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The Phytochemical and Pharmacological Properties of Portulaca

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Abstract

The Portulacaceae family includes *Portulaca oleracea* L., also known as purslane in English and Ma-Chi-Xian in Chinese. An annual grassy plant is widely cultivated across the world, particularly in tropical and subtropical regions. Around the Mediterranean and in tropical Asian nations, it is widely used as a potherb and added to soups and salads. It has also been used as a folk remedy in numerous nations. Many different substances, including flavonoids, alkaloids, polysaccharides, fatty acids, terpenoids, sterols, proteins, vitamins, and minerals, have been extracted from *Portulaca oleracea*. A comprehensive range of pharmacological qualities, counting neuroprotective, antibacterial, antidiabetic, antioxidant, anti-inflammatory, antiulcerogenic, and anticancer actions, are present in *Portulaca oleracea*. However, little is known about molecular mechanisms of action. The phytochemistry and pharmacological properties of this plant are summarized here.

Introduction

Common purslane, also known as little hogweed or pursley, is a plant in the family Portulaceae that is classified as an annual but is actually a tropical perennial in USDA growth zones 10 and 11.Carl Linnaeus first mentioned ***P. oleracea*** in his book Species Plantarum in 1753. Numerous subspecies and variants have been classified as species of their own due to the high degree of diversity, but other studies indicate that they all belong within the ***P. oleracea*** genus's spectrum of variation. The more popularly used names ***P. oleracea subsp. sativa, P. sativa, and P. oleracea var. sativa*** refer to a little

more robust cultivar with larger seeds that cannot be distinguished from the species. There are currently over 40 different varieties of P. oleracea growing.

The flowering plant,which is more frequently referred to as winter purslane (***Claytonia perfoliata***), is a distant relative of the Montiaceae family. ***P. oleracea*** is one of the very few plants that can use the CAM and C4 photosynthesis processes, which were previously thought to be incompatible despite sharing some biochemical characteristics. Drought causes ***P. oleracea*** to move from C4 to CAM pathways, and there is physiological and transcriptional evidence for C4-CAM hybrid photosynthesis under mild drought. Many nations have utilised ***Portulaca oleracea*** as a folk remedy because of its febrifuge, antiseptic, vermifuge, and other effects. It demonstrates a broad spectrum of pharmacological activities, such as antibacterial, antiulcerogenic, anti-inflammatory, antioxidant, and wound-healing qualities. The World Health Organisation lists it as one of the most popular therapeutic herbs and refers to it as a "Global Panacea". It was referred to as a "vegetable for long life" in Chinese folklore, and traditional Chinese medicine has employed it for thousands of years.

Morphology

The plant can grow as tall as 40 cm (16 inches). The leaves, which may be alternate or opposing, are grouped at the joints and ends of smooth, reddish, mainly prostrate stems. The yellow flowers are up to 6 centimetres (14 inch) diameter, have five regular components, and have five petals. The blooms can bloom at any time of the year, depending on the amount of rainfall. On sunny mornings, the flowers only bloom singly at the centre of the leaf cluster for a brief period of time. The minuscule seeds develop in a pod that bursts open when the seeds are ready. Purslane can withstand poor soil and dryness because it has a taproot and fibrous secondary roots. The fruit is a cap with many seeds. One plant has a large seed set; it can produce up to 193,000 seeds. The seeds are light germinators, and even a 5 mm soil layer inhibits germination. They germinate best at temperatures exceeding 25 °C.

Cultivation practices

Purslane normally reproduces by reseeding in natural settings, however stem pieces can also root easily after being cut. Seed is the most common method of propagation in agriculture. The seeds are quite tiny, with a 1000-seed weight of (0.1-) 0.4-0.5 g and a seed rate of approximately 20 kg/ha.

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Fresh seeds require light to germinate, but this requirement vanishes in older seeds. Purslane is shallowly rooted and produced as a densely planted, short-season crop, thus the topsoil should be fertile. At land preparation, organic manure at a rate of 20-30 t/ha is recommended. 3 weeks after planting, 40 kg/ha of urea can be applied as a topdressing. Purslane has to be watered at regular intervals of 3-4 days in dry warm weather. It can be irrigated with saline drainage water. In Indonesia, it is occasionally transplanted to 30 cm 30 cm spacing and grown for a longer period of time. Harvesting can begin 3-4 weeks after sowing, and commercial production allows for 2-3 cuttings at 2-3 week intervals. Cutting should be done at a low level to encourage new growth. Uprooting is also used for once-over harvesting. Flowering after 6-8 weeks affects crop quality. In the tropics, yields of 12-17 t/ha per crop have been observed, with maximum yields reaching 50 t/ha. Purslane can be stored in plastic boxes at 0-1°C and high relative humidity for 2-5 days.

Chemical constituent of Portulaca

Additionally, ***Portulaca oleracea*** is a fantastic source of omega-3 fatty acids, which are often only found in the oil and fat of fish and not in plants. Omega-3 fatty acids are crucial in the prevention and treatment of cancer, hypertension, coronary artery disease, and other inflammatory and autoimmune illnesses, as well as the improvement of immunological function. It contains linoleic and -linolenic acids, which are necessary for healthy human growth, the promotion of wellbeing, and the prevention of disease. Due to their alteration of blood lipids, metabolism, and reduction of blood glucose, the polysaccharides contained in Portulaca oleracea are prospective therapeutic agents for the treatment of diabetes mellitus. Monoterpenes like portulosides A and B, diterpenes like portulene, and -amyrin type triterpenoids are all found in Portulaca oleracea. Additionally, vitamins have also been isolated from the plant's leaves. Among green leafy vegetables, it has the highest concentration of vitamin A, a natural antioxidant necessary for vision, keeping healthy mucous membranes, and guarding against lung and oral cavity cancers. Ascorbic acid, tocopherol, and B-complex vitamins like niacin, pyridoxine, and riboflavin are also present in this plant. The minerals phosphorus, manganese, icon, calcium, and selenium as well as the amino acids isoleucine, proline, leucine, lysine, phenylalanine, methionine, cystine, valine, threonine, and tyrosine are also abundant in this plant. Numerous other substances, including -carotene, glutathione, melatonin, portulacerebroside A, catechol, and bergapten, have also been identified from this plant.

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Several chemicals are present in Portulaca, these are follows:

1. **Flavonoids:**
    - Kaempferol, Apigenin (Leaf and Stem)
    - Luteolin, Myricetin, Quercetin, Genistein and genistin (Whole plant)
    - Portulacanones-A, B, C, D and 2,2'-Dihydroxy-4',6'- dimethoxychalcone (Aerial plant)
2. **Alkaloids:**
    - Dopamine, Noradrenaline (Stem, leaf and seed)
    - Oleraceins- A, B, C, D and E, Adenosine (Whole plant)
    - Oleracins I and II (Stem)
    - N-trans-Feruloyltyramine, Thymine, Uracil, Trollisine (Aerial part)
3. **Terpenoids:**
    - Portuloside A and B, Portulene, Lupeol, Friedelane (Aerial parts)
4. **Organic acids:**
    - 3-Quinolinecarboxylic acid, Indole-3-carboxylic acid, Caffeic acid (Aerial parts)
    - a-Linolenic acid, Linolenic acid, Palmitic acid, Stearic acid, Oleic acid (Leaf)
    - p-Coumaric acid, Ferulic acid (Whole plant)
    - Docosapentaenoic acid, Oxalic acid (Leaf)
5. **Vitamins:**
    - Vitamin A, Riboflavin, Niacin, Pyridoxine, Vit-C, Folates, Pantothenic acid, Thiamin, alpha-Tocopherol, Hesperidin (Leaf)
6. **Minerals:**
    - Iron, Manganese, Calcium, Copper (Root, stem and leaf)
    - Zinc, Selenium, Magnesium (Leaf)
7. **Other compounds:**
    - Portulacerebroside A, beta- Sitosterol, Daucosterol (Aerial part)
    - beta-Carotene, Proline (Leaf)
    - Robustin, Bergapten, Tannin, Chlorophyll and Isopimpinellin

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Pharmacological effect

Renoprotective actions and metabolic impacts are the most significant pharmacological actions. Patients with metabolic syndrome could successfully lower their lipid profile and blood glucose levels by using ***P. oleracea***. Numerous clinical trials have commented on ***P. oleracea's*** safety.

Antiulcerogenic Activity

In a dose-dependent way, ***Portulaca oleracea*** aqueous and ethanolic extracts at 0.8 g/kg and 1.4 g/kg, respectively, might lessen the severity of HCl-induced stomach ulcers; this is comparable to the impact shown with sucralfate at 0.1 g/kg. Additionally, the lesions brought on by 100% ethanol are suppressed by the aqueous extract (0.56 and 0.8 g/kg) and the ethanolic extract (0.8 and 1.4 g/kg). In mice with pylorus ligation, the oral and intraperitoneal administration of both extracts increases the pH of the stomach juice in a dose-dependent manner. As a result of its gastroprotective function, Portulaca oleracea shows considerable promise as an effective treatment agent for gastrointestinal illnesses.

Hepatoprotective Activity

Intraperitoneal treatment of CCl4 causes liver damage in rats, which is evidently accompanied by an increase in serum levels of the hepatic marker enzymes glutamate pyruvate transaminase (GPT) and glutamate oxaloacetate transaminase (GOT) as well as total bilirubin. The hepatoprotective action of Portulaca oleracea is confirmed by a 70% alcohol extract of the plant, which also considerably reduces the rise in hepatic marker enzymes and total bilirubin levels.

Anti-Inflammatory Activity

Pretreatment of human umbilical vein endothelial cells (HUVECs) with Portulaca oleracea aqueous extract inhibits intracellular reactive oxygen species (ROS) production and the over expression of intercellular adhesion molecule-1 (ICAM-1) and vascular cell adhesion molecule-1 (VCAM-1) and E-selectin in a dose-dependent manner. Additionally, this extract blocks the nuclear factor B (NF-B) p65 translocation to the nucleus, TNF-induced NF-B binding, and inhibitor molecule (I-B) degradation. Additionally, TNF-induced mRNA production of interleukin-8 (IL-8) and monocyte chemoattractant protein-1 (MCP-1) as well as HL-60 cells' adherence to TNF-induced HUVECs are both inhibited. The reduction of the vascular inflammatory process linked to the

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emergence of atherosclerosis may also be significantly aided by the aqueous extract of Portulaca oleracea.

Antimicrobial

According to its antifungal activity on dermatophytes belonging to the genus ***Trichophyton***, ***Portulaca oleracea*** has antibacterial, antifungal, and antiviral properties. Due to the suppression of virus penetration rather than virus adsorption, a pectic polysaccharide isolated from the aerial section of this plant has antiherpes function against simplex virus type 2. A 70% methyl alcohol extract of *Portulaca oleracea* exhibits antibacterial activity against the Gram-negative strains *Escherichia coli, Pseudomonas aeruginosa,* and *Neisseria gonorrhoea* with inhibition zones of 14, 15, and 15 mm, respectively, and the Gram-positive strains *Staphylococcus aureus*, *Bacillus subtilis*, and *Streptococcus faecalis*.

Anticancer Activity

Many biological actions, including anticancer, antioxidation, anti-inflammation, and immunity-enhancing capabilities, are displayed by Portulaca oleracea polysaccharides. In rats with ovarian cancer, polysaccharides influence immune responses and appear to remove free radical buildup. In vitro development of HeLa and HepG2 cells is inhibited by sulfated derivatives of POP, a water-soluble polysaccharide derived from Portulaca oleracea. This suggests that sulfation of POP boosts the cytotoxicity in tumour cells. Other bioactive substances, such as cerebrosides, homoisoflavonoids, and alkaloids, also have in vitro cytotoxic effects against human cancer cell lines in addition to polysaccharides. These studies show that Portulaca oleracea may be useful in the management of cancer.

Antioxidant Activity

Portulaca oleracea's components, including gallotannins, omega-3 fatty acids, ascorbic acid, -tocopherols, kaempferol, quercetin, and apigenin, are thought to be responsible for the plant's antioxidant properties. The aqueous extract significantly reduced hydrogen peroxide-induced oxidative DNA lesions in human lymphocytes, whereas the ethanolic extract had no effects, which may be related to the antioxidant constituents present in the aqueous extract, according to the single cell gel

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electrophoresis assay (comet assay), a straightforward, quick, and affordable method for measuring DNA strand breaks.

Antidiabetic Activity

Body weight, serum free fatty acids, and hyperinsulinemia are all reduced by portulaca oleracea. Portulaca oleracea may reduce insulin resistance because it improves insulin sensitivity and improves impaired glucose tolerance and lipid metabolism in rats with type 2 diabetes mellitus brought on by streptozotocin injection (25 mg/kg) and high-calorie forage diet.

Neuroprotective Activity

By scavenging free radicals and inhibiting rotenone-induced neuronal apoptosis, dopamine depletion, and complex-I inhibition in the striatum of rats, Portulaca oleracea may be a possible candidate for Parkinson's disease neuroprotection. The protection provided by Portulaca oleracea extract (EP) against hypoxic damage is most likely due to increased levels of glycolysis, EPO, and hypoxia inducible factor-1 expression. In hypoxic mice, the ethanol extract reduces serum levels of neuron-specific enolase, the pathogenic effects of hypoxia, and caspase-3 activation in neurons.

Other Activities

At concentrations of 100, 200, and 400 mg/kg, respectively, the ethanol extract from Portulaca oleracea exhibits a dose-dependent impact in extending the survival duration of mice in hypoxic scenarios, including closed normobaric hypoxia and potassium cyanide or sodium nitrite toxicosis. The activities of phosphofructokinase, pyruvate kinase, and lactate dehydrogenase in glycolysis are also improved by this extract, as is the concentration of adenosine triphosphate in mouse cortices under hypoxic conditions. A fresh crude extract significantly speeds up the wound healing process by stimulating wound contraction and decreasing the surface area of the excision wound, according to an evaluation of Portulaca oleracea's preliminary wound healing activity in Mus musculus JVI-1. Portulaca oleracea can perform the dual tasks of preventing the occurrence of Se deficiency connected disorders such Keshan and Kashin-Beck diseases by having the capacity to accumulate Se even over the shortest time span of 42 days.

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Conclusion

Numerous traditional uses of P. oleracea, such as its anti-hyperglycemic and anti-hyperlipidemic, renoprotective, and hepatoprotective properties, have now been validated by contemporary pharmacological investigations. Additionally, P. oleracea did not exhibit any negative side effects in many clinical trials, with constipation being the most typical negative side effect. It is concluded that Portulaca oleracea is an edible and medicinal plant that is significant for the food sector and may also play a big role in healthcare given that adequate investigations are undertaken.

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