Review Article

A REVIEW ON PHARMACOGNOSTIC, PHYTOCHEMICAL AND ETHNOPHARMACOLOGICAL FINDINGS OF PEPEROMIA PELLUCIDA (L.) KUNTH: PEPPER ELDER

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ABSTRACT

Peperomia pellucida (L.) Kunth (Family Piperaceae) has been utilizing in folk medicine for many years worldwide and much research have been devoted. This review focused to summarize updated most interesting findings on the morphological, phytochemical, ethnopharmacological and toxicological aspects obtained in the research related to the plant. Local communities around the world have been consumed this plant as a leafy vegetable and in the treatment of gastrointestinal disorders including dysentery, diarrhoea, stomachache; respiratory tract disorders including asthma, nasopharyngeal infections, cough; skin diseases including eczema, wounds, abscess, acne, boils, scabies, dermatitis, rash, sores, scar, and warts; mucocoe tumors and other ailments such as fever, paralysis, epilepsy, convulsions, heart problems, hypertension, kidney disorders, gout, rheumatic pain, conjunctivitis, and measles. This species has been extensively investigated as a source of natural pharmacologically active compounds with potential antimicrobial, anticancer, antipyretic, anti-inflammatory, antioxidant, analgesic, anti-diarrheal, antihypertensive and anti- oedemagenic activities. Phytochemical screenings on the plant have revealed the presence of various pharmacologically active principles of medical importance including tannins, flavonoids (acacetin, apigenin, isovitexin, and pellucidatin), cardiac and xanthone (Pputuloside A) glycosides, alkaloids (secolognans, tetrahydrofururanlignans, peperomins A, B, C, and E, sesamin, and isoswertisin), saponins, inulins, terpenes, phenolic compounds, phytosterols (stigmasterol, sitosterol, and campesterol) and other steroids, and resins. P. pellucida also contains several essential oils, mainly dillapiole, β-caryophyllene, and carotol. The acute toxicity results revealed that this plant might be considered as a non-toxic plant with high therapeutic index. Much additional work is needed to open new biomedical application of these compounds.

Keywords: Peperomia pellucida (L.) Kunth, Pepper elder, shiny bush, ethnopharmacology, phytochemical, dillapiole.

INTRODUCTION

The Asian region of the world enriches with the vast diversity of herbal medicinal plants rich in ethnopharmacological properties that are widely used in different traditional medicinal systems; known as indigenous or folk medicine. The practice of traditional medicine is very popular and widespread in China, Japan, India, Pakistan, Thailand, and Sri Lanka and herbal medicinal preparations are more in demand. Majority of the people in developing countries of Asia and Africa utilize medicinally valuable plants on a regular basis for the primary health care. Ethnopharmacological knowledge on these plants has been used for the discovery, synthesis, and development of novel allopathic medicines. Therefore, it is essential to research on herbal medicinal plants to ensure their better utilization, conservation and to save them from extinction, overexploitation and negative consequences of climate changes.

Peperomia pellucida (L.) Kunth, also known by the common names pepper elder, shiny bush, silver bush, rat-ear, slate pencil plant, clearweed and man to man which belongs to the family Piperaceae, is a common annual weed native to tropical North and South America. In Sanskrit, this plant is known as “Toyakandha or Varshahbo” The name had been derived from the Latin per (through) and lucidus (clear), referring to the somewhat translucent appearance of this plant. It is now pantropic in distribution and is abundantly available in Sri Lanka and locally known as “Diya Thippili” or “Wathura Gas”. Although this plant is considered as a weed, it has been used by Ayurvedic and traditional physicians in Sri Lanka. It has been utilized in folk medicine for many years worldwide and much research have been devoted. This review focused to summarize updated available evidence on the ethnobotanical uses, phytochemical constituents, pharmacological and toxicological studies of P. pellucida.

TAXONOMICAL CLASSIFICATION AND BOTANICAL DESCRIPTION OF P. PELLUCIDA (L.) KUNTH

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida (Dicotyledonae)
Sub-class: Magnoliidae
Order: Piperales
Family: Piperaceae (Pepper family)
Genus: Peperomia Ruiz & Pav
Species: pellucida
Botanical name: Peperomia pellucida (L.) Kunth
Former botanical name: Piper pellucidum (L.)

P. pellucida is an annual or short-lived perennial, entirely delicate, fleshy and glabrous herb usually growing to a length of about 15-45 cm. Stems are translucent pale green, erect or ascending or decumbent, freely branched, internodes usually 3-8 cm long and hairless. Petioles are 1-2 cm long. Its...
light-green leaves are alternate throughout, well-spaced and succulent. Stipules are absent. The leaf blade is broadly ovate or ovate-triangular to deltate (heart shaped), 1-3.5 cm length, length ± equal to the width, cordate at the base with a sinus 1–2 mm deep, thinly membraneous, both surfaces glabrous, translucent, palmately 5–7-veined. It has very small bisexual flowers growing in the form of cord-like spikes. Spikes are slender, solitary, terminal or leaf-opposed (at the opposite side of leaves), and arising from the leaf axils. Mature fruiting spikes are 2-6 cm long and 1-2 mm in diameter. Flowers are loosely flowered, bracts suborbicular, 0.5 mm wide and short-stalked. A flower has two stamens. Anthers are sub-globose. The ovary is ellipsoid. Stigmas are pubescent. The fruits are drupe, tiny, dot-like, round to oblong, 0.5-0.7 × 0.4-0.5 mm, ridged, sessile, longitudinally ribbed with the ladder like reticulations; beat minute, conic, and first green, blackish brown at maturity. They have one single seed and a mustard-like odor when crushed.

**ORIGIN, GEOGRAPHICAL DISTRIBUTION AND HABITAT**

*P. pellucida* is native to tropical North and South America, Africa, and Asia and is often naturalized as a weed and occasionally cultivated. It is often epiphytic, terrestrial and occasionally a lithophyte. It grows in clumps, thriving in loose, humid soils, during rainy periods (often in the spring) and a tropical to subtropical climate. Flowering year-round, the plant is found in various shaded parts of the woods, forests, rock crevices, bases of cliffs, sometimes a weed of cultivation; around nurseries and greenhouses and along coastal plain all over Asia and the America near sea level to 200-2000 m.

**ETHNOMEDICAL USES OF *P. PELLUCIDA* BY VARIOUS COMMUNITIES AROUND THE WORLD**

Leaves and stems of pepper elder are frequently consumed as a spicy leafy vegetable cooked or in salads and condiment in many parts of the tropics. In Africa, it is occasionally cultivated for the food purpose. The whole plant is traditionally prescribed in folk medicine of various countries and the ethnomedical uses are vary depending on the region. It is sometimes grown as an ornamental container plant.

Ayurvedic and traditional physicians in Sri Lanka have been used this plant for various ailments. The leaves and inflorescence are used in the treatment of diarrhoea, dysentery, nasopharyngeal infections, paralysis, epilepsy, convulsions, skin; mucosae tumors and cancers. The entire plant is crushed and rubbed over the burned area to reduce burning sensation and to prevent blisters. An ethnomedical survey conducted in Bangladesh among folk medicine practitioners has revealed that *P. pellucida* is used in the treatment of gastrointestinal disorders such as dysentery, diarrhoea, stomachache, respiratory tract disorders; asthma, bronchitis, pneumonia, cold, cough, mucus, influenza, and tonsillitis, sore throat and skin diseases including eczema, abscess, acne, boils, scabies, itch, infections, dermatitis, rash, sores, scar, and warts. The juice of the leaves is being used by the local people of Bangladesh to relieve a cough and fever, as a remedy for colds, diarrhea, heart problems, hypertension and in the treatment of excited mental disorder. In India, the whole plant is used to treat a cough, kidney disorders (dysuria, urinary retention, and urinary tract infections), and general weakness.

The decoction of the roots is used for tumors by the Mog communities of Tripura State, in northeast India.

Southeast Asians use the crushed mixture of this plant with water to cure haemorrhage in wounds, as a traditional wound healing medicine as well as a wound dressing material and to control abdominal pain. *P. pellucida* has been recognized as one of the top ten herbal medicines approved by the Department of Health in the Philippines, due to its variety of valuable medicinal properties. The wine infusion or decoction of the whole plant is taken orally for gout and kidney troubles and applied externally as a rinse against complication problems. The warmed leaves are applied to sores and boils and according to the Manila Medical Society, it is used to relieve arthritic pains, but it may cause Central Nervous System (CNS) depression.

In Indonesian traditional medicine, this plant is incorporated in the treatment of wounds, boils, abscesses, pimples, abdominal pain, colic, gout, rheumatic pain, fatigue, kidney disease, furuncles, eye inflammation (conjunctivitis), dengue and as an antihypertensive. The crushed leaves are used to treat dizziness or headaches if the patient has a fever. In Malaysia, the plant is known as ‘ketumpangan air’ and it has been used for treating various ailments such as abdominal pain, indigestion, abscess, acne, boils, colic, gout, headache, renal disorders, breast cancer, impotence, measles, mental disorders, smallpox, fatigue, and rheumatism.

Many countries in tropical America used this plant in folk medicine. Fresh juice of leaves and stems is used to treat conjunctivitis in South America. In Brazilian folk medicine, the whole herb is used as a diuretic, cough suppressant and an emollient, to control cardiac arrhythmia, to treat abscesses, furuncles, skin sores and conjunctivitis. In Northeast Brazil, the whole plant is also used to lower the cholesterol levels in the blood (hypcholesterolemic agent) to cure haemorrhage, fever, abdominal pain, boils, renal disorders, rheumatic pain, mental disorder, eaten as a salad for the treatment of gout and arthritis. The whole plant is crushed, mixed with water, heated and then administered orally to stop haemorrhages by Alenos Indians in Bolivia. The solution of the fresh juice of leaves and stem is used against conjunctivitis in Surinam. In the Amazon region of Guyana, the plant has been used as a cough suppressant, emollient, diuretic, in the treatment of cardiac arrhythmia, proteinuria, and hypercholesterolemia.

*P. pellucida* had been reported in Nigeria and other West African countries as being effective and commonly used to manage various ailments by traditional health practitioners. It is one of the most prominent plant species incorporated into the commonly used recipes in the treatment of measles and hypertension in Nigeria. The infusion added with milk is ethnomedically described to boost the immune system of sick people. The aerial parts are used generally as a tonic for healthy well-being and is employed in the treatment of diabetes, abscesses, furuncles, skin sores, conjunctivitis, abdominal pain, acne, boils, colic, fatigue, gout, headache, renal disorders, rheumatic pain, breast cancer, impotence, female sterility, mental disorders, cardiac arrhythmia, and smallpox. In Nigeria and Congo, it is used as an ingredient of an infusion for treating convulsions. An infusion of the plant or a maceration, mixed with salt and palm oil, is taken against a cough in Congo. The aqueous extract is commonly used in Cameroonian traditional medicine for the management of fracture.

In addition to above, the plant species has a history of other ethnomedical uses which include in the treatment of malaria and as a facial rinse for acne and complication problems. However, there has not yet been validated clinical data with
regards to *P. pellucida* dosing but the patients with known hypersensitivity reactions to any of the components of the plant species are contraindicated to its use. Nursing mothers have also been contraindicated due to pharmacologically active components of this plant interfere with prostaglandin synthesis.

**PHARMACOLOGICAL ACTIVITIES OF DIFFERENT EXTRACTS OF *P. PELLUCIDA***

This species has been extensively investigated as a source of natural pharmacologically active compounds with potential antimicrobial, anticancer, antipyretic, anti-inflammatory, antioxidant, analgesic, and anti-oedematogenic activities.

**Antimicrobial Activity**

*P. pellucida* has shown a broad spectrum of antibacterial activity against gram-positive bacteria; *Staphylococcus aureus*, *Bacillus subtilis*, and gram-negative bacteria; *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Salmonella typhi*, *Enterobacter aerogenes*, *Escherichia tarda*, *Flavobacterium sp.*, *Aeromonas hydrophila*, *Vibrio cholerae*, *Vibrio alginiticus*, and *Vibrio parahaemolyticus*.

The aqueous and ethanol extracts of the leaves have shown no anti-Methicillin Resistant *Staphylococcus aureus* (anti-MRSA) activity on clinical MRSA isolates.

In addition, this plant extracts have shown antifungal activity against *Candida albicans*, *Rhizopus stolon*, *Aspergillus niger*, *Penicillium notatum*, and *Trichophyton mentagrophytes*.

Another study has revealed the potential of the macerated methanol extract of this plant as an antimalarial against *Plasmodium falciparum* using Desjardin method.

An antibacterial study performed using agar-well diffusion method for the aqueous and ethanol leaf extract of *P. pellucida* reported that the ethanol extract had shown its highest inhibitory activity on *Proteus mirabilis* and *Pseudomonas aeruginosa* while water extract had shown its highest inhibitory activity on *E. coli*.

N-hexane, ethyl acetate, and ethanol extracts of *P. pellucida* whole plant that grows around Ekiti State, Nigeria had exhibited antimicrobial activity against *E. coli*, *Klebsiella pneumoniae*, *Salmonella typhi*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*.

Ethanol extract had exhibited the least potency whilst the N-hexane extract had exhibited the strongest potency with the zone of inhibition 10-12 mm at the concentration of 25 μg/mL.

According to the results of a study done by Zubair et al.; 2015, the inhibition of bacterial growth of all strains by the hexane, chloroform, ethyl acetate, ethanol, and water extracts of leaves of *P. pellucida* was dose-dependent as evident by the higher zone of inhibitions at higher concentrations. The antibacterial activity had been compared with the 10 mg/mL standard antibiotic penicillin.

Hexane extracts had appeared to be the most effective extract. None of the water extracts had shown any antibacterial activity. Chloroform extracts were inactive against all the gram-positive bacteria tested (*Staphylococcus aureus*, *Bacillus subtilis*, and *Bacillus cereus*). The antibacterial activity of the extracts was more prominent on the gram-negative bacteria (*E. coli*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Pseudomonas fluorescens* and *Salmonella typhi*) than the gram-positive bacteria.

Plant extracts often contain polyphenols and flavonoids which could be the antimicrobial components as suggested by Zubair et al.; 2015.

Anticancer Activity

Peperomia E isolated from this plant had shown anticancer activity/growth inhibitory effects on the cancer cell lines HL-60 (human acute promyelocytic leukemia), MCF-7 (human breast adenocarcinoma), and HeLa (human cervical cancer). The compound 7,8-trans-8,9-trans-7,8-cis-7,7-bis(5-methoxy-3,4-methylenedioxyphenyl)-8-acetoxymethyl-8'-hydroxymethyltetrahydrofuran had exhibited estrogen-like properties in MCF-7 cell line.

Anticancer activity of *P. pellucida* leaf extract had also been observed through Colorimetric MTT (tetrazolium) assay against MCF-7 cell line with the half maximal inhibitory concentration (IC50) of 10.4 ± 0.06 μg/mL.

**Antipyretic Properties**

Intra-peritoneal administration of petroleum ether and ethyl acetate soluble fractions of ethanol extract of the leaves had shown a significant reduction in the elevated body temperature of rabbits and their antipyretic effects were comparable to that of a standard antipyretic drug, aspirin. This study supports the claims of *P. pellucida* by traditional medicine practitioners in the treatment of fever as an antipyretic remedy.

**Antioxidant and Anti-Inflammatory Properties**

Antioxidant activity of the crude extracts of this plant had been determined using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay. Another study had determined the high antioxidant activity of *P. pellucida* even at low concentrations using the scavenging effect on DPPH, hydroxyl radical and ferric thiocyanate compared to the antioxidant standards; butylated hydroxyl anisole (BHA), ascorbic acid, and α-tocopherol.

Petroleum ether, chloroform, and methanol extracts of this plant had shown antioxidant activity using DPPH assay and anti-inflammatory properties using the Carrageenan-induced rat hind paw oedema method. And the total phenolic content of the methanol extract (6.93 %) had shown the highest free radical scavenging activity.

The potent antioxidant activity of the crude methanol extract of this plant was due to its ability to elevate superoxide dismutase and catalase and lower thioredoxin reductase activities in rat liver under oxidative stress. Oral administration of the plant extract in rats had been confirmed to interfere with the synthesis of prostaglandin, thus acting as an anti-inflammatory and analgesic agent.

Phongtongpasuk & Poadang; 2014, had conducted a research to investigate the effect of two extraction techniques; maceration and reflux and three extracting solvents; methanol, butanol, and ethyl acetate on the yield and antioxidant activity of *P. pellucida*.

The results have shown that the methanol extract by reflux method offered the highest extraction yield. Ethyl acetate extract by reflux method had the highest total phenolic contents and the highest antioxidant activity evaluated by DPPH assay. The antioxidant activity was drastically different and depended upon the extracting solvent and extraction method used. Mohamad et al; 2015, had shown that different drying methods used in their study did not affect the antioxidant and antimicrobial activity and chemical constituents of this plant extracts. Hence expensive drying methods are not compulsory, and it is economically beneficial.

A study had shown that *P. pellucida* has a phenological cycle of approximately 100 days. Researchers had tested the anti-inflammatory potential of the aqueous extract during the four distinct development phases (Complete development, the...
beginning of bloom, complete bloom, and seed set) to detect differences in its potency. Aqueous extracts had significant anti-inflammatory activity during phenophases 1 and 2 of winter and spring. Depending on the plant’s phenophase there was variation in the potency of oedema inhibition\(^5\).

An experimental design had been conducted for the ethanol extract of \textit{P. pellucida} using the enzyme xanthine oxidase and xanthine as the substrate. Inhibition of xanthine oxidase had determined enzymatically with the IC\(_{50}\) of 19.5 ppm. IC\(_{50}\) of allopurinol was 1.99 µg/mL. They have proved that the ethanol extract of \textit{P. pellucida}, has efficacy to reduce levels of uric acid excess by inhibiting the action of the enzyme xanthine oxidase\(^5\). Hence \textit{P. pellucida} had efficacy to reduce levels of uric acid excess and this claims the ethnomedicinal use of this plant in the treatment of gout.

The high antioxidant activity of \textit{P. pellucida} at low concentrations stipulates that it could be very useful in the treatment of ailments resulting from oxidative stress and further corroborates the ethnomedicinal uses.

**Fracture Healing Effects**

Orally administered aqueous extract of the whole plant of \textit{P. pellucida} had shown fracture healing effects in female Wistar rats (drill-hole model). The aqueous extract had increased bone calcium levels at the lowest dose (100 mg/kg) but maintained this parameter at a normal range at the high dose (400 mg/kg) in fractured rats. Alkaline phosphatase and phosphorus concentrations reduced significantly (p<0.01) at the dose of 400 mg/kg as compared to fractured rats. Radiological tests had revealed a dose-dependent formation of a highly dense and compact fibrocartilaginous callus at the level of the fracture gap. The mineral content of the plant extract had revealed the presence of calcium, phosphorus, magnesium, sodium, and potassium. The aqueous extract of \textit{P. pellucida} had accelerated bone healing due to the considerable mineral content of the extract. These results claim its incorporation into traditionally used recipes in the treatment of bone fractures\(^5\).

**Antidiarrhoeal Activity**

Plant extracts at a dose of 250 mg/kg and 500 mg/kg had shown antidiarrhoeal activity by inhibiting castor oil induced intestinal accumulation of fluid in male and female white albino mice. Literature had documented that antiinflammatory and antidiarrheic properties of medicinal plants were due to flavonoids, alkaloids, tannins, saponins, and sterols. Tannins, sterols, and alkaloids present in the leaves might be responsible for the antidiarrheal activity of \textit{P. pellucida}\(^5\).

**Central Nervous System (CNS) Depressant Effects**

Diazepam-induced sleep, nikethamide-induced toxicity, light-dark test and force swimming test had been performed in mice for petroleum ether and ethyl acetate fractions of ethanol extract of leaves. Results of this study revealed that it contained psychoactive substances which are CNS depressant in nature. The folk medicinal uses of \textit{P. pellucida} for convulsions, in the treatment of the excited mental disorder and its CNS depressant effects, agree with their experimental results. CNS depression had been reported as the neurotoxic effects of styrene isolated from this plant\(^7\).

**Antidiabetic Activity**

Antidiabetic activity of ethanol extract of \textit{P. pellucida} had been investigated in alloxan-induced diabetic albino male rats. Ethanol extract at the dose 1000 mg/kg had shown the better reduction of blood glucose level than the dose 500 mg/kg\(^9\).

**Cytoprotective Effect**

The ethanol extract of the aerial part of \textit{P. pellucida} had produced significant dose-dependent inhibition of gastric mucosal damage induced by cytodestructive agents (80 % ethanol, 25 % sodium chloride, 0.6 M hydrochloric acid, 0.2 M sodium hydroxide and 30 mg/kg indomethacin) at all doses (10, 30, 100 and 300 mg/kg) in the experimental models of rats. The result suggested that \textit{P. pellucida} possesses anti-ulcer properties as claimed by the ethnomedicine. The findings have justified the traditional use of the plant to treat abdominal pain. Therefore, we can postulate that this plant may have cytoprotective factors based due to the reduction of total lesion area when induced with necrotizing agents\(^8\).

**Immunostimulatory Effect**

A study has shown the huge potential of \textit{P. pellucida} leaf extract as a natural immunostimulant in controlling motile aeromonad septicemia due to \textit{Aeromonas hydrophila} in red hybrid tilapia, \textit{Oreochromis} sp. The significantly higher value of antibody response to \textit{A. hydrophila} in fish which had been determined by enzyme-linked immunosorbent assay and significantly lower percentage cumulative mortality of fish received medicated feed compared to fish did not receive medicated feed (p<0.05), had been observed. Hence, this plant extract can be incorporated into the fish feed to manage fish health for aquaculture uses\(^9\).

**In Vitro Thrombolytic Activity**

The results of a study conducted in Bangladesh to determine in vitro thrombolytic activity revealed that the activity of various extracts had been found in the range of 10.87-55.56 %. The ethanol soluble fraction had exhibited the highest percentage lysis of the clot, hence the highest thrombolytic activity comparable to the standard drug, streptokinase among the hexane soluble fraction, chloroform extract, and aqueous soluble fraction\(^8\).

**Antihypertensive Activity**

Kurniawan et al; 2016, had isolated and determined the chemical structure of the flavonoid (3',4',5'-Dihydroxy-3-5- dimethoxyflavone-7-O-β-rhamnose) which was responsible for the Angiotensin-converting enzyme (ACE) inhibitory activity from the methanol extract of the aerial part that claims the traditional use of this plant as an antihypertensive. The IC\(_{50}\) value for the in vitro ACE inhibitory activity was 7.72 µg/mL. They had suggested this compound inhibits the enzyme activity by competing with the substrate for the active site\(^3\).

A dose-dependent reduction in systolic, diastolic, mean arterial pressure and heart rate had been observed in Sprague-Dawley rats following intravenous administration of \textit{P. pellucida} aqueous plant extract (10-30 mg/kg) and displayed moderate inhibition of CYP3A4 enzyme activity. Their results suggested that the dose-dependent hypotensive, bradycardic and vasorelaxant effects of this extract were mediated through Nitric oxide-dependent mechanisms. The impact on CYPs enzyme activities indicates unlikely adverse drug effect when \textit{P. pellucida} is consumed with other medications reliant on CYP3A4 metabolism\(^8\).
Cholesterol Reduction Effects

Isolation of styrene, campesterol, stigmasterol, and β-sitosterol from this plant has been reported. Cholesterol biosynthesis and cholesterol absorption had been reduced by increased sitosterol, campesterol, and stigmasterol levels37. This claims the traditional use of this plant as a hypocholesteremic agent.

ACUTE TOXICITY STUDIES OF P. PELLUCIDA

The acute toxicity results of P. pellucida revealed that this plant might be considered as a non-toxic plant with high therapeutic index37. Oloyede et al; 2011 had reported that the methanol, hexane, and ethyl acetate fractions of methanol extract of leaves were toxic while the most polar fractions butanol and aqueous fractions were non-toxic by performing the brine shrimp lethality test. Patulside A isolated from this plant has shown cytotoxic properties to brine shrimp nauplii39. Observations of a toxicity study of methanol extract for 14 days (at the dose 500, 1000, 2000, and 4000 mg/kg) had shown that there was no mortality and no symptoms of toxicity on the skin and hair, defecation, feed intake, respiratory system and in behavior between control and the test group of rats. Histopathological observation showed no specific abnormalities in heart, liver, and kidney28.

PHYTOCHEMICALS PRESENT IN P. PELLUCIDA

Preliminary and qualitative phytochemical screening on the plant P. pellucida have revealed the presence of various pharmacologically active principles of medical importance including tannins5,22-23,26,28,36-37, flavonoids1,22-23,26,28,37, cardiac, xanthone and other glycosides5,22-23,37, alkaloids22-23,36,37,41, saponins23,37,41, inulins23,41, terpenes, phenolic compounds, phytosterols30,37,41 and other steroids30,36,41, resins and carbohydrates36.

New structures of the pharmacologically active principles had been elucidated based on chromatographic and spectroscopic methods mainly by Nuclear Magnetic Resonance (NMR) and Mass Spectroscopy (MS) and evaluation of their biological activities have been reported in the literature. The phytochemicals present in the plant were alkaloids, namely, secolignans, tetrahydrofuranlignans, as well as, highly methoxylated dihydronaphthalenone, peperomins A, B, C, and E, sesamin, and isoswertisin. P. pellucida also contained several essential oils, mainly dillapiole, β-caryophyllene and carotol that have high larvicidal activities. Other compounds are flavonoids such as acacetin, apigenin, isovitexin, and pellicudatin, substituted styrenes and antraquinone. Phytosterols such as stigmaster, siosterol, and campesterol had been successfully isolated from dichloromethane extract of the plant5.31-15,23,30,34,41,43.

Phytol had been identified as the major bioactive compound and 2-Naphthalenoldicarboxylic acid, methyl ester and 9,12-Octadecadienoic acid (Z, Z)-methyl ester had been identified as the other phytochemicals presented GC/MS38,49. Bayma et al; 2000, had isolated a novel dimeric ArC2 compound named Pellucidin A, together with the known phenylpropionic dillapiole from the methanol extract of aerial parts of P. pellucida. The isolation and characterization of the compounds from hexane and ethyl acetate fraction of ethanol extract had resulted in three compounds named stigmasterol, analogue phophythin, and β-sitosterol-D-glucopyranoside52.

Another study has reported that thirty-two compounds had been identified by using GC/MS technique from the ethanol extract of the whole plant. Apiol was found to be the major component followed by (3-Methoxy-nitrophenyl) acetic acid, methyl ester, Phytol, n-Hexadecanoic acid, E-2-Tetradecen-1-ol, 5H-Cyclopropa(3,4)benz(1,2-e)azulen-5-one, 4,9,9a-tris(acetolxy)-3-[(acetolxy)methyl], Stigmasteryl, 3,7,11,15-Tetramethyl-2-hexadecen-1-ol, Campesterol, α-Sitosterol, 9,12,15-Octadecatrienoic acid, (Z,Z,Z), Z,Z-2,5-Pentadecadien-1-ol and 3-Hydroxy-4-methoxycinnamic acid50.

A xanthone glycoside isolated from this plant named Patuloside A, and arylpropanoids had demonstrated weak antifungal and antibacterial activity while peperomins had exhibited anticanter activity15,30,43. Dillapiole and Pachypophyllin from the chloroform extracts of air-dried leaves had been elucidated by NMR were active against the fungi Trichophyton mentagrophyte49.

A study on the nutritional and mineral profile of this plant done in Malaysia using atomic absorption spectrometry had determined that P. pellucida be rich in crude carbohydrate, protein, and total ash contents. A high-value mineral composition comprises calcium, iron, and potassium as the main elements. They suggested that this plant would serve as a good source of protein and energy as well as micronutrients in the form of a leafy vegetable for human consumption15.

A commonly used medicinal plant over long durations containing high concentrations of natural radionuclides can cause health problems. Susa et al; 2013, had conducted a study to determine the natural radioactivity in a sample of P. pellucida. The level of radionuclides determined in this study presented the same order of magnitude or slightly higher concentrations than that vegetable foodstuff, tea and herbal medicines concentrations reported in the published literature24.

CONCLUSION

This review summarized updated available evidence on the taxonomy, ethnobotanical uses, phytochemical constituents, pharmacological and toxicological studies of the valuable plant Peperomia pellucida (L.) Kunth. This is widely used in different traditional medicinal systems for various ailments such as gastrointestinal disorders, respiratory tract disorders, skin diseases, neurological disorders, heart problems, kidney disorders, rheumatic pain, conjunctivitis, and in the management of fractures. This species has been extensively investigated as a source of natural pharmacologically active compounds with potential antimicrobial, anticancer, antipyretic, anti-inflammatory, antioxidant, analgesic, antiarrhythmic, antihypertensive and anti-oedematogenic activities. Phytochemical screenings on the plant have revealed the presence of various pharmacologically active principles of medical importance including tannins, flavonoids, glycosides, alkaloids, saponins, terpenes, phenolic compounds, phytosterols and other steroids. P. pellucida also contains several essential oils, mainly dillapiole. This review will be useful for further studies on this plant. More research is needed to isolate and characterize bioactive constituents and establish clinical studies, to explore the potential uses of P. pellucida that may contribute to drug development.

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