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Review Article

Pharmaceutical analysis for Novel drug formulation

Purslane: A Nutritional Powerhouse and Multifunctional Medicinal Herb with Extensive Pharmacological Applications

Ashok Kumar BS

Department of Pharmacognosy, RL Jalappa College of Pharmacy, Sri Devaraj Urs Academy of Higher Education and Research (A Deemed to be University), Tamaka, Kolar, Karnataka, India.

Abstract: Purslane, commonly named *Portulaca oleracea L.,* belongs to the Portulacaceae family and is widely recognized for its medicinal and nutritional value. It commonly consumed in traditional diets across Mediterranean and Asian regions as it is rich with omega-3 fatty acids, flavonoids, alkaloids, and phenolic acids, which contribute to its therapeutic properties. In traditional medicine, it has been used as a febrifuge, antiseptic, and vermifuge, addressing ailments such as fever, dysentery, diarrhoea, eczema, and bleeding disorders. Recent studies have highlighted its pharmacological potential, driven by its diverse bioactive compounds. Purslane demonstrates significant antioxidant, anti-inflammatory, and antimicrobial activities, supported by the presence of alkaloids like oleraceins and isoindole derivatives, as well as flavonoids such as quercetin and kaempferol. It has been investigated for its protective effects against cardiovascular diseases, cancer, obesity, and diabetes, along with its neuroprotective properties in managing Alzheimer's and Parkinson's diseases. Its immunomodulatory, antiviral, anti-asthmatic, and hepatoprotective activities have been documented. Purslane also exhibits cytotoxic effects on cancer cell lines and holds potential as a therapeutic agent for inflammation, anxiety, and depression. Furthermore, its antimicrobial activity against a range of pathogens underscores its utility in combating infectious diseases. The plant's bioactive compounds, including specialized metabolites like cerebrosides and methoxylated flavone glycosides, enhance its pharmacological versatility. With its extensive therapeutic benefits and high nutritional profile, Purslane emerges as a multifunctional plant with promising applications in modern medicine and dietary practices. This review highlights its phytochemical composition, pharmacological activities, and potential role in disease management.

Keywords: Purslane, omega-3 fatty acids, alkaloids, glycosides, anti-inflammatory.

***Corresponding Author**

Ashok Kumar BS , Department of Pharmacognosy, RL Jalappa College of Pharmacy, Sri Devaraj Urs Academy of Higher Education and Research (A Deemed to be University), Tamaka, Kolar, Karnataka, India.

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1. INTRODUCTION

Purslane is a succulent, herbaceous annual plant belonging to the Portulacaceae family. It has a cosmopolitan distribution and thrives in tropical and subtropical regions worldwide. This plant is known by various names across different cultures, such as *rigla* (Egypt), *pigweed* (England), *pourpier* (France), and *Ma-Chi-Xian* (China). Purslane is widely consumed as a nutritious food source and is added to soups, salads, and stews, particularly in Mediterranean and tropical Asian countries. In addition to its culinary uses, purslane has been recognized for its significant medicinal properties, earning the title of "Global Panacea" by the World Health Organization [1]. Purslane has a long history of use in traditional medicine across various cultures, where it is often valued for its broad spectrum of therapeutic effects. In folk medicine, purslane is commonly used as a febrifuge, antiseptic, and vermifuge. It has been employed to treat a variety of ailments, including fever, dysentery, diarrhoea, eczema, and bleeding disorders. It is also considered to have a cooling effect on the body, aiding in detoxification, blood circulation, and promoting overall healing. Native Americans and Australian Aborigines, for instance, ground the seeds of purslane into flour to prepare bread and mush [1-3].

1.1 Nutritive value

Beyond its medicinal properties, purslane is also esteemed for its high nutritional value. It is a rich source of omega-3 fatty acids, particularly alpha-linolenic acid, and contains various bioactive compounds such as flavonoids, alkaloids, and vitamins, which contribute to its anti-inflammatory, antioxidant, and antimicrobial properties. The plant is also utilized in the treatment of conditions like hypertension, cardiovascular diseases, and even cancer, with some studies demonstrating its cytotoxic effects on human cancer cell lines [4,5]. Traditional uses of purslane vary across regions. In Armenia, it is employed to treat conditions like impotence, stroke, urinary tract infections, psoriasis, liver and stomach ailments. The fresh juice of purslane is known for its anthelmintic properties, while crushed seeds mixed with honey are used to alleviate asthma attacks. Similarly, in Azerbaijan, purslane is used to treat diarrhoea and dysentery and as an antipyretic. The leaves and seeds are often prepared as poultices or decoctions to address various health concerns. Purslane is also incorporated into traditional culinary practices. In Georgia, it is used in *mkhali* (an herb and walnut spread) and is often combined with other herbs like *Urtica dioica* (nettle) and *Chenopodium album* (goosefoot). Purslane is pickled or consumed fresh, mixed with oil, vinegar, and spices [6,7].

1.2 Phytochemical constituents

Purslane is a medicinal plant known for its diverse pharmacological properties, primarily due to its rich phytochemical composition. The plant contains a wide array of bioactive compounds, including alkaloids, flavonoids, terpenoids, saponins, phenolic acids, and omega-3 fatty acids, which contribute to its therapeutic effects. Among the alkaloids, the cyclodopa derivatives, such as oleraceins A, B, C, N, J, and U, have been identified and are known for their anti-inflammatory and anti-cancer activities. Additionally, a new isoindole alkaloid, oleraisoindole B, was isolated, which exhibited significant anti-inflammatory activity [8-11]. Flavonoids, including quercetin, kaempferol, and isorhamnetin, are abundant in purslane, particularly in the leaves, and are well-known for their antioxidant, anti-inflammatory, and anticancer properties. These flavonoids play a key role in the plant's ability to combat oxidative stress and inflammation, making it valuable for treating a variety of health issues [4,12]. Purslane also contains phenolic acids, such as rosmarinic acid, and omega-3 fatty acids, which are beneficial for cardiovascular health, reducing inflammation, and supporting overall metabolic function. Specialized metabolites such as cerebrosides and methoxylated flavone glycosides have also been reported, further adding to the plant's pharmacological repertoire [13]. This unique combination of bioactive compounds, present in varying concentrations depending on the plant part, underscores Purslane's medicinal value. The plant’s phytochemical diversity supports its traditional use in treating a wide range of ailments, including inflammation, obesity, cardiovascular diseases, and cancer. Purslane's extensive bioactivity highlights its potential as a multifunctional therapeutic agent.

2. PHARMACOLOGICAL ACTIVITIES OF PURSLANE

2.1. Anticancer activity

Purslane, commonly known as purslane, is recognized for its medicinal properties, including its potential anticancer effects. Research has highlighted the various bioactive compounds in purslane, such as polysaccharides, phenolic compounds, and alkaloids that contribute to its cancer-inhibitory properties. These compounds exhibit a range of mechanisms that may help prevent or inhibit cancer progression. One major pathway through which purslane exerts its anticancer effects is the regulation of the Wnt/β-catenin signalling pathway. Studies have demonstrated that *P. oleracea* extract can reduce the expression of key proteins like c-Myc and cyclin D1, which are known to promote cancer cell proliferation and survival. By inactivating the Wnt/β-catenin pathway, *P. oleracea* effectively suppresses colorectal cancer cell growth, reduces tumor development, and restores the balance of the gut microbiota, further supporting its anticancer potential [14]. In addition, purslane's ability to enhance antioxidant activity plays a crucial role in cancer prevention. The plant's high levels of phenolic compounds and flavonoids have been shown to neutralize free radicals, reduce oxidative stress, and protect cells from DNA damage, which is a key factor in cancer initiation and progression. Studies on purslane extract in functional food products, such as yogurt, have also demonstrated its antioxidant properties, with notable effects on reducing oxidative damage and promoting overall health [15]. Further *in vitro* and *in vivo* research supports the anticancer activities of Purslanepolysaccharides. In animal models of gastric cancer, Purslaneadministration enhanced immune responses, increased the production of important cytokines (such as IL-2, IL-4, and TNF-α), and improved oxidative defense mechanisms. The results indicated that PPs not only boost the immune system but also protect against oxidative damage, contributing to the anticancer effects[16]. Overall, the combination of antioxidant, anti-inflammatory, and immune-modulatory properties of Purslane, alongside its influence on key molecular signalling pathways, makes it a promising candidate for cancer prevention and therapy. Future studies will likely focus on further elucidating these mechanisms and exploring its potential as a functional food ingredient with anticancer benefits.

2.2. *Antioxidant Activities*

Purslane antioxidant activity has been quantified using various methods, including the 1,1-diphenyl-2-picrylhydrazyl (DPPH) and ferric-reducing antioxidant power (FRAP) assays. DPPH scavenging activity showed IC50 values ranging from 1.30 to 3.29 mg/mL, while FRAP values varied significantly across accessions, with some reaching up to 104.2 mg/g DW. Notably, mature plants exhibited higher antioxidant activities than immature ones, correlating with increased total phenol content (TPC) and total flavonoid content (TFC). For instance, TPC in some cultivars ranged from 127 to 478 mg GAE/100 g, showcasing a strong correlation with antioxidant activity. Fractionation of purslane extracts further highlighted specific components, such as chlorogenic, caffeic, p-coumaric, ferulic, and rosmarinic acids, along with flavonoids like quercetin and kaempferol, as major contributors to its antioxidant properties [17,18]. Processing methods like steaming influence antioxidant activities. Raw purslane extracts demonstrated superior free radical quenching capacity (ABTS and DPPH assays) compared to steamed extracts, with a notable reduction in phenolic content post-processing. However, cooking methods like the addition of lemon juice have been reported to enhance antioxidant activity. Overall, Purslane stands out as a potent natural source of antioxidants with applications in food, nutraceutical, and pharmaceutical industries, making it a valuable functional food ingredient [19-22].

2.3. *Hepatoprotective activity*

In carbon tetrachloride (CCl_4) -induced hepatotoxicity models, Purslane treatment significantly restored liver function marker enzymes such as aspartate transaminase, alanine transaminase, and alkaline phosphatase to near-normal levels. Histopathological analyses confirmed the protective effects by showing reduced liver damage comparable to silymarin, a standard hepatoprotective agent [23]. In ethanol-induced liver injury, Purslane reduced oxidative stress markers, enhanced antioxidant enzymes like superoxide dismutase and glutathione peroxidase, and decreased the levels of malondialdehyde nitric oxide, and pro-inflammatory cytokines such as tumour necrosis factor-alpha and interleukin-6. It also mitigated hepatic steatosis by regulating lipid metabolism, as evidenced by decreased triglycerides and alterations in the expression of key enzymes like acetyl coenzyme A carboxylase and lipoprotein lipase [24]. In acetaminophen-induced hepatotoxicity, *P. oleracea* prevented oxidative damage by sustaining glutathione levels, reducing ROS activity, and inhibiting c-Jun N-terminal kinase activation. It downregulated inflammatory cytokines (TNF-α, IL-6) and ameliorated liver histological damage [25]. Purslaneprotective effects were also observed in bile duct ligation models, where it reduced inflammation, hydroxyproline content, and pro-inflammatory gene expression, demonstrating its broad-spectrum hepatoprotective potential. Collectively, these findings highlight Purslane as a promising candidate for the prevention and treatment of various types of liver injuries, warranting further investigation into its bioactive components and clinical applications [26]. Purslane exhibits significant hepatoprotective activity through its antioxidant, anti-inflammatory, and lipid-regulating properties. Various studies demonstrate its effectiveness in alleviating liver injuries caused by agents such as CCl4, ethanol, and acetaminophen.

2.4. *Anti-inflammatory Activity*

Inflammation is a protective response to harmful stimuli, but chronic inflammation can lead to tissue and cellular damage. Purslane and its bioactive constituents demonstrate significant anti-inflammatory properties. Key compounds such as oleracone and oleracimine inhibit nitric oxide production and suppress the secretion of pro-inflammatory mediators, including interleukin-6, tumour necrosis factor-alpha (TNF-α), prostaglandin E2, and the expression of cyclooxygenase-2 and inducible nitric oxide synthase [27,28]. Purslane extracts, in lipopolysaccharide (LPS)-stimulated macrophages, dose-dependently reduced NO production and cytokines like TNF-α and IL-1β. Aqueous extracts inhibited reactive oxygen species (ROS) production, as well as Intercellular adhesion molecule 1 (ICAM-1) and Vascular cell adhesion molecule 1 (VCAM-1) and E-selectin expression in TNF-α-stimulated endothelial cells, thereby preventing immune cell adhesion and suppressing NF-κB activation. Ethanolic extracts attenuated NF-κB signaling and reduced cytokine levels in pulmonary and vascular inflammation models [28,29]. Polysaccharides from purslane exhibited anti-inflammatory effects in diabetic rat models by reducing TNF-α and IL-6 levels, addressing cytokine-driven inflammation associated with insulin resistance. The omega-3 fatty acids in Purslane leaves further contributed to anti-inflammatory activity. *In vivo* studies highlighted the effectiveness of *P. oleracea* extracts in lowering TNF-α, IL-1β, and IL-6 levels in lung, liver, and vascular inflammation models while improving immune cell function and reducing ROS levels [30]. In neuroinflammation models, Purslane extracts enhanced memory and reduced inflammation markers. Oleracone, a novel compound with high bioavailability, demonstrated significant inhibition of NO production and cytokine secretion, emphasizing its therapeutic potential. These findings establish Purslane as a promising agent for managing acute and chronic inflammatory conditions, providing safer alternatives to conventional therapies [31].

2.5. *Antidiabetic Activity*

Purslane has gained attention for its potential antidiabetic effects. Recent studies have systematically investigated its bioactive components, such as polysaccharides, and their therapeutic mechanisms. A crude water-soluble polysaccharide extracted from purslane, has demonstrated notable effects on diabetic animal models. In diabetic rats, Purslane significantly improved body weight, fasting blood glucose levels, glucose tolerance, and insulin sensitivity index (ISI). It also elevated fasting serum insulin levels and reduced pro-inflammatory markers like tumour necrosis factor-α (TNF-α) and interleukin-6. Additionally, Purslane decreased oxidative stress markers, including methane dicarboxylic aldehyde, while enhancing superoxide dismutase activity in liver tissue. These findings suggest that the antidiabetic effects of purslane are closely linked to its antioxidant and anti-inflammatory properties [32-35]. Further studies on high-fat diet (HFD)-induced obese mice revealed that dietary supplementation with purslane powder (5% or 10%) significantly mitigated weight gain, reduced fat accumulation, and improved blood glucose control. Purslane-treated groups showed lower atherogenic index (AI) and cardiac risk factor scores, along with enhanced protein expression of glucose transporter 4 and proliferator-activated receptors (PPAR-α and PPAR-γ). Reduced levels of TNF-α and improved insulin sensitivity were also observed, highlihting its role in lipid metabolism regulation and glycemic control [36,37]. In another model, intraperitoneal injections of purslane extract significantly reduced glucose levels and serum triglycerides, cholesterol, and liver enzyme markers, while increasing high-density lipoprotein cholesterol. Histopathological analyses confirmed the regenerative effects of purslane on pancreatic β-cell mass, suggesting its capacity to protect and restore islet cell function. Additionally, reduced HbA1c levels and inflammatory cytokines were accompanied by increased C-peptide and insulin levels in diabetic rats [38]. These findings collectively underline the potential of Purslane. as a natural, multifaceted therapeutic agent for diabetes management. Its ability to reduce inflammation, combat oxidative stress, improve insulin sensitivity, and enhance β-cell function positions purslane as a promising candidate for diabetes prevention and treatment strategies.

2.6. Neurodegenerative diseases

2.6.1. Alzheimer's disease

Studies on purslane have highlighted its potential neuroprotective properties in Alzheimer's disease. Specific compounds isolated from purslane, such as benzoic acid derivatives and trace alkaloids like oleraisoindole A, demonstrate dose-dependent anticholinesterase activity, offering a possible mechanism for mitigating memory loss. Furthermore, polysaccharides extracted from purslane were found to protect PC12 cells from neurotoxicity by reducing reactive oxygen species and enhancing cell survival. In vivo studies have shown that these polysaccharides improved learning and memory impairments in animal models by increasing antioxidant enzyme activity (e.g., superoxide dismutase, catalase, and glutathione peroxidase) while reducing oxidative stress markers like malondialdehyde [39-42]. Betacyanins from purslane also exhibit significant antioxidant effects, enhancing cognitive function and reducing oxidative damage in brain tissues of memory-impaired mice. These effects were reported to surpass those of vitamin C in certain studies. Additionally, ethanolic and aqueous extracts of purslane improved spatial memory, reduced oxidative stress, and mitigated structural brain damage in various animal models, including those with diabetes-induced neurobehavioral deficits [43-45]. While preclinical evidence supports purslane's potential in managing Alzheimer's disease through antioxidant, anti-inflammatory, and anticholinesterase mechanisms, a lack of clinical trials remains a significant limitation. Further research, including human studies, is necessary to validate these findings and explore purslane's therapeutic role in Alzheimer's disease management.

2.6.2. Parkinson's disease

Research on Purslanehas highlighted its potential neuroprotective effects in Parkinson's disease. Oleracein E, a compound isolated from purslane, has shown promise in both *in vitro* and *in vivo* models of rotenone-induced Parkinson's disease [46]. *In vitro* studies demonstrated that Oleracein E reduced cytotoxicity and apoptosis in SH-SY5Y cells by decreasing Bax expression, caspase-3 activation, cytochrome C release, reactive oxygen species (ROS) levels, and ERK1/2 phosphorylation. *In vivo*, it improved motor function, increased antioxidant enzyme activity [47,48], preserved tyrosine hydroxylase-positive neurons, and reduced oxidative stress markers like malondialdehyde in the substantial nigra and striatum. Additional studies have shown that purslane extracts increase antioxidant enzyme activities (e.g., catalase, glutathione peroxidase, and superoxide dismutase) and reduce markers of oxidative stress, including ROS, lipid peroxidation, protein carbonyl levels, and hydrogen peroxide. The herb also demonstrated anti-inflammatory effects by attenuating the expression of nuclear factor kappa B (NF-κB) and inducible nitric oxide synthase (iNOS). Furthermore, purslane reduced apoptosis by increasing Bcl-2 levels and inhibiting caspase-3 activation [48]. Animal studies using aqueous and ethanolic extracts of purslane revealed motor function improvement and attenuation of tyrosine hydroxylase cell loss, with the aqueous extract showing greater efficacy. In a Drosophila model of Parkinson's, purslane aqueous extract improved locomotor ability, reduced dopaminergic neuron degeneration, and slowed disease progression. Methanolic extracts of purslane seeds also scavenged free radicals, reduced ROS, and ameliorated cataleptic behavior in rodent models [49]. Overall, purslane exhibits potential neuroprotective effects in Parkinson's disease by reducing oxidative stress, inflammation, and apoptosis, as well as preserving dopaminergic neurons and motor function. Despite these promising findings, further clinical trials are needed to confirm its therapeutic benefits in managing Parkinson's disease.

2.6.3. Depression

The pathophysiology of depression involves multiple overlapping mechanisms. Early theories focused on monoamine dysfunction, such as altered synthesis or receptor expression of neurotransmitters like serotonin, norepinephrine, and dopamine. Recent studies have expanded to include factors such as cortisol dysregulation, which impairs neurogenesis, reduced levels of brain-derived neurotrophic factor (BDNF), disruptions in gamma-aminobutyric acid (GABA) ergic and glutamatergic systems, irregular circadian rhythms, and inflammatory cytokine changes. Hormonal disturbances, such as those involving corticotropin-releasing hormone, adrenocorticotropic hormone (ACTH), and cortisol, have also been implicated in specific forms like postpartum depression [50]. Purslane demonstrates potential antidepressant effects due to its rich content of beneficial minerals like lithium, folate, calcium, potassium, and magnesium. These components are thought to contribute to its mood-enhancing properties. Research has shown that aqueous extracts of purslane significantly reduced immobility times in rodent models of depression, such as the forced swim test and tail suspension test. However, the antidepressant effects were mitigated by pre-treatment with NBQX, an AMPA receptor antagonist, suggesting that the antidepressant action might involve AMPA receptor modulation. Another study reported that purslane extract reduced immobility times and ACTH levels, with effects comparable to diazepam, further supporting its antidepressant potential [51].

2.6.4. Anxiety

Purslane has shown anxiolytic potential in preclinical studies. Mice treated with ethanol extracts of purslane demonstrated increased time spent and entries into the open arms of an elevated plus maze, indicating reduced anxiety. These effects were reversed by flumazenil, a GABAA receptor antagonist, but not by WAY 100635, a 5-HT1A receptor antagonist, suggesting that purslane's anxiolytic effects are mediated through the GABAergic system. Similarly, intraperitoneal administration of aqueous extracts of purslane dose-dependently reduced anxiety in mice, increasing open-arm entries and time spent in open arms in comparison to controls [52,53]. These findings suggest that purslane may be a promising natural alternative for managing depression and anxiety, acting through mechanisms that involve modulation of AMPA receptors in depression and GABAergic pathways in anxiety. Further research, particularly clinical trials, is needed to confirm these therapeutic benefits [54].

2.7. Immunomodulatory activity

Purslane exhibits significant immunomodulatory activity through various bioactive components, including polysaccharides, flavonoids, alkaloids, and omega-3 fatty acids. Polysaccharides isolated from Purslanehave demonstrated the ability to activate macrophages, enhancing the production of cytokines like IL-10, IL-12, and TNF-α via ERK and NF-κB signaling pathways [55,56]. These polysaccharides also induce a balanced Th1/Th2 immune response by elevating cytokine levels such as IFN-γ and IL-10, and augmenting humoral immunity, as evidenced by increased titers of specific IgG antibodies in immunized mice. Furthermore, flavonoid compounds, including quercetin, kaempferol, and rutin, contribute to its anti-inflammatory and antioxidant effects by mitigating oxidative stress and reducing proinflammatory cytokines. Studies have shown that extracts of Purslane can modulate immune responses, enhance splenic lymphocyte proliferation, and restore immune function in cyclophosphamide-induced immunosuppression models. Additionally, its alkaloids, such as oleracone and oleracimine, inhibit inflammatory mediators like IL-6 and nitric oxide [57,58]. These findings underscore the potential of Purslane as an immune-enhancing agent, highlighting its applications in managing inflammation, immunosuppression, and as an adjuvant in vaccine formulations.

2.8. Antiviral Activity

Purslane exhibits potent antiviral activity against various pathogens. Its water extract of Purslane effectively inhibits the replication of *influenza A virus* (IAV), particularly the H1N1 strain, with a low half-maximal effective concentration and high selectivity index. Purslane suppresses the production of H1N1 and H3N2 viruses, primarily by inhibiting viral binding to host cells and displaying strong virucidal activity, significantly reducing viral load within 10 minutes [59]. Similarly, Purslanedemonstrates antiviral effects against porcine epidemic diarrhea virus, replication by over 90% *in vitro* by downregulating the expression of the S protein, modulating cytokine levels, and suppressing the NF-κB signaling pathway [60]. Additionally, the methanolic extract of Purslaneshows over 70% inhibition of Hepatitis C virus (HCV) replication, targeting the NS3 serine protease in a dose-dependent manner, suggesting its potential as a complementary therapy for HCV [61]. The polysaccharide fraction of Purslanealso exhibits anti-rotavirus (PoRV) activity by reducing viral protein expression and titre during the internalization and replication stages [62]. It achieves this through immunomodulatory effects, enhancing IFN-α and reducing pro-inflammatory cytokines like TNF-α, IL-6, and IL-10. These findings underscore the promising antiviral potential of Purslane against diverse viral pathogens.

2.9. Antiasthmatic activity

Purslane and its constituents, particularly quercetin, have shown significant antiasthmatic activity by modulating inflammatory responses, improving airway responsiveness, and directly relaxing respiratory smooth muscles. The plant reduces pro-inflammatory cytokines such as IL-4, IL-1β, and TNF-α while increasing anti-inflammatory markers like IFN-γ and IL-10, thereby restoring the Th1/Th2 balance [63]. It also decreases IgE levels in bronchoalveolar lavage fluid (BALF) and reduces lung inflammation markers such as PLA2 and total protein (TP). Bronchodilatory effects are achieved through β2-adrenoceptor stimulation, muscarinic receptor inhibition, and mechanisms like potassium channel activation, calcium channel blockade, and phosphodiesterase inhibition [64,65]. Clinical and experimental studies have demonstrated significant improvements in pulmonary function tests, airway hyperresponsiveness, and tracheal smooth muscle relaxation. Notably, these findings suggest that Purslane could serve as a promising natural therapeutic for asthma, offering both symptomatic relief and preventive benefits through its anti-inflammatory, bronchodilatory, and immunomodulatory actions.

2.10. Antimicrobial activity

The antimicrobial activity of Purslane has been extensively studied using various extracts and methods. Chloroform and ethanol extracts of the aerial parts, tested at a concentration of 40 mg/mL against five bacterial and three fungal species, demonstrated significant activity through the agar diffusion method. *Staphylococcus aureus*, *Bacillus cereus*, and *Klebsiella pneumoniae* were the most sensitive bacterial species, while *Aspergillus fumigatus* and *Neurospora crassa* showed the highest sensitivity among fungi. Conversely, *Pseudomonas aeruginosa* and *Escherichia coli* displayed resistance to these extracts. These findings support the potential of *P. oleracea* as a source of antimicrobial compounds [66,67]. Further investigations using subcritical CO2 extraction identified 41–66 components in the extracts, which exhibited significant activity against clinically relevant microorganisms, including *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, and *Candida albicans* [68]. Ethanolic and acetone extracts demonstrated the most potent antimicrobial properties. Ethanolic extracts showed minimum inhibition concentration (MIC) values as low as 0.05–0.73 mg/mL against pathogens like *S. aureus*, *E. coli*, *Micrococcus luteus*, *Fusarium oxysporum*, and *Aspergillus flavus* [69]. Overall, the results highlight *P. oleracea*'s rich phytochemical profile, including phenols, flavonoids, and alkaloids, which contribute to its antimicrobial efficacy. These findings underline its potential as a natural alternative for developing new antimicrobial agents to combat infectious diseases caused by multidrug-resistant pathogens.

2.11. Antiulcer activity

Purslane demonstrates significant anti-ulcer activity, supported by various studies such as ethanol, aspirin, cold restraint stress, and pyloric ligation, likely by modulating oxidative stress and enhancing mucosal defenses [70]. On animal models of gastric ulceration. Ethanolic and aqueous extracts of purslane have shown a dose-dependent reduction in ulcer severity in ethanol and acetic acid-induced ulcer models. These extracts enhance gastric defense by inhibiting lipid peroxidation, increasing catalase activity, and decreasing superoxide dismutase levels [71]. In pylorus-ligated models, purslane reduced gastric acidity and pepsin secretion while elevating gastric juice pH [72]. Ethyl acetate fractions of purslane exhibited strong anti-ulcer effects by reducing histamine levels, inhibiting H^+/K^+ ATPase activity, and lowering malondialdehyde levels, thereby preventing oxidative damage to the gastric mucosa [73]. Histopathological studies confirmed that purslane extract mitigates gastric mucosal damage and preserves tissue integrity. Additionally, purslane showed cytoprotective effects mediated through increased mucus secretion and reduced pro-inflammatory markers. These findings validate the traditional use of purslane in managing peptic ulcers and highlight its potential as a natural gastroprotective agent [74].

3. CONCLUSION

In conclusion, Purslane demonstrates remarkable potential as a functional food and therapeutic agent due to its rich nutritive value and diverse phytochemical profile. Its bioactive compounds contribute to significant pharmacological activities, including anticancer, antioxidant, hepatoprotective, anti-inflammatory, and antidiabetic effects. Additionally, its neuroprotective properties suggest potential benefits for Alzheimer's, Parkinson's, depression, and anxiety. The plant also exhibits immunomodulatory, antiviral, antimicrobial, antiulcer, and antiasthmatic properties, further emphasizing its medicinal value. While promising, further clinical studies are needed to validate these findings and optimize its applications in modern medicine and healthcare is a valuable plant with a rich phytochemical composition and remarkable pharmacological properties. Its bioactive compounds, including omega-3 fatty acids, flavonoids, alkaloids, and phenolic acids, contribute to its diverse therapeutic benefits, such as antioxidant, anti-inflammatory, antimicrobial, and neuroprotective activities. The plant's potential in managing various diseases, including cardiovascular diseases, cancer, diabetes, and neurological disorders, underscores its significance in modern medicine. Purslane's versatile pharmacological profile, combined with its high nutritional value, highlights its potential as both a functional food and a therapeutic agent in disease prevention and treatment. Future research on this plant should focus on detailed clinical trials to validate its therapeutic efficacy and safety for human use. Advanced pharmacokinetic and pharmacodynamics studies are essential to understand its bioavailability and mechanism of action. Exploring synergistic effects with conventional drugs could enhance its medicinal applications. The development of standardized extraction and formulation techniques will facilitate its use in pharmaceuticals and nutraceuticals. Further studies on its molecular pathways, potential toxicity, and long-term effects will help establish it as a reliable treatment option for various diseases, paving the way for its integration into modern medicine.

4. CONFLICT OF INTEREST

Author declared no Conflict of interest.

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