© by PSP Volume 30– No. 06/2021 pages 6313-6318 Fresenius Environmental Bulletin

NUTRITIONAL COMPOSITION AND BIOACTIVE COMPOUNDS CHARACTERIZATION OF *PORTULACA OLERACEA* L. LEAVES GROWN IN EGYPT

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ABSTRACT

Portulaca oleracea L. (PO), commonly known as purslane, is using as medicinal plant due to its high contents of bioactive compounds. Only few studies have been performed on the biochemical descriptions of *P. oleracea* cultivated in Egypt. Therefore, the present study aimed to determine the nutritional composition of the Egyptian PO leaves. The samples were analyzed for their proximate chemical composition, minerals, vitamins, amino acids and fatty acids. Results showed that, PO leaves contains 19.39% ash, 12.13% protein and 7.24% crude fiber. While the minerals content were: potassium 1283.50 mg/100 g DW., calcium 793.35 mg/100 g and magnesium 517.56 mg/100 g. Furthermore, PO leaves is rich in vitamin A (382.54 µg/100g) and 16 of the most important amino acids, 8 out of them are essential amino acids. Moreovere, PO leaves contains (47.92%) omega-3 fatty acid, twenty-seven phenolic compounds also were identified by HPLC. Data concluded that the purslane leaves excellent resource of pharmaceutical and biochemical compounds that has biological impacts on human health and could be used in the nutraceutical applications.

KEYWORDS:
Purslane, *Portulaca oleracea* L., Chemical Composition, Nutritional Characterization, Omega-3, Phenolic Compounds

INTRODUCTION

Purslane (*Portulaca oleracea* L.) is known as invasive weed among peoples in the Mediterranean countries [1,2], the delicious leaves and stems let the whole plant completely edible. PO belongs to Portulacaceae family which contains more than 120 species of shrubs and succulent herbs. PO is consumed as a vegetable, where leaves and stems are similar to the salty and slightly acidic taste of spinach. In fact, it can be consumed as a fresh plant [3], dried in tea [4] or cooked [5]. PO is characterized by its high contains of β-carotene, α-tocopherol, ascorbic acid [6], cardiac glycosides, polysaccharides, ω3 fatty acids such as α-linolenic acid which has a role in cardiovascular diseases preventing and the immune system reinforcing, anthraquinone glycosides [7], dietary glutathione [8], gallotannins [9] and antioxidants [10] as well as minerals such as magnesium, iron, potassium, and calcium [11].

Due to its medical importance, it is ranked among the top eight common worldwide plants [12]. Now, it is considered as the unique cosmopolitan species listed in the term of 'Global Panacea' [13] and the World Health Organization stated, PO is one of the common global medicinal plants.

The plant aerial parts are used as a folk medicine between population in developing and developed countries to treat human different diseases such as diuretic, fever, antipyretic, antiseptic, anti-asthmatic, anti-ascorbic, antitussive, vermifuge, and antispasmodic effects [14-16]. Moreover, PO extracts has a wide range of different pharmacological effects including hypolipidemic, muscle relaxant, hypocholesterolemic, antibacterial, antiaging, analgesic, wound healing, hypoglycemic, neuropharmacological, anti-inflammatory, bronchodilatory, and antioxidants activity [17-19]. Therefore, the present study, aimed to characterize the nutritional value and phytochemical compounds in *P. oleracea* leaves grown in Egypt.

MATERIALS AND METHODS

Materials. The fresh leaves of purslane were collected from the Zagazeg farms, El-Sharkia, Egypt. The leaves were washed and air-dried for 24 h, then dried in oven at 50°C overnight. The dried leaves were crushed to fine powder and stored in plastic vials.

Chemical Analyses of Purslane Leaves. Proximate Analyses. The moisture, ash, crude protein and crude fiber contents were determined according to the method of AOAC [20]. Total hydrolysable carbohydrates were calculated by the difference. All proximate analyses were performed in triplicate and expressed as g/100g of samples.

Minerals Analyses. The contents of calcium, zinc, potassium, sodium, iron, magnesium, cupper and manganese were determined using a Pye Unicum SP1900 Atomic Absorption Spectroscopy Instrument (Perkin Elmer model 4100ZL, USA) according to the method described by AOAC [20].

Determination of Water- Soluble Vitamins. Vitamin C content of PO leaves was determined using HPLC according to the method described by Romeu- Nadal et al. [21]. Vitamin B complex: B1, B2, B3, B6, B9 and B12 contents of PO leaves was determined using HPLC according to the method of Batifoulier et al. [22].

Determination of Fat- Soluble Vitamins. The vitamins A, D, E, and K were determined in PO leaves using HPLC according to the methods described by Noll [23], Plozza et al. [24], Pyka and Sliwiok [25] and Preez- Ruiz et al. [26], respectively.

Amino Acids Composition Analyses. The amino acid compositions of PO leaves were analyzed using the automatic amino acid analyzer (AAA 400 INGOS Ltd, Czech Republic). 100 mg of sample was hydrolyzed with 10 ml of 6 *M* HCl in a sealed tube at 110ºC in an oven for 24 h. The acid was evaporated in a vacuum evaporator under reduced pressure at 80ºC. The HCl free hydrolysate was dissolved in 2 ml of 0.2 *M* loading buffer, pH 2.2 to inject into the analyzer [27].

Fatty Acids Analyses. The fatty acids composition was analyzed by gas chromatography according to the method of Cossignani et al. [28]. The fatty acid methyl esters were fractionated using Agilent 6890 series GC apparatus provide with a DB-23 column (60 m×0.32 mm× 0.25 µm). Oven temperatures were 150ºC ramped to 195ºC at 5ºC/min, ramped to 220ºC/min and flow rate was 1.5 ml/min.

RESULTS AND DISCUSSION

Chemical Composition of Purslane. Proximate Composition. *Portulaca oleracea* referred to one of the important weed plants in Egypt. PO chemical composition revealed, the presence of wide range of different biochemical and nutritional compounds such as alkaloids, flavonoids, fatty acids, polysaccharides, tarpenoids, vitamins, proteins, minerals, and sterols. In the current study, PO leaves were analyzed to determine, its contents of ash, moisture, crude fat, crude fiber, carbohydrate and crude protein. The results revealed that the purslane leaves contained 19.39% ash, 7.24% crude fiber, 5.83% crude fat, 12.13% protein and 55.41% carbohydrate (based on dry weight matter) as well as, the dried PO leaves contained 9.22% moisture (Table 1).

TABLE 1
Proximate chemical composition (g/100 g dry weight) of purslane leaves

Parameter	Purslane leaves
Ash (%)	19.39
Crude Fiber (%)	7.24
Carbohydrate (%)	55.41
Crude Fat (%)	5.83
Crude Protein (%)	12.13

Mineral Composition. Our results show that, the PO leaves considered rich source of mineral elements. The predominant minerals are potassium (1283.50 mg/100 g), followed by calcium (793.35 mg/100 g) and magnesium (517.56 mg/100 g). Small amounts of sodium (17.06 mg/100 g), zinc (14.17 mg/100 g), iron (10.39 mg/100 g) and manganese (0.57 mg/100 g) (Table 2).

TABLE 2
Mineral composition (mg/100 g dry weight) of Purslane leaves

Mineral	Purslane leaves
Sodium (Na)	17.06
Potassium (K)	1283.50
Calcium (Ca)	793.35
Magnesium (Mg)	517.56
Manganese (Mn)	0.57
Iron (Fe)	10.39
Zinc (Zn)	14.17

TABLE 3
Vitamin composition (µg/100 g) of purslane leaves

Vitamin	Purslane leaves
Fat Soluble Vitamins	
Vitamin A	382.54
Vitamin E	274.15
Vitamin K	3842.14
Water Soluble Vitamins	
Vitamin C	303.56
Thiamin (B1)	16731.64
Riboflavin (B2)	50728.33
Nicotinic acid (B3)	85222.73
Pyridoxine (B6)	5369.40
Folic acid (B9)	6408.10
Cyanocobalamin (B12)	41416.06

Vitamins Composition. The content of fat and water soluble vitamins in PO leaves shown in Table

(3). The results showed that, the purslane leaves contain a logical amount of fat and water soluble vitamins. Regarding fat soluble vitamins; vitamin K was the major fat soluble vitamin (3842.14 µg/100 g) followed by vitamin A (382.54 µg/100 g) then vitamin E (274.15 µg/100 g). While, the water soluble vitamins; vitamin B_3 was the major B-complex vitamin (85222.73 µg/100 g) followed by vitamin B_2 (50728.33µg/100 g) and vitamin B_{12} (41416.06 µg/100 g) then vitamin B_1 (16731.64 µg/100 g). The moderate amount of vitamin B_9 (6408.10 µg/100 g) and vitamin B_6 (5369.40 µg/100 g) were also recorded. In addition to, vitamin C was also calculated in PO leaves (303.56 µg/100 g). PO is characterized by its high contents of vitamin C, vitamin A and B-complex like niacin, pyridoxine and riboflavin.

Amino Acids Content. Our results showed that, the PO leaves contain 8 essential amino acids and 8 nonessential amino acids (Table 4). The major essential amino acids were leucine (9.08%), followed by valine (6.41%), while, the moderate amounts of these essential amino acids were observed including lysine (4.74%) and isoleucine (4.12%), followed by phenylalanine (2.95%), but, the low amounts was histidine (1.96%) and threonine (1.70%). The major nonessential amino acids are glutamic, glycine, aspartic and alanine which recorded as 13.32, 11.14, 10.02 and 9.53%, respectively. The moderate amounts of arginine, serine and tyrosine were recorded as 3.08, 3.02 and 2.89%, respectively, the proline content was limited (0.14%). In addition to, ammonia content of PO leaves was recorded as 15.64%.

TABLE 4
Relative percentage composition of amino acids of Purslane leaves

Amino acid	Purslane leaves (%)
Essential amino acids	
Leucine (leu)	9.08
Valine (Val)	6.41
Lysine (lys)	4.74
Phenylalanine (Phe)	2.95
Histidine (His)	1.96
Methionine (Met)	0.26
Nonessential amino acids	
Glutamic acid (Glu)	13.32
Glycine (Gly)	11.14
Aspartic acid (Asp)	10.02
Alanine (Ala)	9.53
Serine (Ser)	3.02
Arginine (Arg)	3.08
Tyrosine (Tyr)	2.89
Proline (Pro)	0.14
Ammonia (Amm)	15.64
Total amino acids	100

Fatty Acids Contents. The current results show that, the predominant fatty acids of PO leaves were α- linolenic acid (C18:3ω3), linoleic acid (C18:2 ω6) and palmitic acid (C16:0) and recorded as 47.92, 18.65 and 14.24%, respectively (Table 5). The identified saturated fatty acids (SFA) include lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), margarinic acid (C17:0), stearic acid (C18:0) and arachidic acid (C20:0) and recorded as 0.60, 0.88, 14.24, 0.49, 2.70 and 0.50%, respectively. Palmitoleic acid (C 16:1 ω7), oleic acid (C181 ω9) and 11- eicosenic acid (C20:1 ω9) as monounsaturated fatty acids (MUFA) composed 14.02 of lipid content found in purslane leaves. The identified polyunsaturated fatty acids (PUFA) include linoleic acid (C18:2 ω6) and α- linolenic acid (C18:3 ω3). These two fatty acids composed 66.57% of lipid content of PO leaves. One hundred gram of PO leaves contains about 300–400 mg of α -linolenic acid, 1mg of eicopentanoic acid. Moreover, PO leaves contain high percentage of poly unsaturated fatty acid (PUFAs) 66.75% and low percentage of saturated fatty 19.41%. An interesting finding in this study was reported the Egyptian species of PO contains high percentage of α-Linolenic acid (47.92%).

TABLE 5
Relative percentage composition of fatty acid of purslane leaves

Fatty acid	Purslane leaves (%)
Lauric acid (C12:0)	0.60
Myrisitic acid (C14:0)	0.88
Palmitic acid (C16:0)	14.24
Margarinic acid (C17:0)	0.49
Stearic acid (C 18:0)	2.70
Arachidic acid (C20:0)	0.50
Total SFA	19.41
palmitoleic acid (C16:1ω7)	2.76
Oleic acid (C18:1ω9)	9.64
Eicosenic acid (C 20:1ω9)	1.62
Total MUFA	14.02
Linoleic acid (C18:2ω6)	18.65
α-Linolenic acid (C18:3ω3)	47.92
Total PUFA	66.57
Total Fatty acid	100

Variations in the chemical composition of purslane leave reflect the difference in varieties, environmental condition during maturation, age and vigor of the plants. The previous studies on the chemical composition of PO reported that, the protein content was recorded as 15.27% and the crude fat content ranged from 4.5 to 5.3%, while, the protein and ash content was 15.27% and 19.39% [29-33]. Other studies reported, the chemical composition of PO powder contains, moisture content, total acidity, reducing and total sugars as well as crude fibers as 0.68, 3.06, 3.16, 3.72 and 17.99% D.W respectively

[29, 34]. El Gendy [35] reported, PO leaves contained ashes (22.66%), crude protein (23.47%), Lipid (5.26%) and fibers (40.67%).

The obtained results of mineral composition are supported by many authors who reported that, the high percentages of mineral contents of PO dried powder (mg/100g) were potassium and calcium and can be used as alternative treatment of osteoporosis [29]. Moreover, the contents of Ca, Na, Fe and Zn were 1945, 278, 262 and 160 mg/100 g respectively [36, 37]. In addition to, potassium and calcium were 633.64 and 160.0 mg/100 g and some of dietary minerals such as Fe, Zn, B, N, Mn, Cu, Mg were the most abundant in PO, but the other minerals as P, S, Na were existing in relatively low amounts [35]. Variations in the mineral composition of purslane leaves reflect the difference in the floral origin of plant and the plant growth conditions such as soil and geographic origin.

Regarding to vitamin composition of PO, many investigations reported that, PO contained different types of vitamin B-complex such as B1 (thiamine, 0.047 mg/100 g), B2 (riboflavin, 0.112 mg/100 g), B3 (niacin, 0.480 mg/100 g), B5 (pantothenic acid, 0.036 mg/100 g) B6 (pyridoxine, 0.073 mg/100 g) and B9 (folates, 12 mg/100 g), as well as vitamin C (ascorbic, 38.56 mg/100 g) [37, 38].

In respect of amino acid composition, many authors mentioned that, the PO leaves have fifteen amino acids, whereas, the essential amino acid leucine has the highest value 1.41%, while isoleucine was 0.63% and valine (0.7%) was recorded in the moderate amounts, but threonine was appearing as a low value (0.57) [39, 40].

Purslane is best source as some green vegetable rich in omega-3 fatty acids for human consumption. The obtained results of fatty acid composition are supported by many authors who reported that, the fatty acid composition of fresh PO leaves is composed of unsaturated fatty acid was (C18:3) α-Linolenic, linoleic and oleic acid are 33.08%, 18.03% and 8.64%, respectively [29]. Moreover, the total saturated fatty acid in PO (SFA) (32.40%), total MUFA (15.54%) and PUFA (32.40%) [38]. The fatty acids in PO leaves were linoleic acid (C18:2 ω6), α-linolenic (C18:3 ω3) and palmitic acid (C16:0) were recorded 28.71 %, 23.35% and 25.33%, respectively. Recent study reported that, PO is best green vegetable food for human nutrition due to its high contents of omega-3 fatty acids as α-linolenic compared to the other leafy green vegetable [41].

CONCLUSION

Portulaca oleracea is important source of pharmaceutical industries, due to its high contains of a wide spectrum of bioactive compounds including alkaloids, flavonoids, polysaccharides, terpenoids, fatty acids, sterols, vitamins, minerals, and proteins. Our results concluded that, the Egyptian species of PO leaves contains high amounts of ash, protein, crude fiber, potassium, calcium, magnesium. Furthermore, PO is rich in vitamin A and 16 of the most important amino acids and high amounts of omega-3. Therefore, PO has nutritional potential, can play significant role in health care, and can be used in nutraceutical applications.

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Received: **01.01.2021**
Accepted: **06.03.2021**

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