

Purslane (*Portulaca oleracea*) - nutritional value and food uses

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Abstract

Throughout history, humanity has used approximately 7000 plant species for food, fodder, medicine, clothing, and shelter, but only about 200 species are used today. *Portulaca oleracea* is one of the most common eight plants worldwide and can thrive in various environments, including flower beds, cornfields, and waste areas. It is mainly used in green salads and vegetable juices. It can be used to treat burns, headaches and diseases associated with the intestine, liver, stomach, cough, breathing difficulties and arthritis. It has important applications in herbal medicine as a laxative, cardiac stimulant, muscle relaxant, and anti-inflammatory and diuretic treatment. Purslane is recognized as a valuable source of nutraceutical compounds such as omega-3 fatty acids, vitamins A and E, essential amino acids, and polyphenols, all of which have a positive impact on human health and nutrition.

Key words: purslane (*Portulaca oleracea*), portulaca oleracea, chemical compounds, food

1. Introduction

It is estimated that the global population will reach 10 billion people by 2050, an alarming prospect given that ten children already die of hunger every minute. This demographic growth will generate an increased demand for food. However, unsustainable agricultural practices and the use of conventional crops will not be able to meet these challenges. Abiotic factors such as temperature variations, precipitation, CO₂ levels, and rising fertilizer costs exacerbate the problem, leading to soil fertility loss and increased salinity [1, 2, 3].

The lack of regular access to food with a high and sufficient nutritional intake exposes the population to an increased risk of malnutrition and health problems. Although this problem is prevalent in low- and middle-income countries, moderate or severe food insecurity also affects 8% of the population in North America and Europe [3].

Throughout history, humanity has used approximately 7,000 plant species for food, fodder, medicine, clothing, and shelter, but

only about 200 species are used today. This reduction in crop diversity has led to the loss of traditional foods, which are often an integral part of the culture and diet of the communities that cultivate them. It is essential to review plant species based on their nutritional and nutraceutical characteristics, especially those that are underutilized, as they can contribute to food security, particularly in certain rural areas and regions with very low levels of subsistence [1].

Portulaca oleracea L., commonly known as purslane, is an annual, succulent herb from the Portulacaceae family, widespread across the globe, especially in temperate and tropical regions, including Europe, Africa, North America, Australia, and Asia, with the highest prevalence in India and the Mediterranean basin. *Portulaca oleracea* is one of the most common eight plants worldwide and can thrive in various environments, including flower beds, cornfields, and waste areas. It is mainly used in green salads and vegetable juices [4-7].



Figure 1. *Portulaca oleracea* - the purslane (plant, flower, seeds)[34,35]

Portulaca oleracea plants bloom 20-30 days after sprouting, producing a single yellow flower with five petals at the tips of the stems. These flowers generate pods filled with tiny seeds. A plant can produce between 4 and 15 seeds per pods, depending on environmental conditions. The leaves of *Portulaca oleracea* are succulent,

glossy, small, with red edges, and tear-drop or wedge-shaped. They are attached to the stems and arranged alternately at the lower end of the stems, clustered at the tips. The stems are smooth, branched, often exhibiting shades of pink or red, and extend up to 20 centimeters outward from the central root [7].

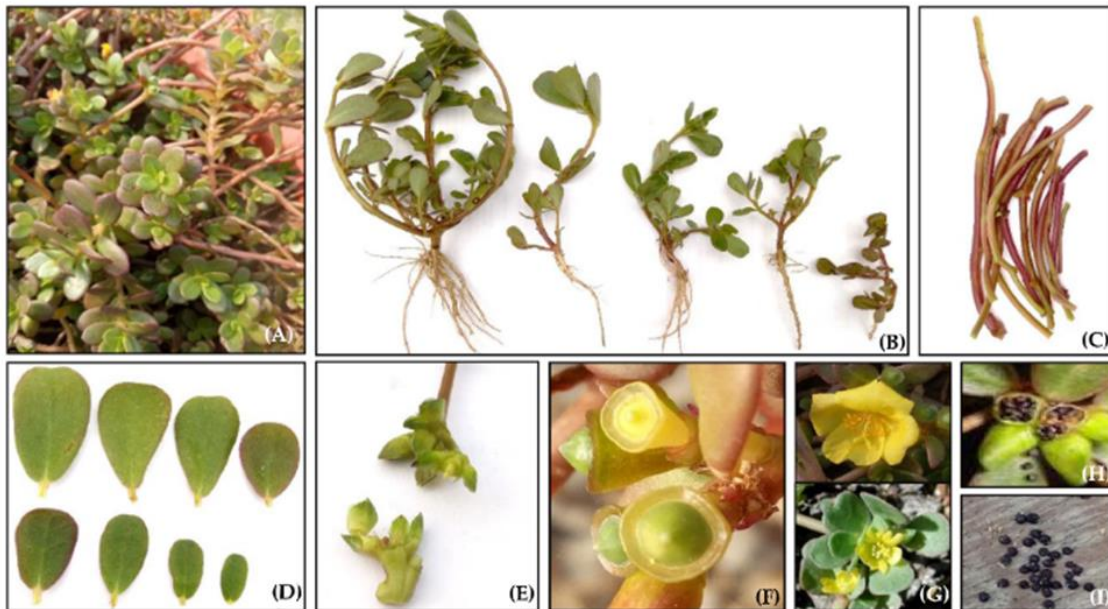


Figure 2 (A)-*Portulaca oleracea*, (B) various plant stages, (C) tender stems, (D) various stages of juicy green leaves, (E) stem bearing a bunch of capsules, (F) capsule after release flowers (G) flowers, (H) black seeds inside capsule (I) dry seeds [25]

2. *Portulaca oleracea* - Medicinal benefits

Purslane (*Portulaca oleracea* L.) is recognized by the World Health Organization (WHO) as one of the most widely used medicinal plants, being referred to as the "Global Panacea"[7,8]. *P. oleracea* L. has been used as food and medicinal plant for thousands of years in various countries. In China, it has been an integral part of traditional Chinese medicine, used to treat dysentery with blood in the stool, as well as for the external treatment of boils, wounds, eczema, erysipelas, and insect and snake bites. Numerous studies have highlighted a wide range of biological effects, including a

relaxing effect on skeletal muscles, analgesic and anti-inflammatory effects, antifungal activity, antifertility effects, and anti-aging properties [6].

Purslane has strong regenerative effects at the cellular level and is rich in antioxidants, beta-carotene, vitamin C, and vitamin E. It also contains a significant amount of omega-3 fatty acids [4,9], which help reduce wrinkles. All these substances are powerful antioxidants that can contribute to improving the appearance of the skin and even prevent the future signs of aging by reducing damage caused by UV radiation. Purslane is an essential element in human nutrition,

improving blood circulation and stimulating the cellular repair process, which can reduce the appearance of scars and wrinkles. Furthermore, this plant is studied pharmacologically for its antifungal, anti-inflammatory, antioxidant, antimicrobial, and wound-healing properties [4].

Portulaca oleracea was considered in ancient times to be one of the plants with anti-magic powers, and it was said that scattering it around a bed offered protection against evil spirits. Young leaves are successfully added to salads, and their mucilaginous quality makes them an effective substitute for okra in soups. More mature leaves are used as medicinal plants. The seeds can be ground into powder and mixed with cereals to be used

in porridge, bread, or pancakes. The plant has antibacterial, antiscorbutic, depurative, diuretic, and febrifuge properties. Fresh juice is used to treat coughs and pains. The leaves are applied as poultices on burns. Additionally, tea made from the leaves is used to treat stomach and headaches. Leaf juice is used for earaches and is said to relieve insect stings. The leaves can be harvested at any time before the plant flowers and can be used fresh or dried. It is important not to administer this remedy to pregnant women or people with digestive problems. The seeds are tonic and vermifuge, being prescribed for dyspepsia and corneal opacities. This plant can be used as an insecticide by pouring its juice on ants.

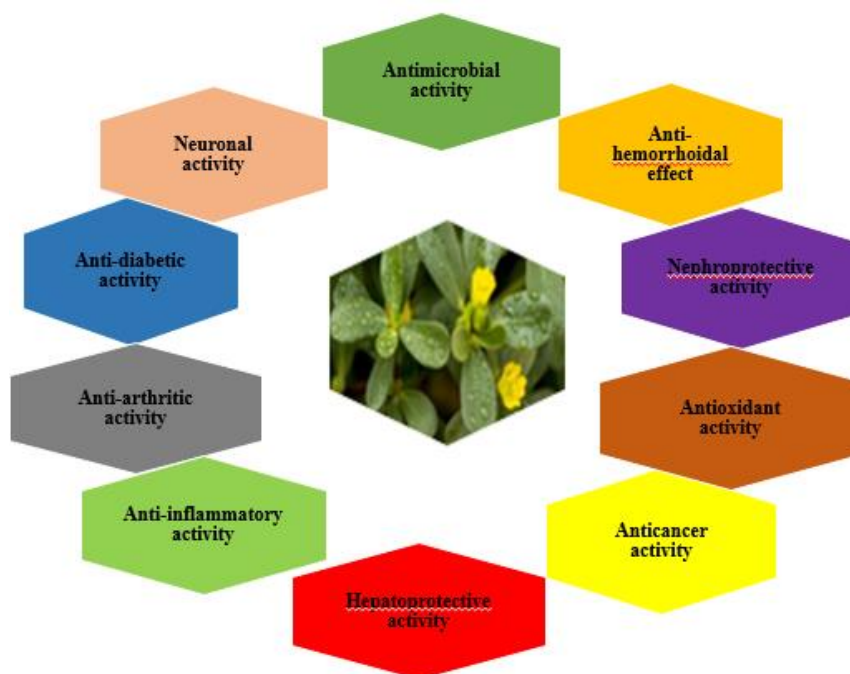


Figure 3. Pharmacological activities of *Portulaca oleracea* [11,12, 30]

Portulaca oleracea was used for ornamental purposes in Roman and medieval gardens [10]. In Africa, the whole plant is considered antiphlogistic and bactericidal in cases of bacillary dysentery, diarrhea and hemorrhoids, and is also used to treat diabetes. The seeds are also soothing and help quench thirst. The infusion prepared from this plant is used as an anthelmintic for children. In Nigeria, the plant is used as a diuretic. The leaves are also used for external use and are applied locally on swellings [10].

It can be used to treat burns, headaches and diseases associated with the intestine, liver, stomach, cough, breathing difficulties and arthritis. It has important applications in herbal medicine as a laxative, cardiac stimulant, muscle relaxant, and anti-inflammatory and diuretic treatment. *Portulaca oleracea* is also used to treat osteoporosis and psoriasis [5].

Kaempferol, apigenin, myricetin, quercetin and luteolin are five major flavonoids in *P. oleracea* L [11].

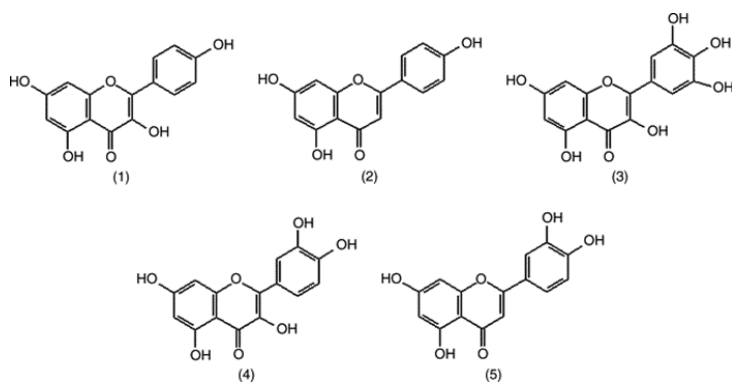


Figure 4. Molecular structures of flavonoids: (1) kaempferol; (2) apigenin; (3) myricetin; (4) quercetin; (5) luteolin.

3. Applications in the food industry

Portulaca oleracea has great relevance in the food industry and beyond, having a long history of use for human food, animal feed and medicinal purposes [12]. Although *Portulaca oleracea* is now considered by many to be a mere weed, it has been consumed since ancient times, being an edible plant in several regions of Europe, Mediterranean countries, Africa, Asia and Australia. Its taste is slightly acidic or sour and it can be consumed in the form of salad, soup, stew and many dishes. The stems and leaves can be eaten raw in mixed salads, especially appreciated for their juiciness and slightly sour taste, which is similar to watercress or spinach, cooked or pickled [5, 13, 14, 15]. When heated, purslane becomes moist and sticky, making it a good thickening agent for soups and stews [14]. Due to its nutritional and therapeutic characteristics, this weed has been called "future power food" and "new crop"[16]. Michael Pollan called it one of the most nutritious plants on the planet in his book "In Defense of Food". Although the stems are edible when still young (and can be pickled), chefs usually keep only the very thin leaves and stems, which are simply pulled from the central stem. Because the plant grows so close to the ground, it must be rinsed very well, several times [13]. The *Portulaca oleracea* plant can be used as an ingredient in functional food products due to its high nutritional value and beneficial bioactive compounds that can be incorporated into various formulations.

3.1. Uses in the food industry

The use of *P. oleracea* in food not only improves the content of nutrients and bioactive compounds of functional products,

but can also influence their sensory and technological characteristics. Although sensory acceptance by consumers is crucial for the commercial success of a product, there are few studies reporting the application of *P. oleracea* in food products and its sensory performance.

- *P. oleracea* in bread flour - From a technological point of view, the incorporation of 5% *P. oleracea* in durum wheat flour for bread resulted in improved rheological characteristics, increased antioxidant properties and reduced omega-6/omega-3 ratio, beneficial for human health, in addition to improving sensory quality [17,18].
- *P. oleracea* in spaghetti - Durum wheat spaghetti enriched with 10% *P. oleracea*, a potential functional food, was appreciated by consumers. They have demonstrated a high concentration of α -linolenic acids (Omega-3), total phenolic compounds and antioxidant properties. Eating 100 g of such pasta per day can provide 75 mg of linoleic acid and 9 mg of linolenic acid, along with a fourfold increase in total phenolic compounds. The amount of palmitic acid doubled in pasta with 15% substitution of *P. oleracea* compared to control pasta in both cooked and uncooked samples [17,19].
- *P. oleracea* in bread - Analysis of bread with different concentrations of *P. oleracea* powder (0%, 5%, 10% and 15%) showed increased water absorption capacity, mixer stability and softening levels as the concentration of *P. oleracea* powder increased. Protein, fat, total ash, moisture and fiber content also increased with *P. oleracea* concentrations. However, bread with 15% *P. oleracea* powder had

the lowest scores for sensory properties, color, taste and texture. The optimal formula, the one with 10% *P. oleracea* powder, had the highest acceptance [17, 20].

- *P. oleracea* based drink - Another innovative functional product was a fermented *P. oleracea* juice enriched with a selected lactic acid bacteria. The results demonstrated an increase in total antioxidants, maintenance of vitamin C, A and E levels and an increased content of vitamin B2 and phenolic compounds [17, 21].
- *P. oleracea* in yogurt - The combination of yogurt or coconut plant extract with fresh leaves of *P. oleracea* reduced the total oxalate content by simple dilution. Soluble oxalate content decreased from 53.0% to 10.7% when *P. oleracea* leaves were added to yogurt [17, 22].
- *P. oleracea* in tomato sauce - Addition of fresh grass grass leaves (between 1% and 10%) to tomato sauces reduced total soluble solids from 9.57° Brix to 9.20° Brix, impacting beneficial on sugar reduction. At the same time, the amount of protein increased significantly from 0.12% to 1.83%. Tomato sauce enriched with various fresh purslane leaves helps to improve the Omega 3/6 balance. The moisture content of the sauce

increased from 86.15% to 87% with higher concentrations of purslane, while the ash content decreased by 1%. The addition of purslane significantly increased the protein content in tomato sauce from 0.12% to 1.83% [17,23].

- *P. oleracea* a valuable food additive. Its leaves and stems contain gum arabinoglycan, which serves as an excellent emulsifier. The physicochemical properties of this gum are similar to those of gum arabic. In addition, the distinctive acidic flavor of purslane leaves makes it suitable for use as an acidifying agent in the food industry [24].

4. Nutritional composition

Due to the increasing consumer demand for healthier food globally, it is crucial to identify new sources of food with high nutritional value and low cost. Purslane is recognized as a valuable source of nutraceutical compounds such as omega-3 fatty acids, vitamins A and E, essential amino acids, and polyphenols, all of which have a positive impact on human health and nutrition [24,25].

The abundance of these essential nutrients in purslane allows it to become a new source of nutritious food for both humans and animals.

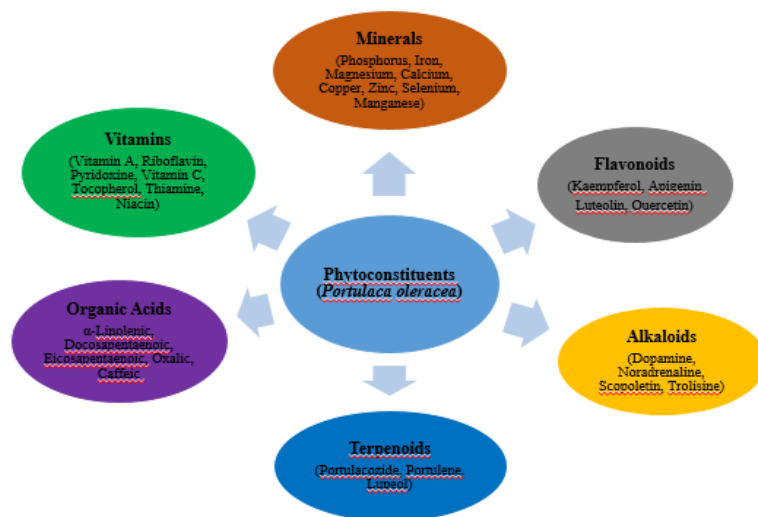


Figure 5. Different phytoconstituents of *Portulaca oleracea* [34].

Portulaca oleracea has remained one of the most abundant plant sources of omega 3 fatty acids and other essential nutrients potentially beneficial to human and animal health [31]. Recent studies indicate that *P. oleracea* has a higher nutritional value compared to other conventional vegetables, with higher amounts

of beta-carotene and alpha-linolenic acid [26]. *P. oleracea* L. leaves and stem could be a good supplement for some nutrients such as protein,

carbohydrates, Ca, K, Zn and Na [27].

Table 1. Nutritive value/100g - *P. oleracea* leaves [26]

Principle	Nutrient Value	Percent RDA	Protein	1.25 g	2%
Moisture	3.67 g	0.1%	Crude fiber	2.1 g	2.1%
Ash	40.55 g	3.1%	Total fat	0.2 g	0.5%
			Carbohydrates	3.4 g	2%

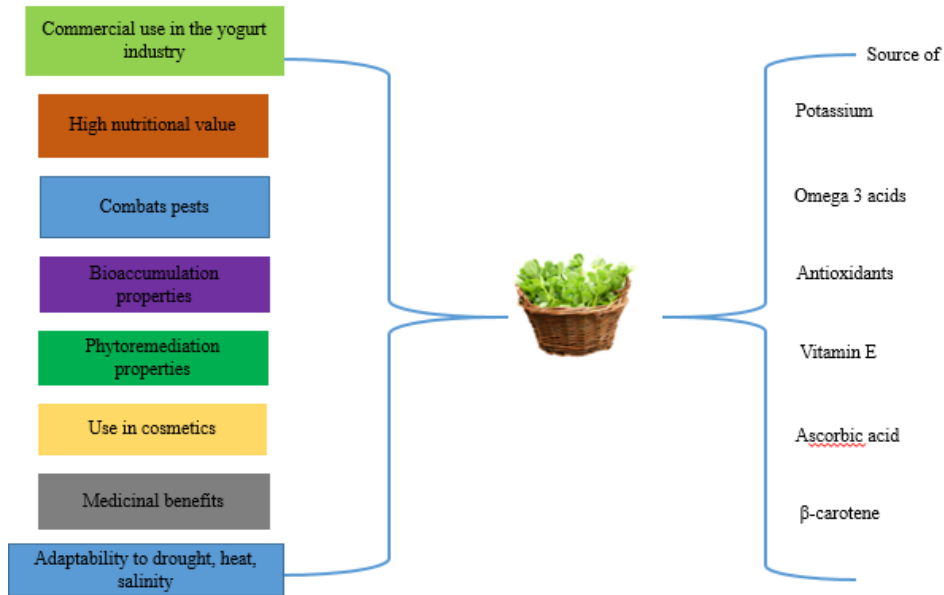


Figure 6. Multiple benefits of *P. oleracea* L[25]

4.1. Fatty acids

The human body cannot synthesize omega-3 fatty acids and must therefore obtain them from dietary sources. Omega-3 fatty acids play an important role in the prevention and treatment of coronary heart disease, hypertension, diabetes, arthritis, cancer, and other inflammatory and autoimmune disorders [28]. *Portulaca oleracea* L is recognized for its high content of ω-3 fatty acids compared to other green plants. Several studies by scientists have shown that oleander has the highest concentration of ω-3 fatty acids of all vegetables investigated so far, especially α-linolenic acid [16,29]. The content of α-linolenic acid in different parts of the plant is 0.47% in stems, 0.51% in leaves and 0.54% in flowers.

Polyunsaturated fatty acids are the most abundant in all parts of the plant, accounting for 78.75% of total fatty acids, followed by saturated fatty acids (16.42%) and monounsaturated fatty acids (4.83%). Fatty acids ω-3 and ω-6 are the most present, with 50% and 46% respectively of the total. In a study conducted by a group of researchers, it was found that the stems of *Portulaca oleracea* predominantly contained palmitic and linoleic acid (20.2-21.8% and 23.02-27.11%, respectively), while the leaves were rich in α-

linolenic acid (35.4-54.92%). Additionally, *P. oleracea* L contains approximately 300-400 mg of α-linolenic acid and 1 mg of EPA per 100 g. The plant is also abundant in γ-linolenic acid, eicosapentaenoic acid, docosahexaenoic acid, and docosapentaenoic acid, with concentrations ranging from 41.4 to 66.4 mg, 0.8-12.6 mg, 1.4-3.3 mg, and 0.3-6.4 mg per 100 g, respectively.

Purslane also contains organic acids such as oxalic and citric acids. Oxalic acid has the ability to bind with dietary minerals such as calcium, iron, magnesium, and potassium to form insoluble salts like oxalates. This reduces the bioavailability of minerals and increases the risk of kidney stones [5].

4.2. Minerals

The minerals in *Portulaca oleracea* L leaves such as iron (Fe), zinc (Zn), potassium (K), boron (B), nitrogen (N), manganese (Mn), calcium (Ca), copper (Cu), magnesium (Mg) are found in higher amounts, while other minerals (phosphorus (P), sulfur (S), sodium (Na)) are found in lower amounts, and also contribute to the valuable nutritional profile of *Portulaca oleracea* L [30,31].

The results of the studies, conducted by several researchers, showed significant variations of Ca, Mg, Na, K, Fe, Zn and Cl in

Vitamins	Value	RDA(%)
Folate	12 µg	3%
Niacin	0.480 mg	3%
Pantothenic acid	0.036 mg	1%
Pyridoxine	0.073 mg	5.5%
Riboflavin	0.112 mg	8.5%
Thiamine	0.047 mg	4%
Vitamin A	1320 UI	44%
Vitamin C	21 mg	1%

purslane leaves at different growth stages. The values of Ca, Mg, K, Fe and Zn in the first 15 days were lower than those of mature plants at 60 days. On the other hand, leaf Na and Cl concentrations were higher in the young stage and lower in the mature stage [16,32].

Table 2. Minerals content/100 g - *P. oleracea* leaves [26]

Minerals	Value	RDA(%)
Iron	1.99 mg	25%
Calcium	62 mg	6.5%
Magnesium	68mg	17%
Sodium	42 mg	3%
Potassium	490 mg	10.5%
Phosphorus	41 mg	6%
Zinc	0.17 mg	1.5%

4.3. Vitamins

Purslane contains vitamins and antioxidants, which made it essential for human health. Among the green leafy vegetables, *Portulaca oleracea* L had the highest vitamin A content (1320 IU), providing 44% of the RDA. Vitamin A is a powerful natural antioxidant, being an essential vitamin for eye health, which maintains and strengthens the immune system.

It is also necessary for maintaining healthy mucosa and skin. Regular consumption of natural fruits and vegetables rich in vitamin A is known to help protect against lung and oral cancers. Purslane is also a rich source of vitamin C and some B-complex vitamins such as riboflavin, niacin, pyridoxine and carotenoids. The content of folate, niacin, pantethenoic acid, pyridoxine and thiamine is 12 pg, 0.480 mg, 0.036 mg, 0.073 mg, 0.112 mg and 0.047 mg respectively. In addition to this, the purslane leaf contains a good amount of vitamin C (21 mg/100 g), which is necessary for maintaining healthy collagen and blood vessels, as well as helping to heal wounds. Purslane leaves contain 12.2 mg α -tocopherol and 1.9 mg β -carotene. The β -carotene content of *Portulaca oleracea* L gives the scarlet color to its stems and leaves [16, 33].

Table 3. Vitamin content of *P. oleracea* L[33]

Conclusion

Portulaca oleracea holds significant potential in the pharmaceutical industry due to its wide spectrum of pharmacological properties attributed to its various phytoconstituents and also she possesses remarkable nutritional, functional, and medicinal value. Purslane has the capacity to be used as an ingredient in the production of several food products. The mineral values of Ca, Mg, K, Fe, and Zn vary depending on the maturity stage of the plants. Purslane represents a valuable source of essential fatty acids, particularly omega-3 fatty acids.

References

1. Montoya-García C.O., García-Mateos R., Elvia Becerra-Martínez, Toledo-Aguilar R., Volke-Haller V.H., Magdaleno-Villar J., *Bioactive compounds of purslane (Portulaca oleracea L.) according to the production system: A review*, Scientia Horticulturae, **2023**, 308, 111584
2. Jacobsen S. E., Sørensen M., Pedersen S. M., Weiner J., *Feeding the world: genetically modified crops versus agricultural biodiversity*, Agron. Sustain. Dev. **2013**, 33:651–662 DOI 10.1007/s13593-013-0138-9 <https://www.fao.org/3/ca5162en/ca5162en.pdf>, FAO **2019**
3. Mulugeta D., Andualem M., Zekeria Y., *Characterization of physico-chemical properties and antioxidant activity of oil from seed, leaf and stem of purslane (Portulaca oleracea L.)*, Biotechnology Reports. **2020**. Volume 27, e00512
4. Nemzera B., Al-Tahera F., Abshirua N., *Phytochemical composition and nutritional value of different plant parts in two cultivated and wild purslane (Portulaca oleracea L.) genotypes*, Food Chemistry, **2020**, 320 126621, <https://doi.org/10.1016/j.foodchem.2020.126621>
5. Junjun A., Leng A., Gao X., Zhang W., Di Li, Xu L., Ying X, *HPLC Determination of the Eight Constitutes in Portulaca oleracea L. from Different Locations*, European Journal of Medicinal Plants **2015**, 5(2): 156-164, DOI: 10.9734/EJMP/2015/13253
6. Alam A., Shukor Juraimi A., Rafii M. Y., Hamid A.A., Hakim A., *Morphophysiological and mineral nutrient characterization of 45 collected purslane (Portulaca oleracea L.) accessions*, Bragantia, 73(4), 426–437, October **2014**, <https://doi.org/10.1590/1678-4499.253>

7. Mastud S.K., Mote G.V., Sahoo A.K., Development of value added products by using purslane (*Portulaca oleracea*), *Journal of Pharmacognosy and Phytochemistry* **2018**; 7(4): 1761-1766
8. Ghada, T. Ahmed, Marwa, M. El Gazzar, Mahmoud, A.A.M. Hashem, Wafaa, K. Galal Evaluation of Some Bakery Products Enriched with Purslane, *Food Technology Research Journal*, **2023**, 2(2), 98-109,
9. Azuka O.I., Ayalokunrin M. B., Orachu L.A.. A review on *Portulaca oleracea* (Purslane) plant – Its nature and biomedical benefits, *International Journal of Biomedical Research*, **2014**, DOI: 10.7439/ijbr.v5i2.462
10. Xu X., Yu L., Chen G. Determination of flavonoids in *Portulaca oleracea* L. by capillary electrophoresis with electrochemical detection, *Journal of Pharmaceutical and Biomedical Analysis*, **2006**, 41 (2), 493–499.
11. Zhou Y.X., Hai-Liang X., Rahman K., Wang S.Y., Peng C., Zhang H.. *Portulaca oleracea* L.: A Review of Phytochemistry and Pharmacological Effects, *BioMed Research International*, **2015**, Article ID 925631, 11 pages, <http://dx.doi.org/10.1155/2015/925631>
12. <https://cnz.to/ingredients-fine-foods/45-things-to-do-with-purslane/>
13. <https://www.webmd.com/diet/health-benefits-purslane>
14. Gonnella M., Charfeddine M., Conversa G., Santamaria P., Purslane: A Review of its Potential for Health and Agricultural Aspects, *The European Journal of Plant Science and Biotechnology* **2010**, 4 (Special Issue 1), 131-136,
15. Manju V., Kaushalendra K., Sharma N., Nutritional Abundance of Purslane: Assessment and Challenges, *IJFANS International Journal of Food and Nutritional Sciences*, **2022**Vol.11 (2), 395-404
16. Gomes de Souza P., Rosenthal A., Menezes Ayres E.M., Anderson Junger T., Potential Functional Food Products and Molecular Mechanisms of *Portulaca Oleracea* L. on Anticancer Activity: A Review, *Oxidative Medicine and Cellular Longevity* Volume **2022**, Article ID 7235412, 9 pages <https://doi.org/10.1155/2022/7235412>
17. Melilli M.G., Di Stefano V., Sciacca F., Pagliaro A., Bognanni R., Scandurra S., Virzì N., Genti C., Palumbo M., Improvement of Fatty Acid Profile in Durum Wheat Breads Supplemented with *Portulaca oleracea* L. Quality Traits of Purslane-Fortified Bread, *Foods*, **2020**, 9, 764; doi:10.3390/foods9060764
18. Melilli M.G., Pagliaro A., Scandurra S., Genti C., Di Stefano V., Omega-3 rich foods: Durum wheat spaghetti fortified with *Portulaca oleracea*, *Food Bioscience*, **2020**, 37,100730,<https://doi.org/10.1016/j.fbio.2020.100730>
19. Delvarianzadeh M., Nouri L., Abdorreza Mohammadi Nafchi, Hossein Ebrahimi, Physicochemical, rheological, and sensory evaluation of voluminous breads enriched by purslane (*Portulaca oleracea* L.), *Italian Journal of Food Science*, vol. 32, pp. 815–830, **2020**, DOI: 10.14674/IJFS.1923
20. Di Cagno R., Filannino P., Vincentini O., Cantatore V., Cavoski I., Gobetti M., Fermented portulaca oleracea L. juice: a novel functional beverage with potential ameliorating effects on the intestinal inflammation and epithelial injury, *Nutrients*, **2019**, 11(2), 248, doi: 10.3390/nu11020248.
21. Moreau A. G., Savage G. P. , Oxalate content of purslane leaves and the effect of combining them with yoghurt or coconut products, *Journal of Food Composition and Analysis*, **2009**, 22(4), 303–306, <https://doi.org/10.1016/j.jfca.2009.01.013>
22. Apostol L.C., Ropciuc S., Prisacaru A.E., Albu E., Characterization of tomato sauce enriched with purslane (*Portulaca Oleracea*) leaves, *Journal of Hygienic Engineering and Design*, **2020**Vol. 31, 127-132,
23. Mishra V., Chugh V., Dwivedi S.V., Sharma KD, Food and nutraceuticals value of purslane (*Portulaca oleracea* L.): An overview, *The Pharma Innovation Journal* **2020**; 9(7): 419-424
24. Srivastava R., Srivastava V., Singh A., Multipurpose Benefits of an Underexplored Species Purslane(*Portulaca oleracea* L.): A Critical Review, *Environmental Management* **2021**, 72(2), March DOI: 10.1007/s00267-021-01456-z
25. Jamal A., Pareek N., Purslane (*Portulaca Oleracea*): A Prospective plant Source of Nutrition and its waste utilization in traditional product, *Journal of Healthcare and Biomedical Science (JHBS)*, **2022**, Volume 1 Number 1 11-16, DOI: 10.31098/jhbs.v1i1.849
26. Aberoumand A., Nutritional Evaluation of Edible *Portulaca oleracea* as Plant Food, *Food Analytical Methods*, **2009**, 2(3):204-207, DOI: 10.1007/s12161-008-9049-9
27. Md. Kamal Uddin, Abdul Shukor Juraimi, Md Sabir Hossain, Most. Altaf Un Nahar, Md. Eaquab Ali, M. M. Rahman Purslane Weed (*Portulaca oleracea*): A Prospective Plant Source of Nutrition, Omega-3 Fatty Acid, and Antioxidant Attributes, *The Scientific*

- World Journal*, **2014**, Article ID 951019, <https://doi.org/10.1155/2014/951019>
28. Carvalho I. S., Teixeira M., Brodelius M., Effect of Salt Stress on Purslane and Potential Health Benefits: Oxalic Acid and Fatty Acids Profile, *The Proceedings of the International Plant Nutrition Colloquium* **2009**, Xvi, Apr 1,
 29. Asma A. El Gindy, Chemical, technological and biochemical studies of purslane leaves, *Current Science International*, **2017**, 6(3), 540-551
 30. Uddin M.K., Quan L., Hasan M., Motmainna, Selamat M., Madom, Purslane: a perspective plant source of nutrition and antioxidant, *Plant Archives* Volume 20 No. 1, **2020** pp. 1624-1630
 31. Uddin K., Shukor Juraimi A., Eaqub Ali, Mohd Razi I., Evaluation of Antioxidant Properties and Mineral Composition of Purslane (*Portulaca oleracea* L.) at Different Growth Stages, *Int J Mol Sci.* **2012**; 13(8): 10257–10267, doi: 10.3390/ijms130810257
 32. Chugh V., Mishra V, Dwivedi SV, Sharma KD. Purslane (*Portulaca oleracea* L.): An underutilized wonder plant with potential pharmacological value, *The Pharma Innovation Journal* **2019**; 8(6): 236-246
 33. <https://egradinarit.ro/beneficii-iarba-grasa-sanatate-si-nutritie/>
 34. https://www.botanistii.ro/blog/informatii-despre-iarba-grasa-scapa-de-buruienile-dicotiledonate-anualeperene/?srsltid=AfmBOoqaQwR3o6IW6RLBDdfCjylsfAakahWNnan0Axx4IZ-t_8oSNsOu