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Portulaca oleracea L. A Review

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ABSTRACT

Portulaca is a genus of succulent herbs distributed in the warmer parts of the world. Four species are found wild in India and two exotics have become naturalized. *P. oleracea*, commonly known as Purslane is an herbaceous weed. In traditional system it has been claimed to cure diarrhoea, dysentery, leprosy, ulcers, asthma, piles; reduce small tumors and inflammations. The herb is considered to possess refrigerant, vulnerary, antiscorbutic, aperient and diuretic properties. It has been reported to possess potent pharmacological actions such as hepatotprotective, analgesic and anti-inflammatory, wound healing, neuropharmacological, bronchiodilatory, antidiabetic, antioxidant, antihypertensive and many other reported biological actions. Chemical constituents such as steroids, vitamins, minerals, fatty acids, alkaloids, saponins, etc. have been isolated from the plant. This review is an attempt to compile the pharmacological and phytochemical literature on *Portulaca oleracea*, to highlight and critically assess the pharmaceutical potential of this plant.

Keywords: *Portulaca oleracea*, Phytoconstituents, Hepatoprotective agent, Anti Nephrotoxic activity, Portuloside A, Pourtlene.

INTRODUCTION

Ethnomedical knowledge, with its holistic systems approach supported by experiential base, can serve as an innovative and powerful discovery engine for newer, safer and affordable medicines[1]. In the last few decades there has been an increasing interest in the ethnopharmacological studies on medicinal plants, which is evident by numerous publications and reports. However, these reports on medicinal plants are widely scattered in journals and books pertaining to different disciplines, such as botany, chemistry, pharmacology, pharmacy and medicine. This review is an attempt to compile the exhaustive literature on *Portulaca oleracea*, to highlight, analyze and critically assess the pharmaceutical potential of this plant that has been underestimated in a systematic way.

Portulaca oleracea commonly known as Purslane is a herbaceous weed. It is known by the name 'Rudravanti' in Hindi; 'Dahna' in Oriya and 'Nuner' in Kashmiri.The name *Portulaca* is thought to be derived from the Latin 'porto' to carry ans 'lac' meaning milk, since the plant contains a milky juice[2]. and has been reported officially in the French, Mexican, Spanish, and Venezuelan Pharmacopoeias[3]. It is distributed all over India, up to 170 m in the Himalaya and in all warm countries. It can be found growing in almost any unshaded area, including flower beds, corn fields, and waste places. Purslane is found all over the world, in the temperate countries of Europe, America, Canada, New Zealand, Australia, abundant in India[4].

The plant is an annual succulent prostrate herb; stems 15.30 cm long, reddish, swollen at the nodes, quite glabrous. Leaves fleshy, sub-sessile, 6.25 mm long, alternate or sub-opposite. Flowers few together, in sessile terminal heads[5]. Microscopic analysis of the leaf powder invariably shows spherical mineral crystals, sieve plates, tracheids with spiral, annular and scalariform thickening and vessels with bordered pits[6].

Purslane in ancient times was looked upon as one of the anti-magic herbs, and strewn around a bed was said to afford protection against evil spirits and nightmares[7]. It has been used in salads and as a medicinal plant (for people) for hundreds of years. The juice of the stems and leaves is applied to scorpion sting. In Jamaica it is employed as a cooling and moistening herb in fevers. In North America it has been considered a cooling diuretic, and the seeds at one time were thought to be anthelmintic, though now known to be inert. In Indo China the juice of the fresh leaves is applied to abscesses, and used as a collyrium, a decoction is given in dysentery and liver diseases[8]. In Nigeria the leaves are used as a local application to swellings[5]. In the Dominican Republic, all parts of *P. oleracea* are used in treatments for internal parasites. The plant always is mixed with other plants (*e.g.*, *Chenopodium ambrosioides*). *P. oleracea* is listed as a treatment for parasites, a blood-cleanser, and to refresh the digestive system. The leaves and tops are employed in anti-hemorrhagic poultices. The roasted seeds are considered diuretic and antidysenteric. The seeds are also used in applications for burns and scalds. In general, their medicinal uses are similar to those mentioned for the herb[9]. Chemical constituents such as steroids, vitamins, minerals, fatty acids, alkaloids, saponins, etc. have been isolated from the plant. The present review on *Picrorrhiza kurroa* gives an account of its chemical and pharmacological investigations done so far by different authors.

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PHARMACOLOGICAL PROPERTIES

According to the literature *Portulaca oleracea* has been reported to possess hepatoprotective, analgesic and anti inflammatory, antioxidant, anticancer, wound healing, bronchodilator, neuroprotective, hypochloresterolemic and many other biological activities. Further pharmacological studies regarding these activities have been undertaken by various workers which are given below:

1.Neuropharmacological effect:
Ethanolic extract of *P. oleracea* var. *sativa*, on intraperitoneal administration, showed a significant reduction in the locomotor activity in mice, antinociceptive activity in rats using tail flick method, an increase in the onset time of pentylenetetrazole-induced convulsions in mice and muscle relaxant activity in *in vitro* (rat hemidiaphragm) and *in vivo* (grip strength) experiments. The anti-nociceptive activity of the extract in rats was attenuated by naloxone pre-treatment indicating the involvement of opioid receptors in its anti-nociceptive effects. It indicated that *P. oleracea* var. *sativa* possesses varied effects on both the central and peripheral nervous system[10].

2.Anti-inflammatory and analgesic effect:
Ethanolic extract of the aerial parts (dried leaves and stem) of *P. oleracea* ssp *sativa*) showed significant anti-inflammatory and analgesic activities after intraperitoneal and topical but not oral administration when compared with the synthetic drug, diclofenac sodium as the active control[11,12,13].

3.Antimicrobial effect:
Aqueous and ether extracts of the herb showed activity against gram-negative bacteria. The antifungal activity of *P. oleracea* extracts against hyphal growth of various fungi was evaluated in real time using an automatic single-cell bioassay system. The antifungal activity of each fraction of *P. oleracea* was evaluated based on the dynamic hyphal growth response curves of test fungi *Aspergillus* and *Trichophyton* and the yeast *Candida*. A crude sample obtained by ethylacetate extract showed a specific and marked activity against dermatophytes of the genera *Trichophyton*[14].Whole plant of *P. oleracea* extracted in ethanol was found inhibitory to *Bacillus subtilis* and those extracted in chloroform, ethanol and hexane to *Rhizobium leguminosarum*. The species failed to prove antagonistic to *E. coli*[15]. Fungitoxicity of aqueous and organic solvent (e.g. hexane, ethanol and chloroform) extracts were tested

against *Aspergillus niger*, *Rhizopus artocarpi* and *Fusarium* sp. by agar cup assay and filter disc methods. Hexane and aqueous extracts showed antifungal activity against *Fusarium* sp., while ethanol and chloroform extracts of the same herb inhibited the growth of *Rhizopus artocarpi*[16].

4.Wound healing activity:
The preliminary wound healing activity of *P. oleracea* was studied using *Mus musculus* JVI-1. For this purpose fresh homogenized crude aerial parts of *P. oleracea* were applied topically on the excision wound surface as single and two doses in different amounts. Wound contraction and tensile strength measurements were used to evaluate the effect of the plant on wound healing. The results obtained indicated that *P. oleracea* accelerates the wound healing process by decreasing the surface area of the wound and increasing the tensile strength. The greatest contraction was obtained at a single dose of 50mg and the second greatest by two doses of 25mg. Measurements of tensile strength and healed area were in agreement[17].

5.Antihypertensive activity:
An aqueous extract of the stems and leaves of *P. oleracea* abolished the twitch contraction of the directly stimulated rat hemidiaphragm preparation. The effects of the extract mimic qualitatively the action of potassium oxalate-a known constituent of *P. oleracea* on the diaphragm. Removal of K^+ ions from the methanol extract by passing it through a cation exchange resin reduced the inhibitory effect of the extract. There was a positive correlation between the concentration of K^+ ions in the extract and the effects of potassium chloride of similar molarity. It was concluded that the K^+ ion content of *P. oleracea* is at least partly responsible for the relaxant effect observed on the isolated rat diaphragm[18]. An aqueous extract of *P. oleracea* leaves and stems produced a dose dependent relaxation of guinea pig fundus, taenia coli and rabbit jejunum and a dose dependent contraction of the rabbit aorta. On spontaneously beating rabbit right atria and electrically paced left atria, the extract produced a dose dependent negative inotropic and chronotropic effects. On rat blood pressure, the extract produced dose dependent pressor responses[19, 20].

6.Anti-fertility effect:
The antifertility effects of alcoholic extract of *P. oleracea* seeds were observed on the reproductive organs of male albino mice after s.c. administrations of 15, 20 and 30 doses (1 dose=50 mg/mouse per alternate day). The treatment produced mass atrophy of spermatogenic elements. Epididymal lumina were devoid of spermatozoa or contained debris. Treatment led to significant decrease in absolute weights of testes, epididymides, vas deferens and seminal vesicles. Administration of 30 doses produced a significant decrease in protein content and sialic acid of testes, epididymides and seminal vesicles remained unaltered after 30 doses while it was drastically reduced in testes. The administration (s.c.) of alcoholic extract of *P. oleracea* seed induced an effective impairment of spermatogenesis[21].

7. Antioxidant Activity:
P. oleracea was studied for its ability to reduce oxidative stress induced by vitamin A deficiency. Vitamin A-deficient male Wistar rats were divided into four groups which were treated for 30 days with different diets: AIN-93G vitamin A-deficient diet (DD), DD supplemented with pure beta-carotene (beta-D) and DD supplemented with malanga (*Xanthosoma sagittifolium*) (MD) or purslane (*Portulaca oleracea*) (PD) leaves as the only source of vitamin A. The thiobarbituric acid-reactive substances (TBARS), reduced (GSH) and oxidized (GSSG) glutathione, and antioxidant enzyme activities were determined in the heart and liver. The rats fed beta-D, MD and PD showed liver and heart TBARS concentrations lower than did DD rats. The liver GSH concentration of beta-D, MD and PD rats was lower compared to DD rats. Thus suggesting that the ingestion of purslane or malanga leaves may have a protective effect against oxidative stress caused by vitamin A deficiency[22].
Three phenolic alkaloids, i.e., oleracein A (OA), oleracein B (OB) and oleracein E (OE), isolated from *Portulaca oleracea* were studied for antioxidant activity, based on scavenging activity against 1,1-diphenyl- 2-picryl-hydrazyl (DPPH) radical and inhibitory effect on hydrogen peroxide-induced lipid peroxidation in rat brain homogenates. The DPPH radical scavenging activities of these phenolic alkaloids were lower than caffeic acid but higher than ascorbic acid and á-tocopherol, being in the following order: OB > OA > OE. OE was most potent in preventing formation of malondialdehyde (MDA) with an EC50 value of 73.13 µM, close to that of caffeic acid (72.09 µM). It was demonstrated that phenolic alkaloids served as a new class of antioxidant agents in this plant[23].

8.Gastric Antiulcerogenic Activity:
Aqueous and ethanolic extracts of *P. oleracea* were studied in mice for their ability to inhibit gastric lesions induced by HCl or absolute ethanol. In addition, their effects on gastric acid secretion were measured. Both extracts showed a dose-dependent reduction in severity of ulcers. The highest dose of extracts exerted similar activity to sucralfate. The oral and intraperitoneal administration of extracts reduced the gastric acidity in pylorus-ligated mice. These results suggested that *P. oleracea* has gastroprotective action and validates its use in folk medicine for gastrointestinal diseases[24].

9.Bronchodilatory Effect:
The bronchodilatory effect of the boiled extract of *P. oleracea* in the airway of asthmatic patients was examined and the results showed that the boiled extract of *P. oleracea* caused significant increases in all measured pulmonary function tests (PFTs), ($P < 0.05$ to $P < 0.01$). There was no significant difference between the maximum increase in measured PFTs due to the boiled extract and theophylline. However, maximum increase in PEF and MEF(25-75) due to the boiled extract were significantly lower than those of salbutamol ($P < 0.05$ for both cases). The onset of brochodilatory effect of extract was similar to that of theophylline beginning 60 min, but the effect of extract decline after 120 min after administration. The results of the study showed that *P. oleracea* has a relatively potent but transient bronchodilatory effect on asthmatic airways[25].

10.Intestinal parasitical Activity:
In this study cognitive measure of salience in free-listing tasks, which reveals five plants commonly used to treat intestinal worms. These were *Ambrosia hispida* (Asteraceae), *Aristolochia trilobata* (Aristlochiaceae), *Chenopodium ambrosioides* (Chenopodiaceae), *Portulaca oleracea* (Portulacaceae), and *Artemisia absinthium* (Asteraceae). Bioactive compounds appear to be present in all of these plants. The cognitive salience of these plant remedies coupled with evidence of biochemical properties suggest that they provide efficacious treatments for controlling intestinal parasite loads[26].

11.In Urinary Problems:
The study was based on ethnobotanical interviews conducted from 1996-2000 in Trinidad and Tobago with thirty male and female respondents. A non-experimental validation was conducted on the different plants used for urinary problems and diabetes mellitus. Thus establishing that the plants used are safe or effective, to help direct clinical trials, and to inform Caribbean physicians of the plants' known properties to avoid counter-prescribing. *P. oleraceae* was one of the plants having sufficient evidence to support their traditional use for urinary problems[27].

12.Anti-phenolic endocrine disruptors:
Portulaca oleracea showed the ability to efficiently remove from water bisphenol A (BPA), which is well known as an endocrine disrupting compound (EDC) having estrogenic properties. In water culture, 50 muM BPA was almost completely removed within 24 h when the ratio of whole plant weight to the water volume was set up at 1 g to 25 ml. The estrogenic activity of the water decreased in parallel with the elimination of BPA. This plant also rapidly removed other EDCs having a phenol group including octylphenol (OP), nonylphenol (NP), 2,4-dichlorophenol (2,4-DCP) and 17beta-estradiol and, thereby, removed the endocrine disrupting activities. In addition, the ability of *P. oleracea* to remove BPA was not affected by BPA concentration (up to 250 microM), by cultivation in the dark, by temperatures ranging from 15 degrees °C to 30 degrees °C, or by pH ranging from 4 to 7. Moreover, the ability of *P. oleracea* to individually remove BPA, NP, and OP was the same as when they were all present thus suggesting that *P. oleracea* is a promising material for practical phytoremediation of landfill leachates and industrial wastewater contaminated with the tested EDCs[28].

13.Hypoxia tolerance activity:
The aim of this study was to investigate whether *P. oleracea* (PO) extracts have hypoxic neuroprotective effects and if so, by what mechanism. After being orally administrated with the PO extracts or distilled water for seven days, adult male BALB/c mice were adapted to a normobaric low oxygen environment (10% oxygen and 90% nitrogen) for different time and then were sacrificed. The results showed that the PO extracts enhanced the EPO mRNA and protein expression in the mouse cortices. Compared to the control group, the mouse in the group treated with the PO extracts by 1 g/day had significantly higher activities of PF, PFK, LDH and higher levels of ATP in the cortices, especially under the hypoxic environment for 24 hours. Histological analysis indicated that the extracts lessened the inflammation damage of the mouse brain. MTT assay results showed the PO extracts raised the viability of the cells under the tested hypoxic conditions and decreased the degree of LDH in the culture medium in a dose-dependent manner demonstrating that the PO extracts had protective effects on hypoxic nerve tissue[29, 30].

14.Neuroprotective Effect:
Neuroprotective effects of purslane herb aqueous extracts (PHAS) at doses of 2.5, 5 and 10 mg/(kg day) on SD mice injected daily with D-gal (50 mg/(kg

day) by behavioral tests. PHAS-fed mice showed higher activity upon induction by new environmental stimuli, lower anxiety and higher novelty-seeking behavior in the open field tasks, and significantly improved learning and memory ability in step-through compared with D-gal-treated mice. The mechanisms involved in neuroprotective effects of PHAS on mouse brain was significantly increased superoxide dismutase (SOD) activity and decreased the malondialdehyde (MDA) level[31].

15.TNF-α and IL-6 Inhibitory Activity:
The effects of drug-carried serum of the different parts of *Portulace oleracea* on cytokine TNF-α and IL-6 secreted by adipose cell in vitro method was explored. The cell viability of each group was tested by Methy thiazolyl tetrazolium (MTT) assay. The levels of TNF-α and IL-6 in the supernatant of cultured adipose cell were assayed by RIA. MTT assay results showed that the drug-carried serum of *P. oleracea* and its different parts act on adipose cell damaged by the high lipid serum, significantly increase the cell viability in the groups in 40% and 20% concentration, and improve the disorder of lipid in different degree by lowering the levels of TNF-α and IL-6 that adipose cell secreted in vitro[32].

16.Anti Nephrotoxic Activity:
Aqueous and ethanolic extracts of *P. oleracea* were studied on cisplatin-induced renal toxicity and changes in renal function. Doses (0.2, 0.4, 0.8 g/ kg, i.p.) of aqueous and doses (0.5, 1, 2 g/ kg, i.p.) of ethanolic extracts, were injected 6 hr or 12 hr before cisplatin and the mentioned doses of aqueous and ethanolic extracts, were injected 6 hr or 12 hr after cisplatin. Functional nephrotoxicity indicators such as BUN (blood urea nitrogen) and Scr (serum creatinine) were elevated in cisplatin-treated rats compared with control. Treatment with aqueous and ethanolic extracts in the highest dose (0.8 and 2 g/ kg), 6 and 12 hr before cisplatin injection reduced BUN and Scr. Tubular necrotic damage was not observed either The protective effect of aqueous and ethanolic extracts before cisplatin injection were relatively similar and these effects were dose dependent. Rats treated with aqueous and ethanolic extract, 6 and 12 hr after cisplatin injection had BUN and Scr levels significantly lower than those receiving cisplatin alone but mild to moderate cell injury was observed thus indicating that treatment with aqueous and ethanolic extracts of *P. oleracea* in the highest dose (0.8 and 2 g/ kg), 6 and 12 hr before cisplatin injection reduced BUN and Scr. Tubular necrotic damage was not observed either[33].

18. Hypochloresterolemic Effects:
Ahmed and his coworkers carried out investigation of hydroalcoholic extract of *P.oleracea* leaves on serum lipids of rabbits fed with hyperchloresteromic diet. Different groups of animals were fed with diet enriched in cholesterol (0.5%). *P. oleracea* extract (200, 400, 800 mg/kg body weight) orally for 12 weeks was administered to hyperchloresterolemic animals. It was found out that serum total cholesterol and atherogenic index decreased in all groups treated with *P. oleracea* extract with respect to positive control group thus indicating that plant may be useful for treatment of hypercholesterolemia[34].

19.Skeletal Muscle Relaxant Property:
The skeletal muscle relaxant properties of an aqueous extract of *Portulaca oleracea* were examined on the twitch and tetanus tension evoked by electrical stimulation using the rat phrenic nerve-hemidiaphragm and frog sciatic nerve-sartorius muscle preparations and on contractures induced by nicotinic agonists using the rat *rectus abdominus* muscle preparation. Observations indicated that the aqueous extract possesses unique skeletal muscle relaxant properties which do not appear to involve interference with cholinoceptor mechanism(s) and that the mechanism of action of the extract may involve interference with Ca^{2+} mobilization in skeletal muscle[35, 36].

The aqueous extract of *P. oleracea* produced skeletal muscle relaxation in rats following i.p. or oral administration, as assessed by the prolongation of pull-up time. The i.p. route of administration was more effective. When compared with chlordiazepoxide (20 mg/kg, i.p.), diazepam (40 mg/kg, i.p.) and dantrolene sodium (30 mg/kg, oral), the extract (200-1000 mg/kg, i.p.) proved a more effective skeletal muscle relaxant. With 1000 mg/kg i.p., 80% lethality was seen. The LD50 in an acute toxicity test in mice was 1040 mg/kg i.p[37].

The effects of aqueous (AEE), dialysable (DIF) and methanol (MEE) extracts of *P. oleracea* stems and leaves were compared with those of dantrolene sodium and methoxyverapamil (D-600) with respect to inhibition of twitch tension on the rat phrenic nerve-hemidiaphragm and with respect to contracture induced by nicotinic agonists on the frog rectus abdominis preparations. The extracts, dantrolene and D-600 inhibited twitch tension due to indirect electrical stimulation via the phrenic nerve (NS) on hemidiaphragm muscle, whereas the extracts and dantrolene inhibited, in addition, twitch amplitude due to direct muscle stimulation (MS). The extracts and D-600 proved more effective in attenuating nicotinic agonist (acetylcholine, carbachol and nicotine)-induced contractures on the rectus abdominis muscle than dantrolene. From these observations, it appears that the *P. oleracea* extracts mimic, in part, the effect of D-600 and dantrolene on the rat hemidiaphragm and frog rectus abdominis muscles; therefore, the muscle relaxant properties of the extracts may be due, in part, inhibition of trans-membrane Ca influx, interference with the Ca-induced Ca release process and/or inhibition of the release of intracellular Ca from stores in the sarcoplasmic reticulum[38].

20.Hepatoprotective Activity:
Treatment of CCl_4 hepatic injured rats with 70% alcohol extract of *P. oleracea* significantly restored the hepatic marker enzymes and total bilirubin to near-normal values demonstrating hepatoprotective activity[39].

21.Anti-hyperglycemic Activity:
The oral administration of the homogenates of *P. oleracea* reduced the blood-sugar level of alloxan-diabetic rabbits to normal[40].

22.Toxicity Studies:
Dried powder of *P. oleracea* were extracted by the dipping method with methanol, ethanol, acetone, ethyl acetate, ether, trichloromethane, dichloromethane, benzene and petroleum ether, and bioactivity of the extracts against *Aphis gossypii* Glover including contact toxicity and antifeeding toxicity were approached. The results indicated that the methanol extract showed the highest contact toxicity among the 9 different extracts and the dichloromethane extract had the highest antifeeding toxicity. No data on the toxicity of *P. oleracea* could be found in the literature. However, the plant does contain cardiac glycosides and oxalic acids, which can be toxic[41].

PHYTOCONSTITUENTS REPORTED
Analysis of edible leaves and stems demonstrated the presence of protein, carbohydrates, mineral matter, calcium, magnesium, oxalic acid, thiamine, riboflavin, nicotinic acid, and vitamin C (29 mg/100 g); carotene (as vitamin A, 3820 I.U/100 g). Vitamin C is highest in the green leaves of young plants and decreases after flowering. A sample from North India contained 16 mg/ 100 g of total carotenoids, of which about one-third were active in terms of -carotene (vitamin A, 7500 I.U/100 g). The oxalic acid content is by far in excess and cannot be compensated by the fairly high amount of calcium present. Purslane is also rich in sodium and potassium[42]. Purslane is rich source of vitamin E, fatty acids and other nutrients, which make it a prime vegetable crop. It is also rich source of omega-3-fatty acid called -linolenic acid. It is suggested that purslane would be a possible crop in arid areas of the Southwestern United States due to its adaptability to both dry conditions and salty soils[43].

The seeds on extraction with petroleum ether give light green oil (17.4%) with the following constituent fatty acids: palmitic, 10.9; stearic, 3.7; behenic, 1.3; oleic, 28.7; linoleic, 38.9; and linolenic, 9.9%; unsaponifiable fraction yields -sitosterol[44]. A crude protein-free extract gave a strong pressor response when injected intravenously into anaesthetized dogs; it was found to contain biologically active 1-noradrenaline, dopamine [4-(2-aminoethyl)-pyrocatechol], and dopa [3-(3,4-dihydroxyphenyl)-alanine], besides an unidentified catechol. The concentration of l-noradrenaline in the fresh plant (2.5 mg/g in one sample) is likely to be greater than that extractable from the suprarenal glands of the mammals. The herb probably contains the bioflavonoid liquiritin. Macerated herb exhibited carbonic anhydrase activity[42]. The fatty acid profile and -carotene content of a number of Australian varieties of purslane (*P. oleracea*) were determined by GC and HPLC. These results indicate that Australian purslane varieties are a rich source of alpha linolenic acid and beta carotene[45]. Leaf wax of *P. oleracea* was studied by Tulloch, 1974[46]. Total lipids and omega-3-fatty acids in *P. oleracea* were determined in leaves, stems and whole plants at three ages. Significant differences existed in levels of total lipids among ages and between leaves and stems, but no relationship of age to plant part was found[47]. From the fresh leaves of *P. oleracea* various hydrocarbons have been characterized and their relative distribution determined through GLC studies. The considerable occurrence of branched chain hydrocarbons was considered an indication of the characteristics of lower plant based on taxonomy[48].

From the methanol extract of *P. oleracea*, a monoterpene glucoside, portuloside A, has been isolated was confirmed to be (3S)-3-(3,7-dimethyl-octa-1,7-dien-6-onyl)—D-glucopyranoside by synthesis from linalool[49]. Fresh aerial parts of *P. oleracea* growing in Jordan were found to contain -sitosterol, -sitosterol glucoside, *N, N´*-dicyclohexylurea and allantoin[50]. Two clerodane-type diterpenes, porwenins A and B have been reported from *P. okinawensis* from biosynthetic and chemosystematic points of view and the structures were elucidated by spectroscopic data[51]. Oleracins I and II (5-*O*—cellobiosides of betanidin and isobetanidin, respectively) and acylated betacyanins have been

reported along with mucilage from leaves. Its acidic fraction consisted of galacturonic acid residues joined by -(14) linkages and neutral fraction composed of arabinose[41] and galactose with traces of rhamnose[42].

Portulaca oleracea leaves were found to contain 0.42% of a mucilage mixture. The mucilage was fractionated into an acidic and a neutral fraction. The acidic fraction consists of galacturonic acid residues joined by á-(1>4) - linkages; 60% of these residues are present as the calcium salt, and esterified galacturonic acid residues are absent. The neutral fraction is composed of 41% of arabinose and 43% of galactose residues, besides traces of rhamnose residues[52]. Five flavonoids (kaempferol, apigenin, myricetin, quercetin and luteolin) in different parts of *P. oleracea* L. were identified by a method based on capillary electrophoresis with electrochemical detection (CE-ED)[53].

Xiang and his coworkers isolated five alkaloids (oleraceins A, B, C, D and E) from *Portulaca oleracea* L., and their structures determined by spectroscopic methods as 5-hydroxy-1-p-coumaric acyl-2,3-dihydro-1H-indole-2-carboxylic acid-6-O-beta-D-glucopyranoside, 5-hydroxy-1-ferulic acyl-2,3-dihydro-1H-indole-2-carboxylic acid-6-O-beta-D-glucopyranoside, 5-hydroxy-1-(p-coumaric acyl-7'-O-beta-D-glucopyranose)-2,3-dihydro-1H-indole-2-carboxylic acid-6-O-beta-D-glucopyranoside, 5-hydroxy-1-(ferulic acyl-7'-O-beta-D-glucopyranose)-2,3-dihydro-1H-indole-2-carboxylic acid-6-O-beta-D-glucopyranoside and8,9-dihydroxy-1,5,6,10b-tetrahydro-2H-pyrrolo[2,1-a]isoquinolin-3-one, respectively[54]. Besides isolating oleracein A, oleracein B and oleracein E Yang and his coworkers isolated hesperidin and caffeic acid for the first time by various column chromatography methods from *Portulaca oleracea*[55]. Chromatographic fractionation of the chloroform extract of *Portulaca oleracea* L. growing in Egypt afforded a new clerodene diterpene portulene, in addition to the known compounds lupeol, beta-sitosterol and daucosterol, which were reported for the first time from the title plant[39].

CONCLUSION

The extensive survey of literature revealed that *Portulaca oleracea*, is an important medicinal plant with diverse pharmacological spectrum. Due to its high content of nutrients, especially antioxidants (vitamins A and C, á-tocopherol, â-carotene, glutathione) and omega-3 fatty acids, and its wound healing and antimicrobial effects as well as its traditional use in the topical treatment of inflammatory conditions, purslane is a highly likely candidate as a useful cosmetic ingredient. Since most of the reported effects of purslane are due to its fresh juice or to its decoction, water extractives would be most suitable. Further evaluation needs to be carried out in order to explore the concealed areas and their practical clinical applications, which can be used for the welfare of the mankind.

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