Review Article

Pharmacological, nutritional and allelopathic attributes of noxious weed, *Trianthema portulacastrum* L. (Horse purslane).

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Abstract

Trianthema portulacastrum L. generally known as horse purslane, is a noxious weed of Family Aizoaceae. The plant is native to South Africa and has been reported to be present in India, Pakistan, Tropical America, West Asia, Srilanka and Africa. It is a diffuse, prostrate, branched succulent annual herb which is considered to be a noxious weed due to high level of infestation in various crops. Trianthemol, ecdysterone and leptorumol are various phytochemicals which has been isolated from this plant. It is an important medicinal plant which is mostly used for fever, jaundice, dropsy, liver and kidney diseases and also well known for its hepatoprotective, anticarcinogenic, diuretic, antimicrobial, antinephrotoxic and antidiabetic activities. Plant is also used as vegetable in various parts of world due to its high nutritional value. This paper gives information on pharmacological attributes, nutritional benefits, allelopathic impact on other plants and effective management of *Trianthema portulacastrum* Linn so that it can be used in a positive way especially for the development of new drugs.

Key words: Medicinal Plant, Hepatoprotective, Allelopathic, Antioxidant.

Introduction

Geographical Distribution

Trianthema portulacastrum L. is an annual terrestrial weed of the Family Aizoaceae. The plant is native to South Africa and also reported to be present in India, Tropical America, West Asia, Srilanka and Africa [1]. It is one of the major summer crop weeds in Pakistan [2] and is widely distributed in Punjab and Sindh regions whereas in India, it has been reported to be

present in Uttar Pradesh, Rajasthan, Haryana, Punjab and Delhi causing infestation in various economically important crops [1, 3].

Botanical description

The plant is commonly known as horse purslane. Synonyms of *Trianthema portulacastrum* Linn. are *Trianthema monogyna* Linn. and *Trianthema obcordata* Roxb. It is a diffuse, prostrate, branched succulent annual herb. The height of stem is

35 cm and it is glabrous to sparsely pubescent (Figure 1a). The leaves of *Trianthema portulacastrum* L. are sub-orbiculate to obovate, 1.5-2.6 cm in length, 0.6-2.5 cm broad, obtuse or acute. The length of petiole is 4-11 mm and its base is dilated. Flowers are axillary solitary and sessile (Figure 1 b). Calyx tube is closely covered by the leaf base. Sepals are five in number, oblong, 2.5-3.0 mm in length, shortly aristate. Stamens are 10-15 in number, unequal in size and length of filaments is 1.5-2.2 mm. Ovary is 2 mm long, and almost conical in shape. It has one style which is linear, 1.5-2.0 mm long and persistent. Seeds are 2 mm broad and black in colour [4].

Germination and Growth

Trianthema portulacastrum is a noxious weed which leads to crop damage at high density. The plant grows rapidly and forms a carpet on the soil due to its prostrate growth [5]. It grows quickly if water is available and has vegetative growth for 35-40 days after emergence. It shows maximum germination at 35° C and increase in pH results in increased germination while at pH 5 it shows lowest rate of germination. High levels of salinity also affects germination [6].

Biological activities

Medicinal properties of *Trianthema portulacastrum* L. has been reported by many researchers as it contains various biologically active constituents such as steroids, flavonoid, alkaloids, terpenes, carbohydrates, tannins and fats.

Antiliathic activity

Treatment of experimentally induced urolithiasis with ethanolic extract of leaves of *Trianthema portulacastrum* Linn. resulted in a restoration of urinary and serum parameters along with significant increase in activity of antioxidant enzymes [7].

Antioxidant activity

Methanolic extract plant showed antioxidant activity against 1, 1-Diphenyl-2 picryl hydrazyl (DPPH) and hydrogen peroxide radicals which was comparable with standard ascorbic acid [8]. Another study reported that stem leave and root hydrolysates of *Trianthema portulacastrum* L. possess reducing potentials, have capability to inhibit peroxidation (43.26~89.98%), and radical scavenging ability (6.98~311.61 µg/mL IC50) thus indicating *T. portulacastrum* as potent source of antioxidants [9].

Antihyperglycemic Activity

Diabetes is a complex disorder which leads to micro & macro vascular complications involving lack of insulin secretion or insulin resistance or both. Diabetes has reached epidemic proportions [10]. Various research studies has been conducted for the evaluation of plants extracts for their antidiabetic activity [11]. Many plants have been known for their antihyperglycemic activity through folklore. Laboratory tests carried out in normal and alloxan induced diabetic rats showed that methanolic extract of *Trianthema portulacastrum* L. produced significant reduction in blood glucose [12]. According to another reported study methanolic extract of horse purslane produced antihyperglycemic activity comparable to satandard, Glibenclamide in streptozotocin induced diabetic rat [13].

Antimicrobial activity

Methanolic, chloroform and aqueous extracts of *Trianthema portulacastrum* L. exhibited antibacterial activity against seven bacterial isolates; *Klebsiella pneumonia*, *Proteus vulgaris*, *Shigella flexneri*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Salmonella typhi* and *Escherichia coli*. While evaluation of anti-fungal activity against *Aspergillus fumigatus*, *Rhizopus oryzae*, *Aspergillus flavus*,

Aspergillus niger, *Mucor indicus* and *Candida albicans* showed that methanol and chloroform extracts displayed less than 100% inhibition against *Aspergillus niger*, *Aspergillus fumigatus*, *Rhizopus* and *Candida albicans* whereas *Mucor* did not show any susceptibility to all the three leaf extracts [14]. According to another study the inhibitory activity of both trianthemol and crude extract of *Trianthema portulacastrum* L. was found to be average [15].

Antibacterial activity of selected Thai weeds against different bacterial isolates i.e, *Plesiomonas shigelloides*, *Aeromonas caviae*, *Edwardsiella tarda*, *Aeromonas hydrophila*, *Salmonella spp.*, *Ralstonia spp.*, *Shigella spp.* and *Xanthomonas campestris* pv. *Vesicatoria* showed that ethanol extract of horse purslane had 20.10% inhibition against *Shigella* spp. [16]. Root extract of horse purslane against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Proteus vulgaris* and *Pseudomonas aeruginosa* showed significant anti-bacterial activity which is comparable to cotrimoxazole [17].

Antinephrotoxicity

Results of studies carried on gentamicin induced nephrotoxicity in rats showed that *T. portulacastrum* possess nephroprotective activity and free radical scavenging activity [18]. Methanolic extract of *T. portulacastrum* L. provide defense against atherosclerotic diet or CCT diet (containing 4% cholesterol, 0.5% thiouracil and 1% cholic acid) induced glomerulosclerosis and hepatic injury in rats. The extract reduced the levels of serum lipid such as alanine transaminases and aspartate transaminases and also reduced creatinine levels [19]. *Trianthema portulacastrum* leaves extract provide relief against adriamycin induced nephrotic syndrome by reducing the serum cholesterol, blood urea nitrogen, and creatinine [20].

Diuretic activity

Crude extract of *Trianthema* at the dose of 50 mg/kg displayed 79% diuretic activity by increasing urinary volume and urinary electrolytes concentration comparable to standard, furosemide, thus suggesting it to be a potential [21].

Anticarcinogenic activity

Investigations have revealed that administration of the chloroform extract of *T. portulacastrum* provide relief against diethylnitrosoamine (DNA) induced hepatocarcinogenesis [22] and diethylnitroso- amine-induced phenobarbital promoted hepatocarcinogenesis [23].

Hepatoprotective activity

The outcomes of study against thioacetamide and paracetamol induced hepatotoxicity revealed significant hepatoprotective activity of *T. portulacastrum* which was evaluated by using different biochemical parameters [24]. Ethanolic extract of *Trianthema portulacastrum* showed hepatoprotective activity against liver injury in mice induced by carbon tetrachloride (CCl₄), comparable to silymarin, a well-known hepatoprotective agent [25]. Oral feeding with the ethanolic extract (from 2 weeks before CCl₄ treatment up to 13 weeks) provided protection against DNA damage [26]. Pre-treatment with *T. portulacastrum* for seven days reduced the serum enzymes levels thus showing hepatoprotective activity of *Trianthema* similar to silymarin [27]. Oral treatment with the extract (100 or 150 mg/kg) provided protection against CCl₄ damage and reduced elevated lipid peroxidation of the liver [28]. In another study *Trianthema portulacastrum* L. ethanolic extract reduced hepatocellular destruction of Swiss albino mice [29].

Anthelmintic activity

Crude aqueous methanolic extract of Horse purslane showed anthelmintic activity

against mature female *Haemonchus contortus* and their eggs (In vitro) while In vivo anthelmintic activity was carried out in sheep infected with different nematodes species [30].

Antihyperlipidemic

Investigations revealed that methanolic extract of *Trianthema portulacastrum* L. provides protection to hyperlipidemic rats by reducing lipid levels [31] and by reducing triglycerides and total cholesterol [12].

Antifertility Activity

Studies were carried out to assess the antifertility activity of Chloroform, alcohol and aqueous extracts of stem, leaves and roots of *Trianthema portulacastrum* L. Results showed that extracts exhibited significant abortifacient activity ranging from 20.31% to 94.02%. The alcoholic extract of was found to show strongest antifertility activity [32].

Chemosterilant activity

Ecdysterone obtained from horse purslane showed chemosterilant activity. The abdomens of house fly larvae were isolated and dipped in the crude extracts of *Trianthema portulacastrum* which revealed molting hormone activity [33].

Analgesic activity

Ethanol extract of *T. portulacastrum* showed analgesic activity by suppressing writhing response induced by acetic acid. A dose of 250 mg/kg extract suppressed writhing response by 50.92% as compared to standard drug Aspirin which blocks writhing response by 67.68% ($P < 0.001$). Apart from that the plant extract also showed significant antinociceptive action [34].

Nutritional profile

Food is the fundamental need of human being, but high rate of population causes shortage of fertile land causing hunger and malnutrition problems [35]. Plants have been used by human being as food, since

prehistoric times. Although a few major crops have been used as food, but in many parts of the world, wild plants also contribute in daily intake of food [36]. Several wild species have been reported well for human consumption due to their nutritional values.

Trianthema portulacastrum L. is also used as food by the people in some areas of world.

Nutritional assessment of *T. portulacastrum* L. revealed that it is a good source of fiber, proteins, potassium, sodium, and iron. Fiber was found to be the highest (430.0 mg/g), followed by ash (348.0 mg/g), moisture (80.0 mg/g), total protein (91.9 mg/g), carbohydrate (30.2 mg/g) and total lipid (20.0 mg/g). Among the macro minerals, potassium was present in higher concentration (51.6 mg/g) than sodium (44.0 mg/g) [37]. Another study reported *Trianthema* as a good source of fodder for ruminants as it contains various nutrients [38]. Analysis of chemical composition of *Trianthema portulacastrum* L. showed that it contains Edible portion (49g), Moisture (90.0g), Protein (2.5g) Ether extract (0.33g), Ash (2.29g), Ca (52mg), P (22mg), K (317mg), Na (16.0mg), Mg (153mg), Iron (4.16mg), Zinc (0.46mg), Copper (0.12mg), Manganese (0.43mg) and Chromium (0.200mg) [39]. Another study conducted on eight different vegetable species revealed that *Trianthema* had the highest concentrations of fats and micronutrients compared to the other seven species, while fibre contents of *Trianthema portulacastrum* had nominal percentage values [40].

Ethnobotanical uses

Trianthema portulacastrum L. is an important medicinal plant which is used worldwide to cure different diseases. Decoction of root is used for constipation by the local herbalists of Tamil Nadu, India [41]. The roots of *Trianthema portulacastrum* are used against jaundice by

indigenous People in District Attock, Pakistan [42]. Various parts of plant are used for treating fever, rheumatism, jaundice, wounds, dropsy and liver diseases [43]. Necklace is made from the short pieces of stem and is hung around the neck to cure jaundice [44]. It is used as potherb in coimbatore districts of Tamil nadu and locally known as Charanai [45]. Juice of young roots used for cooling effect [46]. The leaves of horse purslane have medicinal properties which are used to promote urination and useful in dropsy and kidney disease [47].

Phytochemistry

About 2, 50,000 higher plant species are reported to be present on earth, of which more than 80,000 are medicinal due to presence of active constituents. Isolation of active components from plants and using it alone or in combination with others has opened new era, for the treatment of human disease. Plant based drugs have less side effects as compared to synthetic drugs that's why studies have carried out for development of methods to isolate active compounds from plant sources [48]. For this purpose many research studies have been conducted to detect the active constituents present in *Trianthema portulacastrum* L. Qualitative analysis of this plant showed the presence of various compounds such as steroids, flavonoid, alkaloids, carbohydrates, tannins, terpenes and fats.

Trianthanol (15-hydroxymethyl-2, 6, 10, 18, 22, 26, 30- heptamethyl-14-methylene-17-hentriacontene) [15], a new flavonoid (5, 2'-dihydroxy-7-methoxy-6, 8-dimethylflavone) and leptorumol (5, 7-dihydroxy-6, 8-dimethylchromone) has been isolated from *T. portulacastrum* [49]. It also contains potassium salts, punarnavine, ecdysterone, and trianthemine. Roots of Horse purslane contain saponin glycoside [50]. Vanillic acid, P-Hydroxybenzoic acid, ferrulic acid,

trans-Cinnamic acid, Caffeic acid, Protocatechuic acid, o-coumaric acid and Pyrogalllic acid, are also reported from leaves and stem of *T. portulacastrum* [51]. Ecdysterone has been isolated from the *T. portulacastrum* whole plant which is the most widely occurring phytoecdysone [52]. Phytochemical investigations of *Trianthema portulacastrum* revealed the presence of various compounds, mainly the flavonoids [14] 3, 4-dimethoxy cinnamic acid and Betacyanin [13].

Allelopathic aspects

Allelopathy is a phenomenon of useful or harmful effects of a plant (on its own or other plants) which can have multiple effects on plant distribution and biodiversity conservation [53]. Allelochemicals can either stimulate or suppress growth of another plant [54]. *Trianthema portulacastrum* is a serious weed of cotton and maize crops reducing crop yields by 32% [55]. It has become a noxious weed due to competition with many important crops like millet, maize, wheat, sorghum, mash, mungbean, guar and sunflower [56].

Evaluation of the allelopathic potential of *Trianthema portulacastrum* L. on germination and growth of sesame (*Sesamum indicum* L.) showed that the low concentrations had no significant effect whereas treatments with higher concentrations had negative effects [57]. Studies showed that the stem and whole plant extract of *Trianthema portulacastrum* reduced the dry matter production of soyabean [58]. Studies on allelopathic potential of *Trianthema portulacastrum* L. and *Sesuvium portulacastrum* L. showed that plant extract of *Trianthema portulacastrum* proved harmful to all tested crops than *S. portulacastrum* [59]. Pre sowing soaking of rice in *T. portulacastrum* leaf extract suppressed germination and growth of rice [60]. Studies on the influence

of *Trianthema portulacastrum* and *Zea mays* plant spacing on maize grain yield and quality revealed that *T. portulacastrum* reduced starch and protein contents as compared to control at different weed densities [61]. According to a reported study Horse purslane infests soybean and affects growth, net assimilation rate, dry weight, height and leaf area index [62]. Analysis of interactive allelopathic effects of *Zea mays* and *T. portulacastrum* showed that both plants possess allelopathic potential [63]. Studies carried out to quantify the impact of *Trianthema* on maize, revealed that it is a strong competitor of maize and may cause significant losses in maize crop yield [64]. The effect of allelopathy on many aspects of plant ecology had a red check history among ecologists [65]. Allelopathy plays an important role in invasion of exotic plant species [66]. Studies were carried out for searching positive association between *Trianthema portulacastrum* and *Amaranthus viridis* in terms of allelopathic potential. Findings showed the density of *Amaranthus viridis* increased in the area infested by *Trianthema portulacastrum*. Apart from that seeds treated with *Trianthema* extracts showed high germination percentage as compared to untreated seeds thus supporting the ecological importance of allelopathy [51].

Pests and Diseases

Fusarium chlamydosporum Wollenw. & Reinking was recognised as causal agent of horse purslane leaf spot disease and pathogenicity was confirmed through In vitro inoculation of pathogen [67]. In another study In vitro pathogenicity studies on Horse purslane were conducted using spore inoculum of *Gibbago trianthemae* which was reisolated from inoculated plants and confirmed its host specificity on Horse purslane [68].

Management

Horse purslane (*Trianthema portulacastrum* L.) is a noxious weed of different economically important crops which is mostly managed through mechanical method but this method is time consuming and very expensive [69]. Herbicides are most commonly used to control *T. portulacastrum* but herbicides have harmful effects on human health, agriculture and environment [70]. Thus allelopathy is a new approach for controlling weeds which is cost effective and eco-friendly [71]. Certain chemicals known as allelochemicals are released from different plants that suppress growth of plants. These allelochemicals can be used as an alternative to herbicides as they are eco-friendly and safe to use.

Experiments were conducted to investigate the effect of allelochemicals of various plants like Sorghum, Horse purslane, Sun flower, Parthenium, Eucalyptus and Datura on germination and growth of horse purslane. According to results aqueous extracts of all tested plants have ability to suppress germination, root and shoot length of horse purslane [72]. *Gibbago trianthemae* Simmons, a hyphomycetous fungus reported on horse purslane can be used as a natural biocontrol agent to control horse purslane [73]. Wheat residues and wheat-infested rhizosphere soil have negative effects on germination and growth of horse purslane [74]. Higher concentration of extract of Sorghum bicolor reduced the germination, root and shoot length of Horse purslane by 15 to 20% while lower concentration increased shoot length of plant [2].

Tests were carried out to check the possible effects of combined allelopathic potential of sorghum, sunflower, brassica and mulberry tank mixed with atrazine on horse purslane. The results revealed that Atrazine alone suppressed weed density up to 65-81%, however allelopathic extracts of plants along

with different doses ($\frac{1}{2}$ and $\frac{1}{3}$ rd dose) of atrazine showed 70-75% suppression of weeds density [75]. Another study carried on combination of extracts of *Helianthus annuus*, *Oryza sativa*, *Brassica napus*, *Sorghum bicolor*, *Zea mays* and *Morus alba* in suppressing germination and growth of *Trianthema portulacastrum* L. showed that higher concentration (100%) of extracts of sunflower and Sorghum suppressed germination of *T. portulacastrum* [76].

Herbicides are also used to control horse purslane. Studies were conducted for evaluation of soil applied herbicides alone or in combination with post emergence herbicides. According to results

Pendimethalin, flumioxazin, imazethapyr, Smetolachlor, or dimethenamid controlled horse purslane up to 73% while Pendimethalin in combination with diclosulam or followed by imazethapyr applied premergence controlled horse purslane up to 93%. Along with that Pendimethalin followed by post emergence applications of acifluorfen or lactofen controlled horse purslane up to 92% while pendimethalin followed by post emergence applications of imazapic, diclosulam, imazethapyr, or 2, 4-DB controlled 80 to 88 % [77]. Acifluorfen and lactofen used alone, or in combination with 2, 4-DB controlled *T. portulacastrum* up to 70 per cent [78].

Figure 1. *Trianthema portulacastrum* L. Plant body (a) Flower and Leaf (b)
Table 1. Hierarchical classification of *Trianthema portulacastrum* Linn.

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Caryophyllidae
Order	Caryophyllales
Family	Aizoaceae
Genus	<i>Trianthema</i>
Species	<i>Trianthema portulacastrum</i> L.

Conclusion

From the above discussion it has been revealed that *Trianthema portulacastrum* is an important plant species with regard to its medicinal and nutritional properties. Although it is a major problematic weed but it can be effectively controlled and can be utilized in a positive way for the development of new drugs at low cost as it is easily available and tolerant to adverse conditions. Laboratory experiments have shown significant results, thus further studies are required to investigate all beneficial aspects of plant in order to develop new and efficient medicines which can be effectively used to cure various diseases.

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