Purslane (Portulaca Oleracea L.): A Priceless Underutilized Crop and its Potential to Impact Human Health

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Purslane (Portulaca oleracea L.), is an herbaceous plant believed to be the earliest vegetable consumed by humans and has been a part of traditional culinary and folk pharmaceutical system. It is known by various synonyms at various locations such as Purslane (USA and Australia), Pigweed (England), Pourpier (France), Andulam (Malaysia). Owing to its diverse phytoconstituents, Purslane has been reported to possess potent pharmacological actions such as hepato-protective, antidiabetic, neuronal, hypocholesterolemic, skeletal muscle relaxant, neuroprotective, nephrotoxicity, anti-inflammatory, antimicrobial, antioxidant, anticancer, antihypertensive actions. This review highlights the potential health benefits of purslane, its use as a superfood in alleviating different ailments.

Keywords: alkaloids, health benefits, nutritional, pharmacological, purslane

1. Introduction:

Purslane (Portulaca oleracea L.), commonly referred to simply as purslane, belongs to the Portulacaceae family—a group of around 25 genera characterized by their often succulent herbs and shrubs [1]. Globally, purslane is recognized as a widespread weed and is considered the eighth most common plant species worldwide. It has earned significant recognition, including being listed by the World Health Organization among the most widely used medicinal plants, and has been dubbed the 'Global Panacea' [2].

The plant is known by different names across regions: in the USA and Australia as Purslane, in England as Pigweed, in France as Pourpier, and in Malaysia as Andulam. In India, it carries several vernacular names like sanhti, punarva, paruppu keerai, gangavalli, and kulfa, depending on the local language. The name "Portulaca" is believed to derive from Latin—'porto' meaning "to carry" and 'lac' meaning "milk"—a reference to its milky sap. It has been officially recognized in several pharmacopoeias, including those of France, Mexico, Spain, and Venezuela.

Purslane grows abundantly across tropical and subtropical climates, including vast regions of the United States. It is often consumed as a leafy vegetable or potherb and features in salads and soups in Mediterranean and tropical Asian cuisines [3]. As a widely utilized medicinal herb, it is a succulent, herbaceous annual plant with global distribution across temperate and tropical zones—from Europe to Africa, Asia, the Americas, and Australia.

In traditional medicine, it has been employed to prevent or treat various ailments due to its diverse pharmacological actions, such as blood sugar and cholesterol-lowering effects, anticancer activity, and antioxidant properties [4]. Nutritionally, purslane is rich in alpha-linolenic acid (an omega-3 fatty acid), β-carotene, essential amino acids, vitamins (notably A, C, and E), alkaloids, coumarins, flavonoids (28%), polysaccharides, organic acids (6–12%), α-tocopherols, ascorbic acid, glutathione, and phenolic compounds [5]. Recent studies highlight its broad therapeutic potential, including muscle relaxant, analgesic, anti-inflammatory, antifungal, antifertility, antidiabetic, and wound healing effects [6]. Notably, Portulaca oleracea contains more omega-3 fatty acids than any other leafy green. It is also a source of essential dietary minerals like calcium, magnesium, potassium, and iron, as well as betacyanins with potent antioxidant activities. Additional phytochemicals include oxalates, flavonoids, alkaloids, and cardiac glycosides [7].

Importantly, the calcium-to-magnesium ratio in purslane is 1:1, which is considered optimal for calcium absorption and protective health effects. Among leafy greens, it ranks high in vitamin A content (1,320 IU/100 g, covering 44% of the recommended daily allowance). There are two main cultivars: golden purslane and green purslane. It is an annual, fleshy plant that can grow either horizontally or upright, notable for its high omega-3 and β-carotene content.

Epidemiological data from regions where purslane is consumed suggest lower rates of heart disease and cancer, potentially linked to its omega-3 content [8]. According to Skulski et al. [9], the plant's fresh leaves, slightly tangy in taste, are rich in iron and omega-3s—typically found in seeds. This has made it a valuable component in traditional Chinese medicine, used for its detoxifying, antibiotic, antifungal, and uterine-contracting properties, especially in treating dysentery. It has demonstrated efficacy comparable to sulfa drugs, showing over 90% effectiveness in acute conditions and 60% in chronic cases.

2. Nutritional profile of purslane

Portulaca oleracea L., commonly known as purslane, is a nutrient-rich leafy vegetable recognized for its exceptional water content and low calorific value. As presented in Table 2.1, 100 grams of fresh purslane provides approximately 84 kJ (20 kcal) of energy. It contains 3.39 g of carbohydrates, 0.36 g of lipids, and 2.03 g of protein, with 92.86 g of water, highlighting its hydrating potential. The plant is also a valuable source of micronutrients. It offers 1,320 IU of vitamin A, contributing to 44% of the recommended daily allowance (RDA), and moderate amounts of B-complex vitamins including thiamine (0.047 mg), riboflavin (0.112 mg), niacin (0.48 mg), vitamin B6 (0.073 mg), and folate (12 µg). Additionally, purslane contains 21 mg of vitamin C, a key antioxidant. In terms of mineral content, it supplies notable amounts of calcium (65 mg), iron (1.99 mg), magnesium (68 mg), manganese (0.303 mg), phosphorus (44 mg), potassium (494 mg), and zinc (0.17 mg) [10]. Importantly, it maintains a balanced 1:1 ratio of calcium to magnesium, which is regarded as optimal for effective calcium absorption and physiological functions. The nutritional profile

Table 2.1. Nutritional Composition of Fresh *Portulaca oleracea* L. (per 100 g)

Component	Amount per 100 g	Remarks
Energy	84 kJ (20 kcal)	Low calorific value

Water	92.86 g	High hydrating potential
Macronutrients		
Carbohydrates	3.39 g	—
Lipids	0.36 g	—
Protein	2.03 g	—
Vitamins		
Vitamin A	1,320 IU	44% of RDA
Thiamine (B1)	0.047 mg	Moderate content
Riboflavin (B2)	0.112 mg	Moderate content
Niacin (B3)	0.48 mg	Moderate content
Vitamin B6	0.073 mg	Moderate content
Folate	12 µg	Moderate content
Vitamin C	21 mg	Antioxidant function
Minerals		
Calcium	65 mg	Balanced with magnesium (1:1 ratio)
Magnesium	68 mg	Aids in calcium absorption
Iron	1.99 mg	—
Manganese	0.303 mg	—
Phosphorus	44 mg	—
Potassium	494 mg	High content
Zinc	0.17 mg	—

Petropoulos et al., 2016

Moreover, purslane contains mucilaginous compounds composed of both acidic and neutral fractions. This mucilage is reported to include malic acid, citric acid, dopamine, dopa, and other phytoconstituents such as coumarins, flavonoids, alkaloids, saponins, and urea.

3. Phytochemical Constituents of Purslane

A wide spectrum of phytochemicals has been identified in P. oleracea, underpinning its traditional medicinal uses and therapeutic properties. The plant contains tannins, phosphates, and urea, while saponins have also been reported [11]. The seeds are rich in sitosterols, and the leaves contain leavartenol [12]. Additionally, the plant harbors various mono-, di-, and triterpenes [13].

Two monoterpene glucosides, namely Portuloside A and Portuloside B, were isolated from the methanolic extract of the aerial parts in a Japanese study [14]. The plant also contains numerous free phenolic acids, such as chlorogenic acid, caffeic acid, p-coumaric acid, ferulic acid, and rosmarinic acid. Similarly, it is a source of diverse flavonoids, including quercetin, myricetin, luteolin, apigenin, genistein, genistin, and kaempferol.

Interestingly, flavonoid concentrations vary across the plant's morphological parts, with the highest content in roots, followed by stems, and the lowest in leaves [15].

Advanced phytochemical investigations have led to the identification of unique isoflavonoids from the aerial parts of P. oleracea, referred to as portulacanones:

- Portulacanone A (2′-hydroxy-5,7-dimethoxy-3-benzyl-chroman-4-one),
- Portulacanone B (2′-hydroxy-5,6,7-trimethoxy-3-benzyl-chroman-4-one),
- Portulacanone C (5,2′-dihydroxy-6,7-dimethoxy-3-benzyl-chroman-4-one), and
- Portulacanone D (5,2′-dihydroxy-7-methoxy-3-benzylidene-chroman-4-one) [16].

3. Pharmacological Activities

3.1 Antioxidant activity

Phenolic compounds extracted from the crude and fractionated Portulaca oleracea extracts demonstrated notable antioxidant properties, as determined by their ability to inhibit lipid peroxidation using the TBARS (thiobarbituric acid reactive substances) assay [17]. Purslane is a rich natural source of antioxidant vitamins such as α-tocopherol, ascorbic acid, β-carotene, and glutathione.

Uddin et al. [17] evaluated the efficacy of purslane in reducing oxidative stress caused by vitamin A deficiency. In their study, vitamin A-deficient male Wistar rats were divided into four dietary treatment groups over 30 days: a control group fed the AIN-93G vitamin A-deficient diet (DD); a group supplemented with pure β-carotene (β-D); and two groups receiving either Malanga (Xanthosoma sagittifolium) leaves (MD) or purslane leaves (PD) as the only vitamin A source. Parameters such as TBARS, reduced glutathione (GSH), oxidized glutathione (GSSG), and activities of antioxidant enzymes were analyzed in liver and heart tissues.

The results indicated that TBARS levels in the liver and heart of rats fed β-D, MD, and PD diets were significantly lower than in the DD group. Additionally, liver GSH concentrations were also lower in these groups compared to DD rats, suggesting that both Malanga and purslane leaves offer protective effects against oxidative damage induced by vitamin A deficiency.

Furthermore, three phenolic alkaloids—oleracein A (OA), oleracein B (OB), and oleracein E (OE)—isolated from P. oleracea, were investigated for their antioxidant capacities. These compounds were tested for their ability to scavenge DPPH (1,1-diphenyl-2-picryl-hydrazyl) radicals and inhibit hydrogen peroxide-induced lipid peroxidation in rat brain homogenates. While their DPPH scavenging ability was slightly less than caffeic acid, it exceeded that of ascorbic acid and α-tocopherol, with the potency ranking as OB > OA > OE. Among them, OE showed the highest inhibition of MDA formation, with an EC_{50} of 73.13 μM, closely comparable to that of caffeic acid (72.09 μM). These findings point to phenolic alkaloids as novel antioxidant agents present in purslane [8].

Anticancer Properties

Isoflavonoids extracted from the aerial parts of the plant showed strong anticancer effects against human gastric cancer cell line SGC-7901, with an IC_{50} of 1.6 μg/ml [16]. Specific phytochemicals such as (3R)-3,5-bis(3-methoxy-4-hydroxyphenyl)-2,3-dihydro-2(1H)-pyridinone and 1,5-dimethyl-6-phenyl-1,2-dihydro-1,2,4-triazin-3(2H)-one have also demonstrated efficacy in targeting human cancer cells [18].

Neuroprotective Potential

β-cyanins from *P. oleracea* enhanced antioxidant enzyme activity (SOD, catalase, glutathione peroxidase/reductase) while reducing malondialdehyde levels in D-galactose-induced mice, indicating neuroprotective effects [19].

Anti-Inflammatory Effects

Aqueous extracts of *P. oleracea* inhibited tumor necrosis factor, modulated NF-κB pathways, and reduced vascular inflammation, with activity dependent on the administered dose [20].

Neurological Impacts

Abdel-Moneim et al. [21]evaluated the extract's effects on various brain regions in rats. Treatment with 1.5 mL/kg aqueous extract for 12 days altered neurotransmitter levels (dopamine, norepinephrine, serotonin), enhanced acetylcholinesterase activity, and decreased calcium in the brain cortex. These changes may result from bioactive constituents like melatonin, omega-3 fatty acids, phenolics, and flavonoids, suggesting therapeutic potential in neurodegenerative disorders and depression due to lithium content.

Brain Function and Omega-3 Fatty Acids

Omega-3s in *P. oleracea* are vital for neurotransmission regulation, brain enzyme functions, and glucose transport. Deficiency reduces phosphatidylserine in the brain, whereas supplementation boosts dopamine levels and receptor binding [8].

Melatonin and Neurohormonal Actions

P. oleracea has higher melatonin than most fruits and vegetables, contributing to its antioxidative, anti-inflammatory, and immunoregulatory functions [22].

CNS Activity and Pain Management

Intraperitoneal ethanol extracts of *P. oleracea* showed sedative, anti-nociceptive, anticonvulsant, and muscle relaxant properties. Naloxone reversed these effects, implicating opioid receptors in the mechanism [23].

Anti-Inflammatory and Analgesic Activity

Ethanolic extracts of the leaf and stem demonstrated significant anti-inflammatory and analgesic effects when administered topically or intraperitoneally, outperforming diclofenac sodium in some cases [24].

Gastroprotective and Antiulcer Activity

Both aqueous and ethanol extracts protected against HCl- and ethanol-induced gastric lesions, increasing gastric pH in mice [25].

Liver Protection

Extracts alleviated carbon tetrachloride-induced liver damage by regulating hepatic enzymes and bilirubin [26].

Anti-atherogenic and Immune Modulation

Omega-3 fatty acids from *P. oleracea* mitigated high-cholesterol diet effects, showing promise for cardiovascular protection and immune modulation [27].

Kidney Protection

In cisplatin-induced renal toxicity models, aqueous extracts were more effective than ethanolic ones [28].

Antidiabetic Effects

Seed supplementation (5g twice daily) lowered blood glucose, triglycerides, LDL, and bilirubin, while increasing HDL and albumin, suggesting polysaccharides as active agents. Hypoglycemic effects were noted in diabetic, but not in healthy rats [4].

Cardiovascular Health

Omega-3s reduce heart attack risk, and compounds like levartenol regulate blood pressure and immune function [12].

Cholesterol Management

A 12-week oral administration of leaf extract reduced cholesterol levels in hypercholesterolemic rabbits [29].

Gynecological Uses

Seeds effectively managed abnormal uterine bleeding with no observed side effects or recurrence during a three-month follow-up [30].

Antifungal Activity

The plant inhibited fungal growth, particularly Trichophyton species [31].

Antibacterial Properties

Extracts showed effectiveness against both Gram-positive (e.g., *Staphylococcus aureus*) and Gram-negative bacteria (e.g., *E. coli*) [26].

General Antimicrobial Action

Various extracts (aqueous, ether, ethanol, chloroform, hexane) demonstrated inhibitory effects against bacteria like *B. subtilis* and fungi like *Aspergillus niger* and *Fusarium* spp. [32].

Anti-Obesity and Metabolic Benefits

Dietary inclusion of *P. oleracea* extracts in obese diabetic rats decreased body weight, lipid levels, and improved insulin sensitivity. The mechanisms involve reduced fat synthesis and increased lipid metabolism, potentially influenced by melatonin and other bioactive compounds [33].

Pain and Inflammation Modulation

Petroleum ether extracts reduced inflammatory pain and edema in animal models, supporting analgesic and anti-inflammatory effects [34]. TNBS-induced colitis models showed improved symptoms, reduced inflammation, and restored gut morphology with purslane treatment [35].

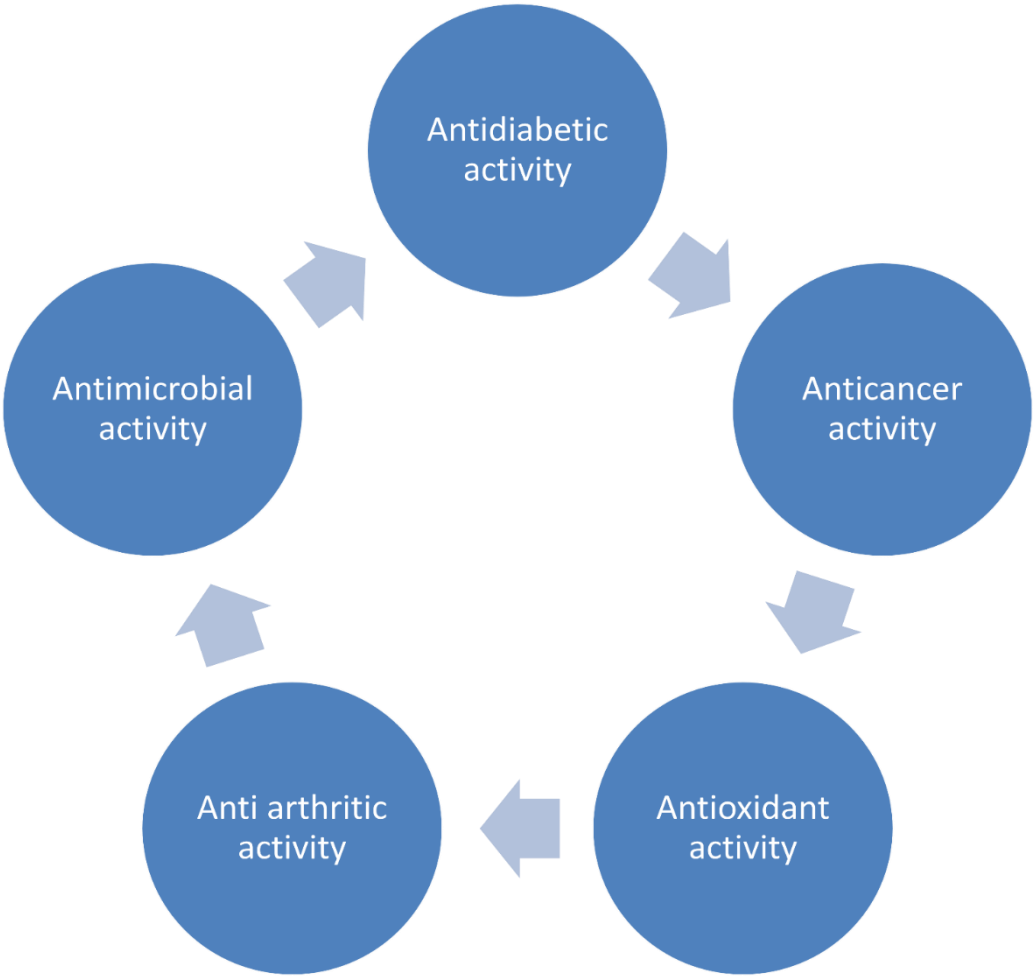

Fig. 1 Health Benefits of Purslane

5. **OTHER USES**

With a protein content reaching approximately 22–25%, Portulaca oleracea stands on par with other traditional forage crops and edible vegetables commonly utilized for protein supplementation, making it a viable option for both human diets and animal feed [36]. Nevertheless, consistent and excessive intake of purslane as livestock fodder has been associated with adverse effects such as lethargy, gastrointestinal disturbances like diarrhea

and colic, and potential damage to liver and kidney tissues. These health issues are thought to arise from elevated levels of free oxalates or bioactive compounds such as anthraquinones and coumarins [37]. Interestingly, such toxic responses have not been documented among Sudanese populations who regularly consume purslane as part of their traditional cuisine [37].

Moreover, purslane has been identified as a promising bioindicator species for assessing the quality of freshwater ecosystems and has potential use in detecting aluminium toxicity. Symptoms of aluminium stress in the plant vary with concentration and typically include suppressed root development and progressive leaf and stem decay. In terms of heavy metal accumulation, purslane ranks aluminium (Al) below cadmium and copper in binding capacity (Cd > Cu > Al > Zn > Hg > Se > Pb) [38].

Remarkably, purslane thrives even in industrially polluted areas laden with multiple heavy metals. It naturally exhibits robust biomass production due to its rapid growth, high regenerative ability, and short life cycle. Notably, it shows significant capacity to hyperaccumulate toxic metals such as cadmium (Cd), chromium (Cr), and arsenic (As), particularly in its root systems, making it a strong candidate for phytoremediation applications [39].

In addition, purslane leaves offer a novel source of natural gum, which has been recognized for its functionality as a stabilizing and emulsifying agent in food formulations [40].

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