Sustainable Extraction and Utilization of Underulised Plant Purslane (*Portulaca Oleracea*) in Food Product Formulations

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Abstract Green leafy vegetables (GLV) have been utilized for generations as a blessing for a secure and healthy life. To meet our daily nutrient needs, green leafy vegetables are a vital part of our diet. Depending on personal preferences, they can be utilized in a variety of ways, including salad and cooked or processed form. Because of the growing consciousness about eating organic or natural foods, people are becoming more and more aware of GLV. GLV holds a significant/high position in the food pyramid, which is a crucial component of a balanced diet. GLV are the best for weight management because they have a low calorie value. They are very nutrient-dense because to their high dietary fiber content, low fat content, and abundance in a range of vitamins and minerals. Low glycemic index nutrition profiles reduce the risk of cancer, cardiovascular disease, and type 2 diabetes. GLV also have a healthy level of polyphenols and antioxidants, which contribute to their therapeutic effect. Due to a lack of understanding on the part of the population regarding their eating habits, purslane (*Portulaca oleracea*) is one of the underutilized green leafy vegetables growing in India. An effort was made in this chapter to raise awareness of this plant and its applications. By promoting the use of GLVs in food and food products, the load associated with synthetic chemicals can be lessened.

Keywords Green leafy vegetables (GLV) · *Portulaca oleracea* · Vitamins · Minerals

1 Introduction

In field of crops and lawns, purslane (*Portulaca oleracea* L.) grows as a weed naturally. Purslane is a plant that is found all over the world and is widely used as a culinary herb in many parts of Europe, Asia, and the Mediterranean area. Mucilaginous compounds found in this plant have therapeutic use. It has a high potassium content (494 mg/100 g), is a good source of magnesium (68 mg/100 g), and is a good

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source of calcium (65 mg/100 g). It also has the potential to be used as a vegetable source of omega-3 fatty acids. Of all green leafy vegetables, it is a very good source of alpha-linolenic acid (ALA) and gamma-linolenic acid (LNA, 18:3 w3) (4 mg/g fresh weight). It had the highest concentration (22.2 mg and 130 mg per 100 g)of alpha-tocopherol and ascorbic acid (26.6 mg and 506 mg per 100 g of fresh and dry weight, resp.). The oxalate content of purslane leaves was reported as 671–869 mg/100 g fresh weight. The antioxidant content and nutritional value of purslane are important for human consumption. It revealed tremendous nutritional potential and has indicated the potential use of this herb for the future (Thakur and Modi 2020).

2 Botany of Purslane

There are a number of fleshy plants in the purslane family, *P. oleracea* is an annual herbaceous succulent that can reach a height of 10–30 cm and prefers warm, sandy soil. Its invasive growth characteristics have led some people to label it a weed. The plant has alternate wedge-shaped leaves, reddish-brown stems, clusters of summer-blooming yellow flowers with 4–6 petals, and a lot of black, shiny, gritty seeds. The botanical name is derived from the Latin words potare, which means "to carry," and lac, which refers to the plant's milky sap. *Portulaca neglecta* Mack. & Bush and *Portulaca retusa* Engelm. *P. oleracea*, sometimes referred to as small hogweed, are synonyms (Rashed et al. 2003). They also possess antimicrobial activity and can be used in different food products to extend storage life.

3 Miracle Benefits of Purslane

Purslane is a rich source of vital phytochemicals like flavonoids, alkaloids (including oleraceins, dopa, dopamine, and noradrenaline), terpenoids, proteins, carbohydrates, vitamins A, B, C, and E, carotenoids, and minerals like phosphorus, calcium, magnesium, and zinc, according to numerous studies. Omega-3 fatty acids, particularly alpha-, gamma-, and linolenic acids, which are not typically produced by terrestrial plants, are found in significant proportions in purslane (Kumar et al. 2021). Additionally, there are antioxidants such tocopherol, ascorbic acid, beta carotene, and glutathione. The amount of alpha-linolenic acid varies depending on the cultivar, region, and environment, with the leaves having a higher concentration than the seeds and stems (Teixeira et al. 2010). The food sector is interested in purslane because of its vivid yellow blossoms since they contain betalain, which contains nitrogen (Wang et al. 2010).

Purslane also contains lipids, glycosides, sterols, coumarins, and triterpenes. Phenolic constituents of purslane include scopoletin, bergapten, isopimpinellin, lonchocarpic acid, robustin, genistein, and others. Amino acids in the leaves of the Portulaca species include phenylalanine, alanine, tyrosine, and aspartate. Plant

acids include isoleucine, proline, leucine, lysine, phenylalanine, methionine, cystine, valine, threonine, and tyrosine.

4 Health Benefit of Green Leafy Vegetable & Importance of GLV in Life

Future problems will focus on the health and nutrition of the growing global population, especially in developing nations. In addition to providing energy, minerals, and nutrients necessary for health, plant foods also contain phytochemicals that have additional health advantages like glycemic management, immune activation, or antioxidant activity. Every person should consume about 50 g of green leafy vegetables per day, according to the Expert Committee of the Indian Council of Medical Research (ICMR 2010), which advised this taking into account nutrient requirements (NIN 2011). The critical micronutrients found in fruits and vegetables are crucial for both nutrition and wellness. Fruit and vegetable output in India ranks either first or second. Micronutrient deficits and widespread anemia are caused by low vegetable consumption. Increasing vegetable consumption to improve micronutrient status through nutrition education. They also looked into culturally relevant ways to convey the educational concepts that go along with the information about how iron intake affects academic performance. Due of their improved understanding of the foods to eat to boost their iron intake, the adolescents who received the interventions consumed more iron overall each day, increasing their intake of heme–iron in the process. The most desirable and long-lasting strategy for reducing micronutrient deficiency is one that is focused on nutrition. These strategies aim to enhance dietary consumption of micronutrients. Changes in behavior that result in an increase in the selection of iron-containing foods and a meal pattern that is conducive to enhanced bioavailability are the major objectives of dietary modification in order to improve and maintain the iron status of a population. Such dietary adjustments, however occasionally challenging to implement, have the potential to significantly and sustainably enhance both iron status and nutrition in general. Such adjustments must be based on issues that consider education, food security, and actual availability. For the prevention and management of nutritional deficiencies, a variety of strategies, such as nutrient supplementation, food fortification, diversification, and public health interventions, have been proposed. The most sensible and long-lasting method of preventing micronutrient deficits is diet improvement. Since it helps to enhance ones overall nutritional state, improving one's diet is of utmost importance. Extraction fortification and dietary supplementation with foods high in micronutrients to combact the micronutrient deficiency.

The standard of living of individuals around the world has improved significantly over the past ten years. The growing industrialization and innovation in every industry are mostly to blame. Due to the quick pace of life, where consumers prioritize convenience and quick access to wholesome, palatable meals, the fast food industry has

likewise rapidly expanded. As a result, there was a dramatic rise in the demand for ready-to-eat items like extruded snack food.

5 Extraction of Omega-3 and Protein Concentrates From Purslane

Food processing operations require antioxidants that can sustain in various temperature, and provide protection to finished products. According to the study, soybean oil was mixed with an ethanolic extract of purslane leaves at three distinct concentrations (T1, T2, and T3): 500, 1000, and 1500 ppm. These concentrations were compared to the control. The sample that had 100 ppm of TBHQ added to it served as the positive control. By calculating the total phenolic content, loss of -carotene, and antioxidant activity of the ethanolic extract of purslane leaves, antioxidant activity was evaluated. It was determined how well soybean oil combined with purslane leaf extract heated (173.2 °C for 24 h; 8-h heating cycles each day) in terms of peroxide value, free fatty acid, total polar material, and fatty acids composition.

The thermal stability of the oils was evaluated using differential scanning calorimeter. The poori was ready to assess the oil's suitability. According to the results, a purslane leaf extract (1500 ppm) may be used to produce soybean oil with reasonable thermal stability and acceptable sensory properties. Even while TBHQ and the purslane leaf extract (1500 ppm) demonstrated nearly same thermal stability, natural anti-oxidants are still chosen over synthetic ones. The purslane leaf ethanolic extract shown remarkable antioxidant action with goodness of omega-3 fatty acids in soybean oil under rapid oxidation during heating in a dose-dependent manner. The existence of strong anti-oxidative compounds with high thermal stability was highlighted in order to highlight the great antioxidant activity of LEP in soybean oil. As a result, purslane leaf extract can be utilized as a substitute source of natural antioxidants to improve the stability of oils and meals that include oils. As a result, the research indicated that purslane has a good chance of being investigated as a source of natural antioxidant (Niharika et al. 2019).

The current way of life, which includes a high-fat diet and little exercise, significantly increases the risk of hypercholesterolemia and cardiovascular diseases. Reactive oxygen species (ROS) that induce oxidative stress are a major factor in the pathogenesis of many diseases, including atherosclerosis and coronary heart disease. One of the risk factors for coronary heart disorders is hyperlipidemia. The reduction of coronary heart disease complications by polyphenolic chemicals present in fruit, vegetables, and other plant material is supported by epidemiological research. According to studies, plant phenolics, flavonoids, flavonolignans, and phenolic acids operate as antioxidants at the molecular level and have health-promoting characteristics. Furthermore, findings point to phenolics' potential to modify and have a favorable impact on lipoprotein metabolism. Additionally, studies show that plant-based phenolics may help reduce coronary heart disease. Therefore, general practice

for treatments based on herbs. Nutraceuticals that can lower complications brought on by hyperlipidemia or control serum cholesterol and triacylglycerol levels have become increasingly important over time. (Makni et al. 2008) studied the hypolipidemic and hepato-protective effect of n-3 and n-6 fatty acid-rich flax and pumpkin seed lipids in hypercholesterolemic rats. Plant extracts contain phenolics, which are possible candidates, but they frequently contain complexes of other compounds that have pro-oxidants and antioxidant characteristics. For this reason, the trial looked into the possibility for hypolipidemic effects of purslane extract. Treatment for atherosclerosis that is effective includes lowering plasma cholesterol levels. Fibrates and statins are two chemical medications that have the ability to decrease cholesterol.

6 Utilization of Purslane Leaves in Various Food Product

Approximately 97% of Americans get an average of 24% of their calories from snack items, according to a USDA research (USDA 2010). On the other hand, due to the advantages they hold, a range of junk foods have also been observed holding a significant part of the diet. These are highly caloric processed foods that are mostly made of starch and fat and lack sufficient fiber. According to epidemiological study, those who consume a diet that is mostly deficient in fiber frequently suffer from gastrointestinal and cardiovascular problems (Kumari and Grewal 2007). A unique array of plant meals, such as those found in fruits and vegetables, provide not just energy and nutrition but also a sizable amount of fiber. According to the National Horticulture Database, which was released by the National Horticulture Board (Oxford University Press 2016), India is the world's second-largest producer of fruits and vegetables, behind China. Despite the fact that vegetables are produced in large quantities, the majority of modern civilizations choose to restrict their diet to a variety of vegetables while avoiding specific green leafy vegetables, such as purslane leaves, which have superior nutritional qualities to major cultivatable vegetables. It is well known that it contains more fatty acids, including alpha-linolenic acid, than any other vegetable. Additionally, because of its outstanding nutritional qualities, purslane is regarded as a "power food" and may be used to a variety of snack meals. It would add extra nutrients to the diet that support the maintenance of our health and wellbeing (McDonald and Nicholson 2006). By incorporating the micro and macronutrients necessary for human health, a supplement improves the nutrient profile of a typical diet. Herbal remedies have historically been used to treat a wide range of issues, including disease, fever, wounds and infections, CVD, constipation, weight management, immune-modulators, and memory loss, among others. Despite having a high quantity of antioxidants, minerals, and omega-3 fatty acids, purslane is considered to be a wild plant and is hence underused. As a result, it is getting more and harder to use natural resources to support the health care system. Additionally, it has been discovered that the demand for nutraceuticals rises as consumers become more conscious of the link between their diet and health. In order to allow improved nutrient absorption, it is crucial to incorporate these active substances with the current food formulations. So,

it is essential to integrate these active ingredients with the current food formulations to facilitate enhanced nourishment with an added advantage to the consumers in relation to health. The consumer's viewpoint on food production and consumption has significantly evolved during the past few decades. Customers are more conscious of how much food affects their health and happiness (Mollet and Rowland 2002). Consumers today consume food not just to satisfy their hunger but also to gain important nutrients, to prevent diseases related to nutrition, and to improve their physical and mental health. According to (Pathania et al. 2017), traditional cuisines from several nations, including India, are recognized to be more nutrient-dense than popular junk food. Functional foods can be quite effective in reducing the symptoms of lifestyle disorders. Due to rising healthcare costs, longer life expectancies, and consumer demand for better eating, these foods have received a lot of appeal and attention (Kotilainen et al. 2006).

The majority of the populace in developing nations consumes vegetarian food. Many families cannot afford to buy meat more frequently than once a week due to its high cost. Only a small portion of the world's edible plants are used to produce food for people. In addition, only 20 crops account for 90% of the world's plant food production. In actuality, only 6 crops are exported or imported from/to a number of nations. According to the Food and Nutrition Board, food plants that provide protein equal to or greater than 12% of their calorific value are regarded to be good sources of protein. Given that they contain a significant amount of the vegetative component, the leaves are frequently taken into consideration for the creation of high-value recombinant proteins (Shanker and Debnath 2015).

Due to its high nutritional and antioxidant content, it is said to be the superfood of the future. It is marketed in stores in the United Arab Emirates and Oman and is regarded as a vegetable in China for long life. It is employed as a herbal skin remedy in traditional Chinese medicine. Purslane has a wide range of other pharmacological actions, including antibacterial, analgesic, anti-inflammatory, and wound-healing properties. Purslane extracts have been demonstrated to have antidiabetic effects when used as an alternative to streptozotocin in diabetic rat models. Numerous organs, including the liver, heart, and kidney, have been shown to experience oxidative stress as a result of hypercholesterolemia. It has been demonstrated that plant bio-active antioxidants have a greater ability to shield people from a wide range of ailments, including cardiovascular diseases. It has also been claimed that purslane has a variety of biological effects, such as hypoxia, hepatoprotective qualities, and an anti-hypertension impact; however, there is no evidence in the literature to support these claims. According to clinical investigations, dyslipidaemia is one of the main risk factors for coronary disease. Preclinical investigations have shown that high cholesterol encourages the buildup of low-density lipoprotein in the artery wall, endothelial cell dysfunction, and the progression of atherosclerosis (Takahashi et al. 2005).

7 Conclusion

Traditional medical practices have employed purslane to treat, manage, and/or control hypertension and diabetes mellitus. Purslane can be used to manage or control hyperlipidemia because research showing that its leaves can be used to prevent hyperglycemia also shows that the plant's leaf aqueous extract has hypolipidemic capabilities. Purslane's effect on lipid metabolism needs to be further confirmed, nevertheless, by dietary research. Additionally, purslane can be utilized as a convenient supply of natural antioxidants.

In light of this, an effort was made to use purslane greens to create inexpensive, fiber-rich goods for consumers who are deficient in micronutrients and to evaluate the sensory quality of such products.

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