

PHARMACOLOGICAL, PHYTOCHEMICAL, BIOLOGICAL EVALUATION AND FUTURE PROSPECTS OF POLYGONUM HYDROPIPER

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ABSTRACT

Plants are source of medicines from ancient times and they are also used now a days very much because of side effects from allopathic medicines. Plants from the genus polygonaceae have been used in traditional medicines and one of the important plant from this family is *Polygonum hydropiper* which has tremendous medicinal uses. It is found in muddy and damp areas, ditches, flooded river banks and forests. It is native to entire northern hemisphere (Europe, Asia and North America). The plant can also occur as a weed in poorly drained farmlands. A wide range of chemical compounds including Flavanoids, phenolic compounds and glycosides are found in this plant. This Plant has been known to possess Anti-inflammatory activity, Antineoplastic activity, Antiulcer activity, In Respiratory disorders, Anti-alzheimer activity and other miscellaneous activities.

KEYWORD: Polygonum hydropiper, Pharmacological activities, Phytochemical constituents, Medicinal uses.

INTRODUCTION

Medicinal plants play a very important role in promoting the livelihood of human beings. Many new drugs discoveries have actually exhibited vital impacts on health of human beings and many new drugs from plants are yet to be discovered. One of them from these important plants is smartweed, as its name suggests this plant is actually smart because it has various important medicinal uses.^[7] *Polygonum hydropiper* is also called as smartweed, marshpepper, knotweed. It is a plant of *polygonaceae* family. All plant parts have been commonly used in traditional system of medicine. **Flavanoids** are the main group of compounds found in this plant and the plant have numerous pharmacological activities.^[6] The plant grows in shallow water and in damp places and it is mainly found in New Zealand, Australia, Temperate Asia, North America. The plant is harvested from wild sources during flowering period and dried in shade at temperature not exceeding 40°C. When dried its active substances decreases therefore should preferably be used fresh if it is intended to be used as a spice or for medicinal purpose.

The plant is a annual herb growing to 0.8m (2ft 7 inches) and flower in the month of July to September. The plant comprises of 6 to 8 stamens with 2 function less ones and 2 to 3 styles to pistil^[7] The plant cannot grow in shade and it requires light (sandy), medium(loamy) and heavy (clay) soils. Wet soil is preferred for its growth and it can also grow in water. This plant is self fertile and the flowers are hermaphrodite (having both male and female organs).^[16] This plant has various medicinal properties as it contains glycosides, flavanoids etc. It is also used in cooking. The leaves and stems can be used as raw or cooked leaves are said to contain rutin (which helps to strengthen fragile capillaries) and this helps prevents bleeding and it also make it useful in treating bleeding, skin problems, diarrhoea. Traditionally juice of the leaves is used in pain, headache, toothache.^[22] It is also used as Anti-inflammatory, carminative, diaphoretic, diuretic, stimulant and stomachic.

CLASSIFICATION

Synonyms: Waterpepper (Netherland), biting persicaria, bity tongue, arcmart, pepperplant, smartgrass, ciderage, redknees, culrage, bloodwort, arsesmart, sickleweed, boginger, vaspepper (Norway), wasserpfeffer, Knoeterich, pfeffernoeterich, Wasserpffefer Knoeterich (German), renoueepoivrede'eau(French), pimientodelagua(Spanish), brennibadka (Icelandic), bidendpileurt(Danish), Katkeratatar(Finland), bitterpilort (Swedish)^[8] Bishkatali, Pakruma, Panimarich (Bangladesh), bidendpileurt (Denmark), queddab, qordaab, qordeyb(egypt)

Borsuskeserufu (Hungary), bishkatal, packurmul (India) erba pepe, idropepe, pepeb, acqua, poligono pepe-acquatica (Italy), Yanagitabe, yanagitade(Japan), chillo(mexico), caatai (Paraguay), rdest ostrogorzki (Poland), fluful el ma, zangabil et kilab(Saudi arabia), Bitterblad, bitterpillort(Sweden), dvornik papreni, dvornik tankoklasni (Yugoslavia)^[15]

TAXONOMY

Domain: Eukaryota.

Kingdom: Plantae.

Phylum: spermatophyte.

Subphylum: Angiospermae.

Class: Dicotyledonae.

Order: polygonales.

Family: polygonaceae.

Genus: polygonum.

Species: polygonum hydropiper.^[15]

A stoutish annual, stem decumbent at base and ascending, 30-50 cm long. Leaves linear-lanceolate, 3.8-8 cm long, sessile; stipules glabrous, with few and usually deciduous bristles mostly under 2.5 mm long. Flowers white, small, in rather lax, very slender or filiform racemes which are erect, flexuous or decurved.^[22]

HABITAT

The plant is mainly found in abundant amount in places that are underwater during the winters like Great Britain and Ireland, Europe, in Russian Asia to Arctic regions. The plant grows in muddy and damp areas, ditches, flooded river banks at forests. The plant can also occur as a weed in poorly drained farmlands.^[8] Anthropogenic (man-made or disturbed habitats), meadows and fields, shores of rivers or lakes, swamps, wetland margins (edges of wetlands).^[17]

It is native to entire northern hemisphere (Europe, Asia and North America). It has a tendency to sprawl and lean on adjacent plants for support. The hairless stems are green or red (often the latter).^[29]

MACROSCOPICAL CHARACTERS

This plant is odourless and having bitter peppery taste and flavour is also peppery (due to the presence of polygodiol). The leaves are dark green in colour. Flowers are white to light pink in colour. Fruit is flattened and triangular dull dark brown nut. The species contain many plants and it is difficult to distinguished all of them. The plant *Polygonum hydropiper* can be identified by some of the facts which are:

1. Its racemes are pendulous or nodding.
2. Flowers are greenish white
3. Recemes are slender shaped with flowers distributed over it.
4. Sepals of flower have glandular pits which are brown or yellow.^[29]



Fig. 1: *Polygonum hydropiper*^[29]

USES IN FOLK MEDICINES

Earlier this plant was known for its peppery taste and from ancient time it is used as a spice and in medicines for the treatment of various disorders like epilepsy, rheumatism, toothache and gout. Its juice is used to get rid of worms from ear canal. It has a history of use in Peru to combat bacterial infections.^[30] In Bangladesh, Garo tribes uses the juice of leaf for the treatment of Menstrual pain and Paste of the leaf is used to stop the bleeding. The juice of the leaves is used for many health problems like gastric ulcer, liver enlargement, loss of appetite, toothache, dysmenorrhoea and their roots are also useful as diuretic, anthelmintic, carminative, tonic and stimulant. Seeds and leaves are used in a folk medicine for the treatment of cancer.^[6] It is also used as a medicine in stomatitis, to treat wounds and cuts. Fresh plant is used to treat scurvy because of the presence of high content of vitamin C.

Sometimes it is used as a herb (in tea) as a digestive tonic and for the treatment of digestive disorders like dyspepsia, diarrhoea, dysentery, colic and intestinal worms.

PHARMACOLOGICAL ACTIVITIES OF SMARTWEED

Anti inflammatory activity

Traditionally smart weed is used to treat various inflammatory diseases such as rheumatoid arthritis. This herb can be squeezed and applied on inflamed body part to reduce soreness and inflammation. Smartweed has inhibitory effects on production of inflammatory mediators.^[20] This plant shows anti-inflammatory property because of the presence of polygodolide. This is isocoumarin which has been isolated from methanolic extract of roots of the smartweed.^[9]

Antiulcer activity

Polygonum hydropiper extract, saponins and leaf oil exhibited significant in-vivo antiulcer, urease inhibitory as well as anti proteus activities. Several compounds are present which can be responsible for gastroprotective potentials.^[13] It is found that it shows antiulcer activity due to high content of quercetin which is a flavanoid that has antioxidant property.

Antibacterial, Antifungal and Cytotoxic activities

Ethanollic stem extract of *Polygonum hydropiper* has significant activity against four gram-negative (*E.coli*, *Pseudomonas aeruginosa*, *salmonella typhi* and *shigella sonnei*) and three gram-positive (*Bacillus subtilis*, *Bacillus megaterium* and *staphylococcus aureus*). The antibacterial action of smartweed is due to the presence of polygodol present in the essential oil of smartweed extracted from the leaves of the plant. Another compound confertifolin which is also isolated from the essential oil of the leaves has been found to have antifungal action against *Epidermophyton floccosum* and many other fungi because of the presence of polygodol and it acts by several mechanisms like by increasing the production of reactive oxygen species and by decreasing cytoplasmic and mitochondrial glutathione. Many fractions and methanolic extracts of *Polygonum hydropiper* showed the anti-proliferative activity against various kind of carcinoma.

Antioxidant activity

Flavanoids act as antioxidant. Oxidation causes ageing and antioxidants defence against it and protect the human body from free radicals.^[7] Smartweed contains flavanoids so it acts as a powerful antioxidant and helps in healthy functioning of human body. Some of the flavanoids isolated from different parts and from different type of extracts of smartweed are quercetin, 3-sulphate, isorhamnetin-3,7-disulphate and tamarixetin-3-glucoside-7 sulphate which are present in leaves of smartweed. Other flavanoids present in leaves of *Polygonum hydropiper*

are quercitrin, kaemferol, 6-hydroxyepigenin, galloylkaemferol-3-glucoside, scutillarein, 6-hydroxyluteolin, galloyl quercitrin. Among all these galloyl quercitrin was the most powerful antioxidant found in a study. Total antioxidant capacity of different type of polygonum extracts were calculated using the standard curve of ascorbic acid. It was found that ethanolic extract of smartweed shows the highest antioxidant efficacy.^[14]

Respiratory disorders

Traditionally smartweed has been used for respiratory support.^[30] Smartweed is used for the treatment of various respiratory problems like infections of the upper respiratory tract, in sore throat, cough and asthma. It is given in the form of herbal concoctions. It is also used for preparing herbal medicines that are used to clear the respiratory tracts.^[7]

Immune effects and anticholinesterase activity

The crude extracts of smartweed inhibits the AchE activity. They also increase phagocytic activity and phagosomes-lysosome fusion in human neutrophils and monocytes in dose-dependent manner. The extracts did not changes the release of superoxide anion release from neutrophils so it can be used as a functional food for the prevention of dementia (neurocognitive disease).^[2]

Antipyretic activity

Methanolic, Ethanolic and chloroform extracts of polygonum hydropiper shows antipyretic effect in a study and the effect is measured by determination of percentage reduction. The fever is induced by administering brewer's yeast s.c in mice and the temperature is measured before and after giving extract. The result shows satisfactorily decrease in temperature when compared with standard drug paracetamol.^[19]

Gastrointestinal Motility

The plant also has capability of to increase GIT motility. During a study when compared with standard drug loperamide the chloroform extract shows very close result as loperamide.^[19]

Antihyperglycemic Activity

The extract of smartweed were tested for ant hyperglycemic activity. Blood glucose levels were measured by standard glucose oxidase method. The percentage lowering of blood glucose levels were calculated. The results were compared with standard drug glibenclamide.^[22]

Reduces swelling and Redness

Degenerative bone and joint problem is very common these days which causes extreme discomfort. Smartweed is effective in relieving these problems. Some studies reported that polygonum is able to inhibit the enzymes that produces swelling and redness.^[30]

Anti-alzheimer Activity

The plant of this family have been known for its neurological disorders like Alzheimer disease. In a recent study β -sitosterol was isolated from polygonum hydropiper and tested for its Antioxidant and for in-vivo inhibitory potentials against choline-estersae. It shows effective In-vivo and In-vitro cholineesterse inhibitory effects and also shows decline in free radicals load in brain tissues in β -sitosterol treated animals as compared to transgenic saline treated groups and in other experiments it shows gradual improvement in working memory, spontaneous alteration behavior and motor coordination. These findings shows that β -sitosterol is effective in management of Alzheimer's disease^[1]

Action against some insect pest of tea and rice

It can be inferred that the leaves of plant polygonum hydropiper possess insecticidal property against BPH within 24 hours of treatment with benzene extract. From this study we can say that it is good candidate for control of insects in rice and can be used by the farmer.^[31] similarly tea is also infested by various insect species in north-eastern region of india.^[32] The annual consumption of insecticides is also very high. By using large quantity of insecticides the residue get left which is not good for health and creates other problems.^[18]

Herbal Fish toxicants

It is found to be very effective in case of weed fish control for pre-stocking pond management in aquaculture pond. However, in case of fish catching, it may be little difficult as running water dilutes the concentration of the poison.^[27]

Action on gastric mucosal lesions

The extracts from Polygonum hydropiper L exhibited significant protective effects against ethanol-induced acute gastric mucosal lesions.^[20]

Activity against aphid pests

Some studies showed the activity of Polygonum. hydropiper in management of mustard aphid. Polygonum. Hydropiper extract @10% followed by panchgavya @10% topical sprays were found significantly effective for the treatment of mustard aphid.^[23]

Activity against mosquitoes

The biological activity of essential oil extracted from the leaves of *Polygonum hydropiper* and a compound, confertifolin, isolated from this plant was bioassayed against larva of mosquitoes, *Anopheles stephensi* and *Culex quinquefasciatus* and results shows it is effective against them.^[24]

Antineoplastic Activity

Study was carried out to evaluate the in-vivo antitumor activity of the methanolic extract of *Polygonum hydropiper* leaves (MPHL) against Ehrlich ascites carcinoma (EAC) in mice. Preliminary phytochemical study indicated the presence of steroids, tannins, phenolic and flavonoid compounds and glycosides in crude extract of *Polygonum hydropiper*.

A number of scientific reports indicate certain steroids and phenolic compounds such as tannins, coumarins and flavonoids have a chemopreventive role in cancer through their effects on signal transduction in cell proliferation and angiogenesis. The anticancer activities of MPHL are probably due to the presence of phenolic compounds as well as flavonoids and their synergistic effects. Plant derived extracts containing antioxidant principles showed cytotoxicity towards tumor cells and antitumor activity in experimental animals MPHL significantly reduced tumor growth and viability of tumor cells and normalized the hematological and serum biochemical profiles, raising lifespan as compared with those of EAC control mice.^[26]

Treatment of cholera and jaundice

The plant is used in the treatment of cholera and jaundice. In case of jaundice the fresh plant is squeezed and the juice is given to the patient and in cholera hot decoction of plant is used for the treatment.^[7]

PHYTOCHEMICAL CONSTITUENTS

Polygonum hydropiper contain mainly flavonoids, sesquiterpenes, sesquiterpenoids, and phenylpropanoids. Various fractions and extracts of *Polygonum hydropiper* herbs or whole plant consists of flavonoids, such as: isoquercitrin, quercetin, (-)-epicatechin, hyperin, (+)-catechin, isorhamnetin, kaempferol, quercitrin, rhamnazin and rutin; drimane-typed sesquiterpenes, like 3- β -angeloyloxy-7-epifutronolide, 7-ketoisodrimenin, changweikangic acid A, dendocarbin L, (+)-fuegin, futronolide, polygonumate and (+)-winterin,

phenylpropanoid esters, including hydropiperosides A and B, and vanicosides A, B and E, as well as phenolic acids, like ρ -coumaric acid, caffeic acid and chlorogenic acid.

Bioactive phenolics and sesquiterpenoids of *Polygonum hydropiper*

Methanolic (80–100%) extract of the leaves contains flavonoids, including galloyl kaempferol-3-O-glucoside, galloyl quercetin-3-O-glucoside, galloyl quercetin-3-O-rhamnoside, galloyl quercitrin, isoquercitrin, isoquercitrin-3-glucoside, isorhamnetin, isorhamnetin-3,7-disulphate, kaempferol rutinoside, kaempferol-3-O-glucoside, percicarin/persicarin, quercitrin, quercetin, quercetin-3-O-glucoside, quercetin-3-O- β -D-glucuronide, quercetin-3-O-rhamnoside, quercetin-3-sulphate, rhamnazin, rhamnazin-3-sulphate, rhamnetin, scutillarein, tamarixetin-3-O- β -glucoside-7-sulphate, 3'-methylquercetin, 6-hydroxyluteolin, 6-hydroxyluteolin-7-O- β -D-glucopyranoside, 6-hydroxyapigenin, and 7,4'-dimethylquercetin; phenylpropanoids, such as hydropiperosides and vanicosides A, B, and D; and 3,5-dihydroxy-4-methoxybenzoic acid. Additionally, the leaf diethyl ether extract was found to have sesquiterpenes and sesquiterpenoids, such as confertifolin, drimenol, (+)-fuegin, isodrimeninol, isopolygodial, isopolygonal, polygodial, polygodial acetal, polygonal, polygonic acid, polygonone, valdiviolide, warburganal, and 11-ethoxycinnamolide, whereas the essential oil had acetic acid, confertifolin, diethyleneglycol monoacetate, ethyl benzene, ethyl propionate, and n-propyl acetate.

The petroleum extract of top part had polygodial and the methanol extract of roots had anthraquinone, ellagic acid 3,3'-di-O-methyl ether, gallic acid hydropiperosides, and polygonolide. While the methanolic extract of stems and leaves contains hydropiperosides A and B and vanicosides A, B, and E. Several sesquiterpenes and sesquiterpenoids, such as confertifolin, drimenol, isodrimeninol, isopolygodial, polygodial, polygonal and warburganal, have been isolated from diethyl ether extract of the seeds. (+)-catechin, (+)-epicatechin, and (+)-epicatechin-3-O-gallate were produced by the callus and suspension-cultured cells of *P. hydropiper*. Flavonoids isolated from the leaves of *P. hydropiper* are galloyl kaempferol-3-glucoside, quercitrin, kaempferol-3-glucoside, 6-hydroxyapigenin, scutillarein, 6-hydroxyluteolin, 6-hydroxyluteolin 7-O- β -D-glucopyranoside, quercetin 3-O- β -D-glucuronide, galloyl quercitrin, and quercetin. Hydropiperosides B and vanicoside A isolated from the *P. hydropiper* methanol leaf extract demonstrated antioxidant activity in 1,1-diphenyl-2-picrylhydrazyl.^[6]

CURRENT MEDICINAL USES

In today's herbal medicine, water pepper is main topical astringent agent. The tannins, bitter substances, essential oil, glycosides, organic acids and vitamin C are considered to be the most important medicinal substances in the water pepper. These substances give the herb its astringent, styptic, diuretic and anti-inflammatory properties. It can also be used internally as a tea against heavy menstrual bleeding after childbirth, vaginal bleeding between periods and minor bleeding of digestive tract caused by hemorrhoids. Sometimes the herb is used as a digestive and for the treatment of digestion related diseases like dysentery, dyspepsia, colic and intestinal worms.

SIDE EFFECTS

Only when taken in large doses it causes irritation of digestive system. The fresh plant sap can also cause skin irritation.^[8] Not enough is known about the use of smartweed during pregnancy and breast feeding. Stay on the safe side and avoid use.

Ulcers or other stomach and intestinal (gastrointestinal, GI) disorders

Smartweed can irritate the tissues that line the stomach and intestine making ulcers and GI problems worse. Avoid using smartweed in ulcers or another GI disorder. When the fresh plant is handled it can cause skin irritation and swelling (inflammation). Smartweed contains large amounts of vitamin K. Vitamin K is used by the body to help blood clot. Warfarin (Coumadin) is used to slow blood clotting. By helping the blood clot, smartweed might decrease the effectiveness of warfarin Coumadin.^[25]

FUTURE PROSPECTS

Polygonum hydropiper seed extracts treatment showed the best control effect in terms of reducing the infections and enhancing plant growth. These results provide promising baseline information on the potentiality of these plants to develop novel, efficient and eco friendly herbal antifungal products as alternatives of chemical fungicides.^[32] *In vitro*, *in vivo*, behavioral and docking studies support the potential use of β -sitosterol as AD modifying agent.^[1] This plant serves as a promising candidate as a multipurpose herbal medicinal agent owing to its economical viability and being a reservoir of many significant medicinal properties in treating diseases and ailments related to microbial infections, inflammation, pain, allergy, uterine disorders, fertility, obesity, and improvement of memory.^[6]

CONCLUSION

The medicinal plants play a very important role in maintenance of health of human beings. Several medicinal plants (herbal drugs) are now available for the treatment of various disorders. Medicinal plants shows versatile properties against many types of disorders and can be used for the treatment for various types of diseases with less side effects. The Scientific Reserarch on Polgonum hydropiper suggests a huge potential of this plant and the information given in this review might provide the use of this plant for the treatment of various disorders.

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