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Phytochemical and pharmacological potentials of *Pedalium murex* Linn and its traditional medicinal uses

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ABSTRACT

The aim of this study is to assess the pharmacological and phytochemical aspects of the *Pedalium murex* (Linn) (*P. murex*) and its traditional medicinal uses of different parts of the plant. Flavonoids, phenolic compounds, glycosides, carbohydrates, reducing sugars, phytosterols, tannins, triterpenoids, alkaloids, xanthoproteins, aromatic oil, stable oil, saponins and resins are the main phytochemical groups that have been found in different chemical extracts of *P. murex*. Pharmacological activities of *P. murex* have proven its importance for medicinal uses. This review will be helpful to create interest to use *P. murex* for developing new formulation in therapeutic medicines.

1. Introduction

Pedalium is a genus of plant in the Pedaliaceae family including one species, *Pedalium murex* Linn (family: Pedaliaceae) (*P. murex*). It is distributed in India, Pakistan, Sri Lanka and tropical Africa.

P. murex is an annual herb, and grows abundantly in the coastal area of Tharparkar and Cholistan in Pakistan, Sri Lanka, Mexico, South India and tropical Africa. *P. murex* has great medicinal importance. The leaves extract of *P. murex* contains the dinatin glycoside and diosmetin glucuronides[1,2]. Gonorrhea and dysuria diseases are curable through infusion obtained from its leaves and stems. Many flavonoids have been extracted from the flowers and leaves. Recently, two more new compounds are extracted and isolated from the fruit of *P. murex* (heptatriacontan-4-one, tetratriacontanyl octacosanoate)[3]. A broth of its fruit is used as antispasmodic, diuretic, demulcent and aphrodisiac while the broth of its root is used for antibiliary purpose. Clinical uses of *P. murex* are proved to have depository for different medicinal active compounds in its different plant parts which ensures its pharmacological potential. Therefore, it provides possibility to further investigate the aspects of its medicinal uses. Some researchers believe that *P. murex* can be explored as biopesticidal plant and potent fertility enhancing drug[4]. Urinogenital disorders were treated with trioctanyl dotrioctanoate and 2',4',5'-trihydroxy

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5,7-dimethoxy flavones, sourced from its fruits[5].

Historically, it has been used for the cure of ulcers, fevers, puerperal diseases, wounds, general debility, digestive tonics and disorders. The plant is also studied for the presence of phytochemicals. Study of phytochemicals encourages us about the new knowledge of a more attractive synthesis of pharmaceuticals. Ethanobotanical uses of *P. murex* for different purposes are shown in Table 1.

Indians have been using this plant for the cure of various ailments since the immemorial time. An enormous data about the uses of plant are likely to be amassed in regions wherever the utilization of *P. murex* against different illnesses still has a lot of significance. Phytochemicals are very important remedial chemicals in plants which have a potential to influence the particular physiological changes on the animal body and they are considered to have therapeutic attributes. The majority of vital bioactive compounds of these plants are flavonoids, alkaloids, phenolic compounds and tannins.

Table 1
Ethanobotanical information of *P. murex* (Watt, 1962; Anonymous, 1966; Singh and Panda, 2005).

Active part	Traditional uses	Preparation
Root	Antibilious	Dissection
Fresh leaves and shoots	Aphrodisiac	Mucilaginous infusion
Leaves	Aphthae	Juice
Stem	Ardor urinae	Extract
Dried fruits	Calculi	With sugar
Leaves	Demulcent	Infusion
Leaves	Diuretic	Infusion
Stem	Dysuria	Extract
Leaves	Emmenagogue	Juice
Fruit, stem, leaves	Gonorrhoea	Milk of exudates
Leaves	Gonorrhoeal rheumatism	Powder
Dried fruits	Incontinence of urine	Decoction
Root	Pousthik	Powder
Stem	Spermatorrhoea	Extract
Dried fruits	Strangury	Decoction
Leaves	Ulcer	Extract

In the developing countries, the inhabitant plants are still significantly used for ordinary disease treatment. A widespread investigation and dealings with local herbal drug vendors, ethano-pharmacologists and rural healers exposed that the parts of local plant *P. murex* were regularly and extensively employed for the healing of different disorders of livestock and humans.

P. murex has different names in different languages, such as farid booti in Urdu, yenugupalleru in Telugu, brihatgokshur in Sanskrit, bada gokhuru in Hindi, and large caltrops in English.

This plant belongs to kingdom as follows: plantae, phylum/division of Magnoliophyta, class of Magnoliopsida (Dicotyledonae). Furthermore, it is subclassed in Lamiidae with order of Caryophyllales and family of Pedaliaceae. Moreover, it belongs to the genus of *Pedalium*, with the name of *P. murex* for the species.

Flowering period of this plant is from May to December and fruiting period from June to January.

2. Botanical explanation

It has creeper lengthening about two to three feet and branches spreading all over, while the leaves are in twosomes of five to eight with irregular shape shown in Figure 1[1]. Small yellow colored flowers are shown in Figures 2 and 3, while brown aromatic nature roots are four to five inches elongated as shown in Figure 4. Figure 5 depicts fruits as round with five to twelve chambers and every chamber carrys a seed. The seeds hold aromatic oil. Early winter is the season for the plant to flower then turn into fruits. *P. murex* is juicy and aromatic plants originated close to sea coast of South India, and Tharparkar and Cholistan deserts of Pakistan. It appears during the month of May to January. It grows widely as a weed in crop lands and nutrient-rich soils at a temperature range of 25-45 ˚C.

Figure 1. Whole plant of *P. murex*.

Figure 2. Flowers of *P. murex*.

Figure 3. A close view of plant *P. murex* and its flower.

Figure 4. Roots of *P. murex*.

Figure 5. Fresh green and dried fruits of *P. murex*.

3. Phytochemistry

Fruit is rich with alkaloids (3.5%-5.0%), glycosides, stable oil, resins, aromatic oil, triterpenoids, carbohydrates and saponins.

Stem contains phytosterols, saponins, tannins, herman and carbohydrates.

Root is full of reducing sugars, xanthoproteins, saponins, alkaloids, triterpenoids, flavonoids and phenolic compounds.

Leaves have splendid alkaloids, resins, flavonoids, saponins, proteins and steroids.

Initial investigation for chemical composition of *P. murex* shows subsistent occurrence of diverse chemical components. Each part of *P. murex* is reported to carry phytochemicals with therapeutic potential. Generally, fruits consist of alkaloids (3.5%-5.0%), resins, carbohydrates, saponins, stable oil, aromatic oil, triterpenoids, and glycosides, and also two more significant flavonoids *i.e.*, trioctanyl dotrioctanoate and 2′, 4′, 5′-trihydroxy-5, 7-dimethoxy flavones[1,2]. *P. murex* includes some essential flavonoids like dinatin and 7-glucoronide, diosmetin and its 7-glucoronide, pedalin and pedalitin (3’,4’,5,6-tetrahydroxy-7-methoxyflavone) in its leaves. Moreover, steroids, alkaloids, saponins, proteins and resins are extracted as well. The root is enclosed with unique phenolic compounds like phenol 2-(5,6-dimethyl pyrazinyl) methyl[1,6]. Saponins, phytosterols, tannins and carbohydrates are obtained from stem.

Flower is the source of quercitrin, quercetin, dinatin, and an unidentified diglycoside of quercetin. Some phytochemicals with their structures and groups found in *P. murex* are shown in Table 2.

Table 3 shows the estimation of primary metabolites [milligram per gram fresh weight of tissues (mg/gfw)] in *P. murex*[1,6]. Yield of flavonoids isolated from various plant parts of *P. murex* has been estimated by Sharma *et al*. and is given in Table 4[7]. Ecological position and relative density of *Pedalium* along with other 12 medicinal plants in community have been reported by Das, shown in Table 5[8].

Table 2

Structures and phytochemical groups found in *P. murex*.

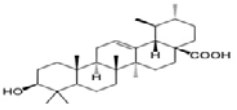
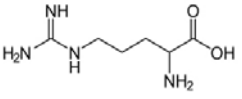
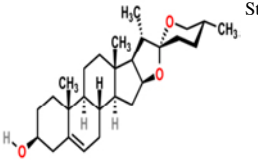
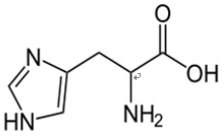
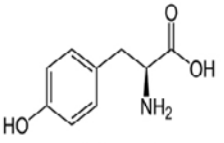
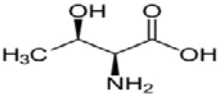
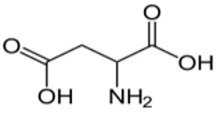
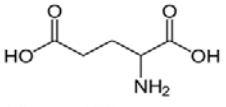
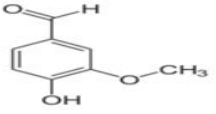
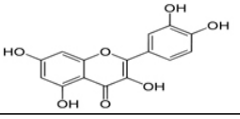
Compound	Structure	Phytochemical group	Part of plant
Ursolic acid		-	Leaves
Arginin		Amino acid	Fruit
Diosgenin		Steriod	Whole plant
Histidine		Amino acid	Fruit
Tyrosin		Amino acid	Fruit
Threonin		Amino acid	Fruit
Aspartic acid		Amino acid	Fruit
Glutamic acid		Amino acid	Fruit
Vanillin		Phenol	Fruit
Quercetin		Aglycones	Flowers

Table 2, continued

Structures and phytochemical groups found in *P. murex*.

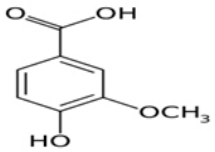
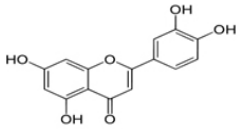
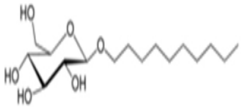
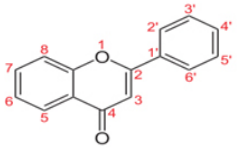
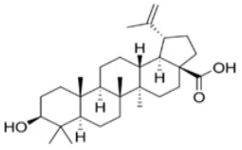
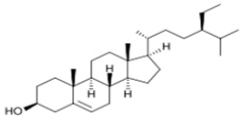
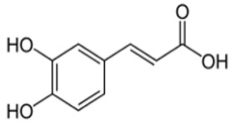
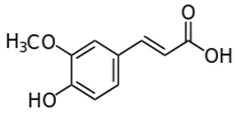
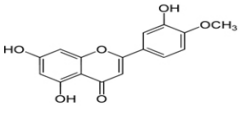
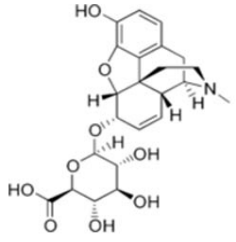
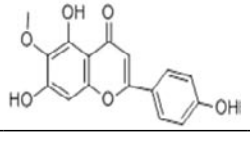
Compound	Structure	Phytochemical group	Part of plant
Vanillic acid		Phenolic acid	Leaves
Luteolin		Flavones	Fruit
Nonacosane	 [CH3(CH2)27CH3]	Hydrocarbon	Fruit
Glucoside		-	-
Flavones		-	-
Triterpenoids		-	-
Beta-sitosterol		-	-
Caffeic acid		Phenolic acid	-
Ferulic acid		Phenolic acid	-
Diosmetin		Flavonoids	Leaves
Glucuronide		-	-
Hispidulin		Flavonoids	Leaves

Table 2, continued

Structures and phytochemical groups found in *P. murex*.

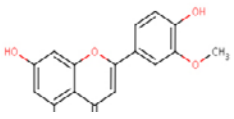
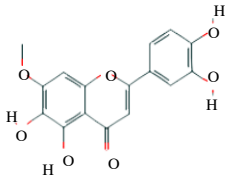
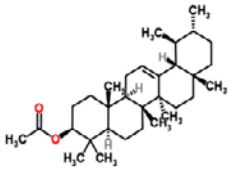
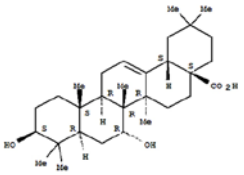
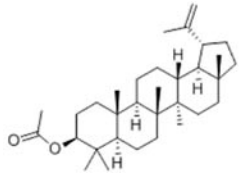
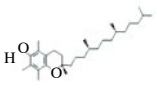
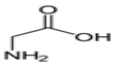
Compound	Structure	Phytochemical group	Part of plant
4',5,7-Trihydroxy-3'-methoxy flavone		Flavones	Fruit
Pedalitin		Flavones	Fruit
α-Amyrin acetate: (3β)-urs-12-en-3-yl acetate		-	-
Rubusic acid (3β,7α-dihydroxyolean-12-en-28-oic acid)		Flavone	Fruit
Lupeol acetate		Triterpenoid	-
α-Tocopherol		Alkaloid	Fruit
Tritriacontane		-	Fruit
Glycine		Amino acid	Fruit

Table 3

Estimation of primary metabolites in *P. murex*[5]. mg/gfw.

Plant parts	Primary metabolites in *P. murex*				
	Sugar	Starch	Lipid	Protein	Phenol
Leaf	35.60 + 1.28	32.13 + 0.91	21.80 + 0.97	34.20 + 0.49	52.06 + 1.21
Stem	43.80 + 1.33	39.60 + 0.08	32.30 + 0.26	41.30 + 0.44	29.00 + 0.34
Callus	29.00 + 1.26	22.10 + 1.37	19.50 + 0.51	21.20 + 0.45	43.30 + 0.37

Table 4

Yield of flavonoids isolated from various plant parts of *P. murex*[6]. mg/gfw.

Parts	Free flavonoids			Bound flavonoids			Total flavonoids		
	Q	K	T	Q	K	T	Q	K	T
Leaf	0.39	0.47	0.86	0.41	0.55	0.96	0.88	1.02	1.82
Stem	0.26	0.42	0.68	0.29	0.21	0.50	0.55	0.63	1.18

K: Kaempferol; Q: Quercetin; T: Total.

Table 5
Relative density of species[8].

Name of the species	Relative density (abundance)	Parts used
Achyranthes aspera L.	56.0	Whole plant
Ageratum conyzoides L.	12.0	Leaves
Alternanthera sessils DC.	4.8	Leaves
Amaranthus spinosus L.	6.9	Whole plant
Andrographis paniculata (Burm F.) Wall. Ex. Nees	5.0	
Anisomeles indica (L.) Ktze	1.2	Leaves
Aristolochia indica L.	1.0	Roots
Blumea lacera DC.	1.1	Leaves
Cassia mimusoides	7.0	Seeds
Catharanthus roseus (L.) G.Don.	1.0	Leaves
Hemidesmus indicus R. Br.	1.0	Roots
Hybanthus eneaspermus (L.) F. Muell	1.0	Whole plant
P. murex	0.8	All parts
Total of 13 species	98.8	

4. Pharmacological uses

4.1. Antifeedant and biopesticidal activity

Ethanolic extract (0.1%, 0.2%, 0.4% and 0.8%) of *P. murex* root was tested for antifeedant and insecticidal activities against *Spodoptera litura* larvae at different stages through leaf dip methodolgy. According to the indication of anti-feedant activity of *P. murex*, a reduction was found in food consumption index, approximate digestibility, growth rate, food conversion efficiency of ingestion and food conversion efficiency of digestion in *Spodoptera litura*. Being stronger biopesticidal plant in contrast to *Neem gold*, *P. murex* can be adopted as biopesticidal plant in coming days[1,9].

4.2. Anti-hyperlipidemic activity

High fat diet-fed rats with ethanol extract of *P. murex* fruit at doses of 200 and 400 mg/kg body weight were tested against the anti-hyperlipidemic potential of the plant. *P. murex* in comparison with the reference standards gemfibrozil and atorvastatin was tested against some biochemical components like cholesterol of blood serum, lipoproteins (high density, low density, very low density) and triglycerols and the result was observed in the treated animals. At different tested doses, the ethanolic extract has shown remarkable decline in very low density lipoproteins ($P < 0.01$), triglycerols ($P < 0.01$) as well as total cholesterol ($P < 0.001$), low density lipoproteins ($P < 0.001$) and very prominent boost in high density lipoproteins ($P < 0.05$)[1,10].

4.3. Antinephrolithiatic activity

At the coastal areas of Pakistan and India, *P. murex* is found abundantly with a very good remedial use for ailment against urinary diseases.

For the evaluation of antinephrolithiasis activity of *P. murex*, different extracts like aqueous, ethanolic, petroleum ether and chloroform extracts were prepared and tested on albino rats, which shows that *P. murex* has great antinephrolithiasis activity[1,11].

4.4. Nephroprotective activity

Nephroprotective efficacy in rats with induced renal damage by cisplatin dosage was tested against ethanol extract of *P. murex* fruit.

Cisplatin 5 mg/kg body mass was fed to Wistar rats to induce nephrotoxicity. Losses in body weight, blood urea and serum creatinine were observed as kidney damage indicators by dosing 250 mg/kg orally concurrent ethanolic extract of *P. murex*. Ethanolic extract was found very effective to prevent the kidney damage. Therefore, it can be concluded that cystone ethanolic extract of *P. murex* is significantly nephroprotective[1,12].

Peptic ulcer and acid peptic diseases are inducers of gastrointestinal bleeding that are caused due to bad eating habits and modern life styles[1,13]. In contrast to drugs, herbal medicines are more suitable to have high effectiveness and very nominal side effect. Due to the presence of biochemically active phytochemicals and their ethanomedicinal uses, the importance of *P. murex* has been boosted[1,14].

4.5. Antiulcer activity

The changes in lifestyles and eating habits have induced the peptic ulcers in human beings. The antiulcer activity of aqueous extract of *P. murex* leaves on gastric damages induced by feeding ethanol was tested.

For this purpose, a number of chemical contents like ulcer index, glutathione, acid volume, total acid and total protein were investigated. The rats fasting for 36 h were orally fed with 80% ethanol (1 mL/kg) to induce the ulcer, and one hour ahead aqueous extract of *P. murex* leaves with feed level of 50, 100 and 200 mg/kg of body mass and reference drug famotidine at dose of 3 mg/kg of body mass were fed to them. Hence, presence of flavonoids and mucilage in the leaves extract of *P. murex* made the plant a valuable antiulcer drug[1,15].

4.6. Anti-inflammatory efficacy

Various medicinal significances of different parts, *i.e.* root, leaves and seeds, of *P. murex* and *Abutilon indicum* were studied. It was found that *P. murex* had relatively more anti-inflammatory activity than *Abutilon indicum*. Albino Wistar rats were studied for carrageenan-induced paw edema principle. Concentration level of paw was observed in each Wistar rat before the injection of carrageenan with intervals of 1 h, 2 h, 3 h, 4 h, 5 h and 24 h, and it was found that concentration level of paw was significantly

increased after injection of carrageenan in subsequent intervals. The edema component of inflammation was determined[1,16].

4.7. Anti-oxidant efficacy

Rat liver intoxicated with carbon tetrachloride (CCl_4) was investigated against methanolic extract of *P. murex*. The rats with hepatotoxic effect were given methanolic extract orally at a dosage level of 70 mg/kg of body mass, for 90 days on daily basis. Its healing effect of CCl_4-methanolic extract dosed rats has shown the efficacy of methanolic extract to overcome the oxidative stress due to hepatic injure and decreased efficacy of glutathione catalase, glutathione reductase, peroxidase antioxidant enzymes and superoxide dismutase in CCl_4-intoxicated rats[1,17].

The results of the studies have revealed that different alcoholic extract fractions of these plants have very high contents of phenolic components that are very effective anti-oxidants for human health[1,18]. Micronutrients and phenolic components comprising in different extracts of *P. murex* are main consequences of anti-oxidant activity of the plant. From the studies, it can be concluded that *P. murex* has efficacy of free radical scavenger[1,19].

4.8. Antibacterial efficacy

About 12 different pathogenic microbs were tested for their antibacterial efficacy against methanolic extracts of leaf and fruit. Result of positive control (streptomycin) was found without any inhibition with negative control[1,20].

Phytochemicals like alkaloids, glycosides, flavonoids, phenols, steroids, and tannins were found in methanolic extract of *P. murex*. Bacteria species like *Streptococcus progeny* and *Enterococcus faccalis* (Gram positive) have shown more antibacterial efficacy in methanolic extract of *P. murex* as compared to the Gram-negative bacteria[1,21].

4.9. Hepatoprotective activity

In the pathogenesis of liver damage, the function of reactive oxygen species generation and oxidative stress is ascertained. The reasons behind are addiction of alcohol and different drugs. As per acute oral toxicity 425 guidelines, the extreme toxicity of aqueous and ethanloic/methanolic extracts of *P. murex* fruit was tested by oral dosage to the Swiss albino mice. For alcohol- and isoniazide-induced liver damage, alcohol and aqueous extracts of *P. murex* at dose level of 400 mg/kg of body mass have been investigated for hepatoprotective efficacy. By dosing aqueous-alcoholic extract of *P. murex* fruits, the high-level of (intoxicated by isoniazide) the biochemical parameters like triglyceride, total bilirubin, cholesterol, serum glutamic-oxaloacetic transaminase and serum glutamic pyruvic transaminase in rats were decreased extensively upto regular range. The main phytochemicals of tannin and flavonoid groups from aqueous-alcoholic extract of *P. murex* are liable for hepatoprotective activity by scavenging free radicals[1,22-25].

4.10. Anti-diabetic effect

Ethanolic extract of *P. murex* root was investigated for anti-diabetic efficacy on alloxan-induced diabetes rats. By dosing ethanolic extract of *P. murex* for three weeks with dosage of 100 and 200 mg/kg of body mass, considerable decline of blood sugar level and boost of blood insulin were observed. The free radical formation in tissues of liver and kidney organ was decreased by ethanolic extract of *P. murex*. In addition to its anti-diabetic efficacy, the antioxidant properties of *P. murex* ethanolic extract have revealed decline of thiobarbituric acid components as well as hydroperoxides and boost in level of superoxide dismutase, catalase, gluthione peroxide, and reduction of glutathione-s-transferase and glutathione. The ethanolic extract of *P. murex* (200 mg/kg of body mass) has shown larger efficacy in comparison to glibenclamide, a standard reference drug[1,26].

5. Toxicity limit

The acute toxicity study of *P. murex* plant with dosage range of 2–260 mg/kg of body mass in mice was reported to be safe. The study was performed on the male Swiss albino mice (20–25 g) which were orally administered with ethanolic extract of *P. murex* and according to Committee for the Purpose of Control and Supervision of Experiments on Animals guidelines experiential for any symptoms of toxicity upto 48 h. Karber's method was used to investigate the LD_{50} that resulted within level of 2–260 mg/kg, *p.o*. Keeping in view these findings based on the results, 250 mg/kg dosage was set for future pharmacological studies. Even after 48 h span, and oral dosage (2–260 mg/kg body weight) of ethanolic extract of *P. murex* to the Swiss albino mice, no any side effect or toxicity was observed[27]. *P. murex* mucilage was found safe with $LD_{50} > 2\,000$ mg/kg without any toxic syndrome symptoms[28].

6. Conclusion

Through literature survey, it is revealed that *P. murex* is a very important medicinal plant with very diverse phytochemical constituents. Being non-toxic, very economical and easily available, herbal medicines have attained great preferences over synthetic drugs. *P. murex* contains a number of valuable phytochemicals with various pharmacological activities and gains a lot of importance in ethnomedicinal ailments. Hence, the plant shows a likely exploration into its new curative uses. Scientists have investigated a number of biological active components from

leaf, branch, root and fruit extracts of the *P. murex*. Extensive researches are required to use *P. murex* for the formulation of natural therapeutic drugs. However, parameters like toxicity, bioactivity and chemical biomarker must be investigated to support the traditional use of *P. murex* in therapeutic medicine.

Conflict of interest statement

We declare that we have no conflict of interest.

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