PHYTOCHEMICAL STUDIES ON *PORTULACA OLERACEA* (PURSLANE) PLANT

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Summary

Portulaca oleracea L. (PO) is one of the most commonly used 'power plants' globally, spread across different world regions. It is commonly called Purslane, used as spice, vegetable and medicine and has achieved almost identical recognition in each culture for its benefits. The relevance of a plant is usually attributed to the level or nature of its usefulness. The search for power plants for food and medicine has brought PO to the limelight as further research has proven its pharmacological and nutritional properties. Phytochemicals are the bioactive molecules that give any plant its perceived or proven function. The quality and quantity of the phytochemicals in any plant determine the

extent of use and application of such a plant for biological and non-biological uses. PO boasts of a rich source of many important bioactive compounds, many of which have the potentials of being translated into useful products. This chapter has reviewed the phytochemicals of PO with a focus on their extraction methods, safety, pharmacological activities and possible scientific applications. This insight will open up more opportunities for research with PO as it shows the characteristics of being the food of the future.

1. Introduction

1.1. Plant Profile

1.1.1. Local / Botanical Names

Portulaca oleracea L. (PO) is one of the most cultivated plants worldwide. It has been identified in various countries and cultures, given its ability to thrive in poor soils. The botanical name *Portulaca* is believed to have been derived from the Latin word 'porto', which means to carry, and 'lac' which means milk owing to the plant's milky sap. Purslane is commonly called many names in English: Garden purslane, pigweed, parsley, pusley, wild Purslane, common Purslane, purple-flowered Purslane, kitchen – garden purslane, Portulaca, green Purslane and common Indian Purslane. It has other local names depending on the country and culture as listed in Table 1:

S. No.	Language	Name
1	Afrikaans	Porselein
2	Arabic	Baqlatul Humqa, Khurfa, Baqlatul Mubarika, Ríjala
3	Ashanti	Adwere
4	Australian	Purslane, munyeroo, wakati, lyawa
5	Bambara	Missed kumbare
6	Bengali	Baraloniya, Chotaluniya, Kulfi, Munya, Nunia Sag.
7	Berber	Tafrita, Rejla, Arhilem, Bouguel, Benderakesh
8	Bombay	Kurfah
9	Can	Duda-gorai
10	Caribbean	Pussley, Purslane, hog bhaji/meat, poupyé, koupyé.
11	Chinese	Ma Chi Xian
12	Efik	Eferemakara
13	English	Garden purslane, pigweed, pursley, pusley, wild purslane, common purslane, purple-flowered purslane kitchen-garden purslane, green purslane, common Indian parselane
14	Ewe	Afiaa, devio-fe'ama
15	French	Pourpier, Pourcellaine, Pourpie potager
16	German	Gartenportulak
17	Greek	Andrachni, Andrakala, Antrakala
18	Gujarati	Loni, Ghol

19	Hausa	Baba jibji, halshen Saniya, Mano, toa p'lo
20	Hindi	Kursa, luaniya, Kannada- kaama sakkare, Lunia.
21	Igbo	Ntioke, Idiridi.
22	Italian	Porcellana, portulaca
23	Mah	Bhuigoli; Ghoibhaji; Motighol.
24	Malawi	Matakoatsanu (N), Mataga atsanu (Y), Matakaoali (To), Matakogwaoli (Nk).
25	Malay	Koluppa
26	Malayalam	Nelatsjira
27	Marathi	Bhuigholi, ghole, gholbhaji
28	Mende	Tanguipeta
29	Mexican	Verdolagas
30	Philippino	Alusíman (Bik.), ausíman (Bik.), bakbakad (if.), dupdupil (Bon.), golasíman (Tag.), gulasíman (Bik.), kantatába (Pang.), kolasíman (Tag.), lungum (If.), makablíng (Tag.), ngalug (Ilk.), olasíman (Bik., Tag.), ulisíman (Bik., Tag.).
31	Persian	Cholza, Khurfah, Kurfah, Lonika
32	Sanskrit	Brihalloni, Gholika, Lona, Lonamla, Loni, Lonika, Lunia.
33	Sind	Lunak.
34	Sinhalese	Gendakola
35	Spanish	Verdolaja
36	Tamil	Karikkirai, Parpukire, Parupukkirai, Passalakkirai, Pulichchankirai, Pulikkirai
37	Telulelam	Peddapavila kura
38	Trinidad & Tobago	Pursley or pusley
39	Urdu	Boondaqi, khurfa
40	Oriya	Puruni-sag
41	Vietnamese	Rau sam, mã hiên, phjãc bia, slòm cà (Tay)
42	Xhosa	Igwanitsha
43	Yoruba	Esan omode, Papasan
44	Zulu	Amalenyane

Table 1. Local names of *Portulaca oleracea* L. (PO)

1.1.2. Botanical Classification

Figure 1 shows the Taxonomical classification of *Portulaca oleracea* L. (PO)

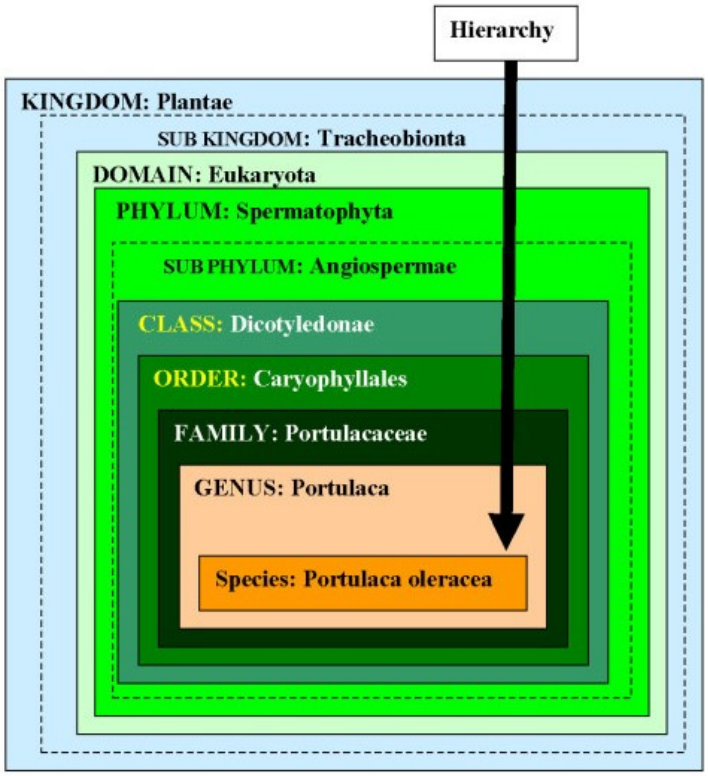

Figure 1. Taxonomical classification of *Portulaca oleracea* L. (PO)

1.1.3. Morphology

1.1.3.1. Macroscopy

PO is a copiously branched, herbaceous, succulent plant that could either be erect or procumbent. It is primarily an annual plant (but maybe perennial in the tropics) and can grow as high as 50 cm and as low as 20.6 cm, depending on its species and location. Its cylindrical stem is entirely glabrous, succulent, diffusely branched, and about 2-3 mm thick. Its colours vary from purplish-red to green. The leaves are sessile, oval, alternate, opposite, flat, smooth, fleshy, and with a wedge-shaped apex and a rounded base. The leaves may range from 40 mm x 15 mm up to 60 mm x 25 mm in fertile soils. The flowers are sessile, 3–5 mm long, 0.5–4 cm × 0.1–2 cm across, bisexual, brightly yellow but can be purple or white-pink. The flowers are connate at the base and have five petals, two green sepals, and 7–12 stamens. Flowering is initiated from May to September and bloom around June and July. The flowers grow in clusters. The fruit is a capsule, ovoid or globular-shaped, oblong, about 4 - 8 mm long, 3 mm in diameter, and many-seeded (can produce as many as 240,000 seeds). The seeds are greyish black or reddish-brown, almost spherical, flattened, hairless, compressed and may be as small as 0.5 – 1 mm in diameter.

1.1.3.2. Microscopy

Figure 2 shows the PO plant with stems and leaves.

Stem - The transverse section of the stem has a circular outline. The stem has a cortex, an epidermis, and a pith. The walls of the epidermal cells are thin, polygonal-shaped, tangentially elongated, slightly bulged and surrounded externally by a striated cuticle. Next to the epidermis is the cortex. The stem is broad and consists of 2-3 layers of outer collenchyma, with the remaining portion composed of thin-walled, less compact parenchymal cells. The pith of the stem is also broad and made up of parenchymatous cells. The vascular bundles are collateral and arranged in a ring, and the xylem and phloem are leaned outwardly. Calcium oxalate crystals are abundant in the cortex and pith regions of the stem.

Leaf - The transverse section of the leaf shows a broadly concave outline on the adaxial side and a convex outline on the abaxial side. The leaf is bilaterally symmetrical and contains an epidermis, palisade parenchyma, spongy parenchyma, and ground tissue. It has a prominent lateral vein that forms extensive, rectangular islets with mostly one vein termination in each islet. Epidermal cells are thin-walled, rectangular or polygonal and slightly lobed.

The epidermis contains stomata on both sides of the leaf, which are paracytic - subsidiary cells placed parallel to the pore and contained more stomata on the abaxial surface than on the adaxial surface. Next to the epidermis is the palisade and spongy parenchyma. The entire mesophyll, which contains crystals of calcium oxalate, is almost made up of aqueous tissue. The vascular bundles of the mesophyll (which are about 2-4 in number) are collateral, closed, placed almost centrally, and arranged in an arch that opens towards the adaxial surface. The midrib region has a small, median-placed vein that forms a vascular bundle. Each bundle has varied xylem and phloem elements and is about 50 x 100 μm in size. The lamina is 600 μm thick along the midrib and 450 μm thick along with the wings; the vascular bundle of the laminal region is surrounded by a ring of dilated vascular bundle sheath called Kranz tissue. The ground tissue comprises 4-6 large, rounded, thin-walled parenchymatous cells with distinct intercellular spaces.

Petiole - Transverse section of the petiole is bulged at its lower surface and slightly depressed at its upper surface. The epidermis is uniseriate and made up of tangentially elongated tubular parenchymatous cells. The anticlinal surface of the lower epidermal cell is curved and contains some dark pigments.

Root - The transverse section of the root has a circular outline. It has a periderm, a cortex and a central core of the primary xylem. The periderm is thick and made up of 2-3 layers of phellem, a single layer of phelloderm, and a phellogen layer. The cortex consists of 4-6 layers of thin-walled, tangentially stretched parenchyma cells, and the centre and narrow cortex have diarch or triarch primary xylem. The xylem bands have narrow, thick-walled elements, and the phloem occurs only along with the xylem bands.

Flower – epidermal cells of the calyx and corolla have a wavy margin, although the calyx cells have more wavy margins than the corolla. The pollen grains are rounded. The anther has an angular projection on its surface and has two lobes.

Figure 2. The leaves and stem of the *Portulaca oleracea* plant

1.1.4. Ecology, Propagation and Distribution

PO dates back to 4,000 years ago and is a common vegetable during the Roman Empire. It is considered to be native to parts of Europe, Africa, India, China, and Japan. However, the succulent stem and fleshy leaves suggest that it may have originated from the Middle East and India, adapting to the desert climate. It is distributed in almost all warm countries of Europe, Africa, North America, Asia, and Australia. PO thrives in sunny and warm areas and can be found growing on grasslands and bushlands in riverine areas, riverbeds, gardens and dumpsites. It can grow in a wide range of soils, although loamy and sandy soils best suit it. It germinates in late spring at the surface of the soil, often after irrigation or rain. It is grown as a summer plant when the soil temperature reaches about 15-40 °C. It grows from sea level up to 2400 m in temperate regions and has very low frost tolerance. Although most young seedlings die, those who survive grow rapidly into plants and produce flowers in few weeks; a seed takes roughly 40-56 days to produce a crop. PO requires an abundant supply of rainfall and irrigation, moist light and a sunny position. After cultivation, the fleshy stem remains viable and moist for several days and can re-root to transform into a new plant when re-irrigated. Under normal conditions, PO propagates by reseeding. The rate of seed germination is affected by the depth of sowing; a depth of over 6cm can potentially halt germination and negatively affect the general yield

1.1.5. Karyotype

Like most species of Portulacaceae, PO exhibit nine sets of chromosome as its gametic set of chromosome. Its somatic chromosome number is forty-five with some marked morphological variation but no apparent or marked size difference. Comparatively, there are six long chromosomes with nearly primary constrictions (3.1 fl. - 3.4 fl.); thirty-one medium-sized chromosomes with nearly median primary constrictions (2.3 fl. - 2. 7 fl.); and eight short chromosomes with median primary constrictions (1.7 fl. - 2 fl.).

1.1.6. Nutritional Value

PO has a very high nutritional value. It has the highest vitamin A content among green leafy vegetables and is also rich in other vitamins, dietary minerals and electrolytes. The mineral content of PO changes with the plant's growth stage and varies significantly depending on the plant's part. The level of Calcium, Magnesium, Potassium, Iron, and Zinc increases significantly from a young to a mature age; sodium and chlorine, on the other hand, are high at the young state of the plant's development and low at the mature stage. Similarly, a higher quantity of phosphorous is found in leaves than the roots and stem, while iron content is greater in the roots and leaves than in the stem. The manganese content is higher in roots than in leaves and stem. Table 2 shows the nutritional contents as well as the value of each nutrient.

Nutrients	**Value / 100g**
Energy	16 kcal
Carbohydrates	3.4 g
Protein	1.30g
Total fat	0.1g
Cholesterol	0 mg
Folates	12µg
Niacin	0.480mg
Pantothenic acid	0.036mg
Pyridoxine	0.073mg
Riboflavin	0.112mg
Thiamine	0.047mg
Vitamin A	1320IU
Vitamin C	21mg
Sodium	45mg
Potassium	494mg
Calcium	65mg
Copper	0.113mg
Iron	1.99mg
Magnesium	68mg
Manganese	0.303mg
Phosphorus	44mg
Selenium	0.9µg

Table 2. The Nutrient Profile of *Portulaca oleracea* (Purslane) Source: USDA National Nutrient data

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Biographical Sketch

Izuchukwu Azuka Okafor is a Lecturer in the Department of Anatomy, Nnamdi Azikiwe University, Nnewi Campus Nigeria. He is a distinction Anatomy graduate of the University of Lagos and is an African Union Doctoral scholar in Reproductive Biology at Pan African University. He has a strong research interest in phytomedicine and has focused on studying the effects of Purslane plant extracts in different human systems culminating in over 15 scientific publications. One of his reviews on Purslane still stands out in literature as one of the most cited plant-based reviews. He is currently investigating the effect of this plant on some essential reproductive function genes: Kiss1 and Kiss1r. Izuchukwu has other research and academic interests spanning anatomical sciences, reproductive biology and endocrinology, neurosciences, medical education, science advocacy and science communication.