ABSTRACT

Portulaca pilosa L., belonging to the family Portulacaceae, is commonly known as Balibalua in Odia, Lumbia in Hindi, Nunia sag in Bengali, Peddapavilkari in Telugu and kiss me quick in English. It is a warm-climate, herbaceous succulent annual weed with a cosmopolitan distribution. It is eaten extensively as a potherb and added in soups and salads around the Mediterranean and tropical Asian countries and has been used as a folk medicine in many countries. Diverse compounds have been isolated from P. pilosa, such as flavonoids, alkaloids, polysaccharides, fatty acids, terpenoids, sterols, proteins vitamins and minerals. P. pilosa possesses a wide spectrum of pharmacological properties including antibacterial, anti-ulcerogenic, anti-inflammatory, antioxidant, diuretics, analgesic, and wound-healing, properties. However, few molecular mechanisms of action are known. This review provides a summary of phytochemistry and pharmacological effects of this weed.

Keywords: Medicinal weed, Traditional and modern medicine, Portulaca pilosa, Symptomatic management
In recent years, the use of traditional medicine information on plant research has again received significant interest. In recent times, there have been increased rate of interest in the field of research in natural products and natural chemistry. This level of interest can be attributed to several factors, including unmatched therapeutic needs, the remarkable diversity of both chemical structure and biological activities of naturally occurring secondary metabolites, the utility of novel bioactive natural compounds as biochemical probes, the development of novel and sensitive techniques to detect biologically active natural products, improved techniques to isolate, purify, and structurally characterize these active constituents, and advances in solving the demand for supply of complex and essential herbal products.

*Portulaca pilosa* L. is a warm-climate, herbaceous succulent annual weed with a cosmopolitan distribution belonging to the family Portulacaceae. It is commonly known as *Balibalua* in Odia, *Lunia* in Hindi, *Nunia sag* in Bengali, *Peddadavilikari* in Telugu and kiss me quick in English. It is distributed widely in the tropical and subtropical areas of the world including many parts of the India and is eaten extensively as a potherb and is added to soups and salads around the Mediterranean and tropical Asian countries. *P. pilosa* also provides a source of nutritional benefits owing to its rich omega-3 fatty acids and antioxidant properties.

*P. pilosa* has been used as a traditional folk medicine in many parts of our country, acting as an anti-rheumatic, febrifuge, antiseptic, vermifuge, and so forth. It exhibits a wide range of pharmacological effects, including anti-bacterial, anti-ulcerogenic, anti-inflammatory, antioxidant, diuretics, analgesic, and wound-healing properties. It is also listed by the World Health Organization as one of the most used medicinal weed.

**Description**

Annual herb, glabrous, fleshy with numerous decumbent branches, to 35 cm long. Leaves spiral or sub-opposite, often crowded at ends of branches, sessile or sub-sessile, obovate or spatulate to linear oblong, cuneate or attenuate at base, rounded or truncate at apex, 1-3 x 0.2-1.5 cm; stipular hairs very few, inconspicuous, 1 mm long, caduceus. Flowers sessile, 3 mm across, terminal, 1-15, surrounded by a cluster of crowded leaves; bracts ovate-acuminate, to 3 mm long, membranous. Sepals connate at base into 2 mm long tube; lobes oblong-ovate, keeled or slightly winged on back, 2-4 mm long. Petals 4 or 5, connate at base, broadly obovate or oblong-obovate, rarely emarginate at apex, 4-8 x 2-6 mm, yellow. Stamens 7-12; filaments to 4 mm long. Ovary ovoid; style short, to 5 mm long with 3-6 subulate lobes. Capsules obovoid to ovoid, 4-5 x 3 mm, enveloped by marcescent corolla, dehiscing transversely in middle; seeds many, mostly glossy black or iridescent gray, less often brown, orbicular-reniform, minute, often tuberculate, without caruncle, 0.5-1 mm across, granular, dull black.

*Figure 1: Figure of the plant Portulaca pilosa Linn. (Family: Portulacaceae).*

**Pharmacology**

Over the past decades, numerous researchers have investigated the pharmacological activities of *P. pilosa*. This review provides a comprehensive summary of the main pharmacological properties which are presented below.

**Neuroprotective activity**

Administration of *P. pilosa* can scavenge free radicals and antagonize rotenone induced neurons apoptosis, dopamine depletion, and complex-I inhibition in striatum of rats, suggesting that *P. pilosa* may be a potential
neuroprotective candidate against Parkinson’s disease.11 The extract of P. pilosa protects nerve tissue/cells from hypoxic damage probably by elevation of glycolysis, EPO, and hypoxia inducible factor-1 expression levels.12 The ethanol extract decreases the activity of caspase-3 in neuron whilst reducing serum levels of neuron specific enolase in hypoxia mice and the pathological damages caused by hypoxia. In these studies, an increase in the neuron viability and an induction in the mRNA and protein expression of endogenous erythropoietin have also been reported. Thus, the stabilization of hypoxia inducible factor-1 α expression is associated with the neuro protective effects of EP against hypoxia injury by eliciting endogenous erythropoietin expression.13 The total alkaloidal extracts from 31 traditional Chinese Herbal Medicines were tested for their acetyl cholinesterase (AChE) inhibitory activities by Ellman’s method and modified TLC bioautographic assay. As a result, the alkaloidal extract of P. pilosa significantly inhibited AChE activity at a final concentration of 100 µg/mL with the IC50 value of 29.4 µg/mL. The use of AChE inhibitors has been a promising treatment strategy for Alzheimer’s disease (AD); therefore, P. pilosa may be an effective agent for the prophylaxis and treatment of AD.14

Antioxidant activity

The antioxidant property of P. pilosa is attributed to its constituents, such as gallotannins, omega-3 fatty acids, ascorbic acid, α-tocopherols, kaempferol, quercetin, and apigenin.8 The single cell gel electrophoresis assay (comet assay), which is an simple, rapid, and inexpensive method for measuring DNA strand breaks, confirmed that the aqueous extract significantly alleviated hydrogen peroxide-induced oxidative DNA lesions in human lymphocytes, whereas the ethanolic extract had no effects, which may be associated with the antioxidant constituents contained in the aqueous extract.15 The aqueous extract decreases high fat diet-elicited oxidative damage by modulating blood and liver antioxidant enzyme activities, elevating leptin/β-actin and liver PPARα/β-actin and inhibiting the protein expression of p-PERK and the FAS mRNA expression of liver and spleen in mice.9 In another study, the aqueous extract at a concentration range of 100, 150, 200, and 400 µg/mL and the ethanolic extract at a range of 1200 and 1800 µg/mL, respectively, exerted cytoprotective effects on 2,2’-azobis hydrochloride-induced hemolytic damages of RBCs in a concentration-dependent manner.16

Anticancer activity

Polysaccharides from P. pilosa display several biological activities, such as anticancer, antioxidation, anti-inflammation, and immunity enhancing properties.17,18 Polysaccharides evidently scavenge the accumulation of free radicals and modulate immunity functions of rats with ovarian cancer.19 Sulfated derivatives of POP, a water-soluble polysaccharide isolated from P. pilosa, have a suppressive effect on the growth of HeLa and HepG2 cells in vitro, suggesting that the sulfation of POP increases the cytotoxicity in tumor cells.20 In addition to polysaccharides, other bioactive compounds such as cerebrosides, homo isoflavonoids, and alkaloids also show in vitro cytotoxic activities against human cancer cell lines. Portulacerebroside A stimulates human liver cancer HCCLM3 cell apoptosis via the activation of the p38MAPK and JNK-triggered mitochondrial death pathway and 2,2’-dihydroxy-4’,6’-dimethoxychalcone is more active against cell line SGC-7901 with an IC50 value of 1.6 µg/mL than mitomycin C which has an IC50 value of 13.0 µg/mL.21 Portulacanones B is active against SGC-7901 cell lines with an IC50 value of 16.2 µg/mL, which is very close to the value obtained with mitomycin C. 2,2’-Dihydroxy-4’,6’-dimethoxychalcone is moderately active against K-562 cells with an IC50 value of 24.6 µg/mL and portulacanones B–D show selective cytotoxic activity against SF-268 and/or NCI-H460 cells with IC50 values of 14.3–20.1 µg/mL.22 Ntrans-Feruloyltyramine, (7’R)-N-feruloylnormetanephrine, 1,5-dimethyl-6-phenyl-1,2-dihydro-1,2,4-triazin-3(2H)-one, and (3R)-3,5-bis(3-methoxy-4-hydroxyphenyl)-2,3-dihydro-2(1H)-pyridinone have weak bioactivities against K562 with IC50 values of 222.77, 66.94, 90.09, and 41.52 umol/L.
respectively, and moderate bioactivities against A549 with IC₅₀ values of 28.80, 21.76, 24.54, and 37.20 umol/L, respectively. These studies demonstrate that *P. pilosa* has a potential application in the treatment of cancer.

**Antimicrobial**

*P. pilosa* possesses antibacterial, antifungal, and antiviral activities as revealed by its antifungal effect against dermatophytes of the genera *Trichophyton*. A pectic polysaccharide isolated from the aerial part of this weed displays antitherpes property against simplex virus type 2 which is due to the inhibition of virus penetration and not virus adsorption. A 70% methyl alcohol extract of *P. pilosa* shows antibacterial activity against the Gram negative stains: *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* inhibition zones of 13, 14, and 15 mm, respectively, as well as antifungal activity against *Candida albicans* with inhibition zone of 12 mm.

**Anti-inflammatory activity**

Pretreatment with the aqueous extract of *P. pilosa* inhibits tumor necrosis factor- (TNF-) α-induced production of intracellular reactive oxygen species (ROS) and over expression of intercellular adhesion molecule- (ICAM-) 1, vascular cell adhesion molecule (VCAM)-1, and E-select in human umbilical vein endothelial cells (HUVECs) in a dose-dependent manner. This extract also suppresses the translocation of nuclear factor κB (NF-κB) p65 to the nucleus, TNF-α-induced NF-κB binding, and the degradation of inhibitor molecule (IkB). Furthermore, an inhibition in the adhesion of HL-60 cells to TNF-α-induced HUVECs and TNF-α-induced mRNA expression of interleukin- (IL-) 8 and monocyte chemoattractant protein- (MCP-) 1 is also observed. The aqueous extract of *P. pilosa* may also play an important role in the suppression of the vascular inflammatory process related to the development of atherosclerosis.

**Anti-ulcerogenic activity**

Aqueous and ethanolic extracts of *P. pilosa* at 0.8 g/kg and 1.4 g/kg, respectively, can reduce the severity of HCl-induced gastric ulcers in a dose dependent manner; this is comparable to the effect observed with sucralfate 0.1 g/kg. In addition, the aqueous extract (0.56 and 0.8 g/kg) and the ethanolic extract (0.8 and 1.4 g/kg) display suppression of lesions induced by absolute ethanol. The oral and intra peritoneal doses of both extracts dose dependently increase the pH of gastric juice in mice with pylorus ligation. Thus, *P. pilosa* holds great promise as an effective therapeutic agent for gastrointestinal diseases due to its gastroprotective activity.

**Hepatoprotective activity**

Intra peritoneal administration of CCl₄ elicits liver injury in rats, which notably upregulates the levels of total bilirubin and serum hepatic marker enzymes, including glutamate pyruvate transaminase (GPT) and glutamate oxaloacetate transaminase (GOT). A 70% alcohol extract of *P. pilosa* significantly reverses the increase in hepatic marker enzymes and total bilirubin levels, confirming the hepatoprotective activity of this weed.

**Other activities**

The ethanol extract from *P. pilosa* at a concentration range of 100, 200 and 400 mg/kg, respectively, displays a dose-dependent effect in prolonging the survival time of mice in hypoxic models, including closed normobaric hypoxia and potassium cyanide or sodium nitrite toxicosis. This extract also enhances the activities of phosphor fructo kinase, pyruvate kinase, and lactate dehydrogenase in glycolysis and the level of adenosine triphosphate of mouse cortices in hypoxia models. The preliminary wound healing activity of *P. pilosa* has been appraised in *Mus musculus* JVI-1 and it has been shown that a fresh crude extract significantly accelerates the wound healing course by the stimulation of wound contraction and down regulation of the surface area of the excision wound. *P. pilosa* also has the ability to accumulate Se even at the shortest time span of 42 days, and hence it can perform the dual
functions of preventing the occurrence of Se deficiency linked diseases such as Keshan and Kashin-Beck diseases.28

Conclusions

While centuries of use in traditional settings can be used as testimony that a particular herbal ingredient is effective or safe, several problems must be addressed as these ingredients are incorporated into modern practice. One problem is that ingredients once used for symptomatic management in traditional healing are now used in developed countries as part of health promotion or disease prevention strategies; thus, acute treatment has been replaced by chronic exposure. This means that a statement about “thousands of years of evidence that a product is safe” may not be valid for the way the product is now being used. This does not expressly mean that an ingredient is unsafe; it does mean that safety in the modern context cannot be assumed. A second problem is that efficacy and effectiveness have rarely been demonstrated using modern scientific investigations. An evidence based approach to this issue has only recently been implemented, and the results reveal that for most herbal products, considerable gaps in knowledge need to be remedied before one can be convinced about their efficacy.

Portulaca pilosa is of considerable importance to the food industry and also possesses a wide spectrum of pharmacological properties such as neuro protective, antimicrobial, antidiabetic, antioxidant, anti-inflammatory, anti-ulcerogenic, and anticancer activities, which are associated with its diverse chemical constituents, including flavonoids, alkaloids, polysaccharides, fatty acids, terpenoids, sterols, proteins, vitamins, and minerals. Although bioactivities of extracts or compounds isolated from P. pilosa are substantiated by using in vitro and in vivo studies including animal models and cell culture studies, the mechanisms of action have not been addressed. Hence, more mechanistic studies are required before P. pilosa can be considered for further clinical use. This review concludes that P. pilosa is an edible and a medicinally important weed which is important for the primary health care and may also have a significant role to play in health care provided that adequate studies are conducted.

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