existing research done may prove about its medicinal properties but further research is need to be done for clinical application. This review was done to emphasis the medicinal properties of the plant and the need for additional research to be done so that they can be used more in modern medicine.

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