Ethnopharmacology, phytochemistry and pharmacology of *Tephrosia purpurea*

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[ABSTRACT]
*Tephrosia purpurea* (L.) Pers. is popularly known as ‘Sarapunkha’ in classical Ayurvedic texts. It is a perennial plant belonging to the family Fabaceae, and occurs throughout the Indian subcontinent. *T. purpurea* is traditionally used to treat spleenomegaly, cirrhosis, cough and cold, abdominal swelling and as an antidote in the Ayurvedic system of medicine. Phytochemical investigations indicate the presence of semiglabrin, pongamole, lanceolatins A and B, rutin, lupeol, and β-sitosterol. Flavonoids including (+)-tephrorin A and B, (+)-tephrosone, an isoflavone, 7, 4'-dihydroxy-3', 5'-dimethoxyisoflavone and a chalcone, (+)-tephropurpurin were isolated from the whole plant. Pharmacological activities of different parts of the plant reported include anti-inflammatory, antiulcer, antimicrobial, antioxidant, antiallergic, antidiabetic, hepatoprotective, antitumor and insect repellent activity. In the present review, the literature on the phytochemical and pharmacological investigations of *Tephrosia purpurea* (L.) Pers. are summarized to August, 2012.

[KEY WORDS] *Tephrosia purpurea*; Phytoconstituents; Flavonoids; Antitumor; Anti-inflammatory; Hepatoprotective


Introduction

The generic name *Tephrosia purpurea* (L.) Pers. is derived from the Greek word *tephros*, meaning "ash-colored," referring to the grayish tint given to the leaves. *Tephrosia* is a genus of flowering plants in the pea family, Fabaceae, comprising more than 400 species [¹]. The genus is well known for its richness in prenylated flavonoids and is considered to possess insect repellant, larvicidal, piscicidal, antimicrobial and anticancer properties [²-⁵]. Many species in the genus are poisonous, particularly to fish, because of their high concentration of rotenone. *Tephrosia* species have historically been used by indigenous cultures as fish poisons. There are several species of *Tephrosia* that are medicinally important and are found worldwide. *T. pondensis* is a species which is found only in South Africa, whereas in Yemen, *T. odorata* and *T. socotrana* are the local species. In Australia *T. rosea* and *T. clementii* are found. Throughout the Midwest, New England and southeastern United States, *T. virginiana* is found. *T. densiflora* is grown especially for use as a fish poison in West Africa, has abortifacient properties and is used against parasitic skin diseases. *T. pumila* and *T. tinctoria* are reported to have antibacterial, antifungal, and piscicidal activities [⁶-⁷].

Most surprisingly, *T. purpurea* is not found in the Vedic literature of India, or in Ayurvedic classical texts, like *Caraka samhita*. Only three references are traceable from the classical texts of *Susruta Samhita* [⁸] and from the third century, *Vagbhata's Astanga Hridaya* [⁹]. At later times, lexicons or dictionaries dealing with medicinal plants having their origin between 8–10 AD, known as Nighantus, have high-lighted its role in the management of spleenomegaly, which in Ayurvedic terms is known as ‘Plihodara’. Hence another synonym of *T. purpurea* is *Pliha-satru* (enemy of enlarged spleen). *T. purpurea* has the following synonyms: *Cracca purpurea* L., *Tephrosia diffusa* (Roxb.) Wight & Arn., and *Tephrosia wallichii* Grah. ex Fawc. & Rendle [¹¹].
**Botanical Description and Varieties**

*T. purpurea* is an erect or spreading annual, or short-lived perennial, herb, sometimes bushy, 40–80 cm tall, rarely up to 1.5 m, stem slender, erect or decumbent at base. Leaves compound (imparipinnate) with free lateral stipules triangular in shape, rachis up to 14.5 cm long, leaflets 5–25 mm long, obovate to narrowly elliptical, terminal leaflet (7–28) mm × (2–11) mm, acute at base, apex rounded to emarginate, venation reticulate unicostate. Inflorescence is racemose. Flowers in fascicles of 4–6, pedicel 2–6 mm long; flower 4–8.5 mm long, purplish white to black, bisexual, symmetrically zygomorphic, hypogynous. Calyx-bell shaped gamosepalous, persistent, unequally 4–toothed, teeth pubescent inside. Corolla papilionaceous (i.e. polypetalous irregular corolla), standard broadly ovate posterior petals ((3.5–7.3) mm × (5–10) mm), two lateral petals are clawed, two anterior petals are very small and slightly united at the base, called keel or carina ((2.2–4.5) mm × (2–3) mm); Stamens are 10, cohesion of stamen-diadelphous, staminal tube 4–6 mm long, ovary superior, style up to 4.5 mm long, upper half glabrous. Pod of *T. purpurea* is dry dehiscent (Legume) type, flat, linear, (2–4.5) cm × (3–5) mm, somewhat up-curved towards the end. Seed rectangular to transversely ellipsoid, (2.5–5) mm × (1.8–3) mm, light to dark brown to black, sometimes mottled. According to the Indian Materia Medica there are mainly three varieties of *T. purpurea*, i.e. Sveta Sarapunkha, Kantaki Sarapunkha, and Rakta Sarapunkha. They can be correlated with their modern counterparts, as follows: Sveta Sarapunkha–*T. procumbens/T. candida*, Kantaki Sarapunkha–*T. villosa*, Rakta Sarapunkha unknown.

**Ethnopharmacology**

The whole plant is useful in the treatment of jaundice and hepatomegaly [12]. This plant is also named in Sanskrit as, *Sarwa wranvishapaka*, which means that it has the property of healing all types of wounds [13–15]. The dried herb is effective as a tonic, laxative and diuretic. It is also used in the treatment of bronchitis, bilious febrile attack, boils and pimples, diseases of the teeth, scrofula, painful blood and bleeding piles. The roots and seeds are reported to have insecticidal, piscicidal, and vermifugal properties. Leaves are prescribed in dyspepsia, pectoral disease and hemorrhoids, etc. [16]. The roots are effective in leprosy wounds and the root juice is useful in skin eruptions. Seeds, roots and ash are useful traditionally and also cultivated as fertilizer [17]. Certain ethnomedical uses are given below: for cough and cold the inhalation of *T. purpurea* smoke is an excellent remedy, whereas for rodent bites, the seed powder of *T. purpurea* is used with butter milk to treat poisoning. Traditionally, in abdominal swelling it is highly effective when taken in kshara form (burnt ash form) along with *Terminalia chebula* powder, old and dirty wounds are treated with rice water containing *T. purpurea* root. *T. purpurea* roots are chewed directly or taken with butter to treat spleenomegaly. In Sri Lanka, it is employed as an anthelmintic for children. Roots are used to stupefy or poison fish in French Guiana.

**Chemical Constituents**

Phytochemical screening of the plant has revealed the presence of rotenoids, isoalloxazines, flavonones, chalcones, sterols, flavonols and flavones. Seeds contain karanjin (1), purpurin [18], pongamol (3), lanceolatin B (4), purpurinin (5), and purpurinethemite [19], etc. Roots contain flavonoids, apollinine, semiglabrin, semiglabrinol, tephro- glabrin, tepurindiol, pongamol, iso-lonchocarpin, O-methylpongamol, lanceolatins A and B, etc. Leaves contain a flavonoid: rutin, a triterpenoid: lupeol, and a sterol: β-sitosterol, etc. The whole plant contains the flavonoids (+)-tephrorins A and B and (+)-tephrosone [20], an isoflavone 7, 4′-dihydroxy-3′, 5′-dimethoxysoflavone and a chalcone (+)-tephropurpurin [21].

Reinvestigations of the extract of aerial parts of *T. purpurea* resulted in the isolation and structural elucidation of three compounds, namely an aromatic ester, a sesquiterpene of the rare rotundane skeleton and a prenylated flavonoid isolated for the first time from this species.

Some newly discovered compounds are 4-isopropyl-1, 8-dimethyl-decachydro-azulene-5, 8, 9-triol (6), 2-propenoic acid, 3′-(4′-acetoxy-3′-methoxyphenyl)-3-(4-acetoxy-3-methoxyphenyl)-2-propenyl ester (7), and the prenylated flavonoid (8). Chemical investigations of the aerial parts of *T. purpurea* yielded the rare prenylated flavonoids, tephropurpurin A (9) and isoglabratephrin (10), in addition to a previously identified flavonoid, glabratephrin. Three novel flavonoids, (+)-tephrorins A (11), tephrorin B (12) and (+)-tephrosone (13) were also isolated from *T. purpurea*, and their absolute configurations were determined by the Mosher ester methodology [20]. Compounds 11 and 12 are flavonoids containing an unusual tetrahydrofuran moiety. Compounds 11–13 were evaluated for their potential cancer chemopreventive properties using a cell-based quinone reductase induction assay [22].

**Pharmacology**

**Hepatoprotective activity** [23]

The ethyl acetate fraction of an ethanol extract of the roots of *T. purpurea* was evaluated for its efficacy in rats by inducing hepatotoxicity with CCl₄. Serum levels of aspartate aminotransferase, alanine transaminase, alkaline phosphatase, bilirubin, and triglycerides were used as biochemical markers of hepatotoxicity. The results showed that oral administration of *T. purpurea* resulted in a significant reduction in aspartate aminotransferase, alanine transaminase, alkaline phosphatase and total bilirubin, when compared with CCl₄-damaged rats. A comparative histopathological study of liver from the test group exhibited almost normal architecture, as compared to the CCl₄-treated group. The results are comparable to that of...
Silymarin. Hepatoprotective activity of *T. purpurea* exhibited better effectiveness than Silymarin in certain parameters. *In vitro* studies revealed that the alcoholic extract, exerted a significant hydroxyl radical scavenging activity. It prevents cellular leakage and loss of functional integrity of the liver cell membranes caused by various hepatotoxic agents.

**Anti-inflammatory activity** [24]

Analgesic activity of *T. purpurea* was carried out using acetic acid-induced writhing in mice and the tail flick test in rats. The anti-inflammatory activity was evaluated using carrageenan-induced rat paw edema and cotton pellet granuloma formulation in rats. The effects of the administration of reference standard (ibuprofen and hydrocortisone) were also evaluated. *T. purpurea* were found to be more effective in preventing carrageenan-induced rat paw edema, cotton pellet granuloma formation, and acetic acid-induced rat paw edema.

**Antimicrobial activity**

A novel oleanene type tri-terpenoid glycoside was isolated from the butanolic extract of the seeds of *T. purpurea*. Its structure was elucidated as 3-O-([β-D-glucopyranosyl-(1→6)[α-L-rhamnopyranosyl-(1→2)]β-D-glucopyranosyl-(1→4)[β-D-glucopyranosyl-(1→2)]β-D-xylpyranosyl]-2, 1-dihydroxy-23, 29-dihydroxymethylolane-11, 13(18)-diene-28-oic acid. The isolated saponin was tested for its antimicrobial activity. Maximum inhibition was recorded against the Gram-positive bacterium *Streptococcus pneumoniae*, and complete inhibition was observed on the growth of the fungus *Alternaria alternata*. The potency of the extract was quantitatively assessed by determining the minimum inhibitory concentration values against selected bacteria [25]. In another research study, the petroleum ether extract, alcoholic extract and aqueous extract of seeds of *T. purpurea* were found to have antibacterial activity against *Bacillus subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa* [26].

**Antiulcer activity**

Antiulcer activity of *T. purpurea* extract was studied in rats in which gastric ulcers were induced by oral administration of ethanol, or 0.6 mol·L⁻¹ HCl, or indomethacin, or by pyloric ligation, and duodenal ulcers were induced by oral administration of cysteamine HCl. Omeprazole was used as a reference drug. The ulcer index in the *T. purpurea*-treated animals was found to be significantly less in all the models compared to vehicle control animals. The antiulcer property was more prominent in animals in which ulcers were induced by HCl, indomethacin, and by pyloric ligation. Omeprazole produced a significant gastric and duodenal ulcer protective effect when compared with the control group. The anti-ulcer activity of *T. purpurea* was however, less than that of omeprazole. Results suggest that *T. purpurea* possesses significant antiulcer property which could be either due to cyto-protective action or by strengthening of gastric and duodenal mucosa, and thus enhancing mucosal defense [27].

The aqueous root extracts of *T. purpurea* (100 and 200 mg·kg⁻¹) were screened for ulcerative colitis using the method of acetic acid-induced ulcerative colitis in mice. Macroskopical study of the colon, level of myeloperoxidase in colon, and histopathology of the colon tissue were studied for the assessment of activity. Results showed that the aqueous extract was effective in the treatment of ulcerative colitis at a dose of 200 mg·kg⁻¹ [28].

**Antidiabetic activity** [29]

Studies revealed that an aqueous seed extract of *T. purpurea* resulted in a decrease in the blood glucose concentration, and also increased insulin level, which could be due to the stimulation of insulin secretion from remnant pancreatic
β-cells which in turn enhance glucose utilization by peripheral tissues. Hyperglycemia is associated with an altered hexokinase and glucose-6-phosphatase activities, elevated lipid peroxidation, disturbed enzymatic superoxide dismutase, catalase, glutathione peroxidase and non-enzymatic glutathione, vitamin C and vitamin E. Antioxidant status was observed in streptozotocin-induced diabetic rats.

There is decreased hemoglobin and increased glycosylated hemoglobin levels in diabetic rats. Increased hemoglobin in *T. purpurea*-treated diabetic rats indicated decreased blood glucose level and glycosylated hemoglobin. Oral administration of *T. purpurea* to diabetic animals significantly improved hexokinase and glucose-6-phosphatase activities.

**Antioxidant activity [30]**

Anxiety disorders are among the most common mental disorders besides depressive disorders, and approximately affect one eighth of the world population at some point in their life.

Anxiolytic activity of a hydroalcoholic extract of *T. purpurea* was studied in mice using the elevated plus-maze, elevated zero-maze, y-maze, and hole-board models. Furthermore, the anxiolytic effects of the hydroalcoholic extract at the dose 200 and 400 mg·kg⁻¹ orally was compared to a known active anxiolytic drug, diazepam. The extract administered orally in two different doses, was able to increase the time spent and the number of arm entries in the open arms of the elevated plus-maze and elevated zero-maze, as well as decrease the visits by mice in the Y-maze, it also significantly increased nose poking, line crossing, and rearing in the hole-board assay. This effect was comparable to that of the diazepam, indicating that the extract of *T. purpurea* is an effective anxiolytic agent at the dose of at the dose 200 and 400 mg·kg⁻¹.

**Mast cell stabilizing potential (anti allergic) activity [31]**

Mast cell stabilizing potential of *T. purpurea* was evaluated for the management of asthma using experimental animal models. An extract of the aerial part of *T. purpurea* was prepared, and the mast cell stabilizing potential evaluated against clonidine-induced mast cell degranulation, in adult Wistar albino rats, the result revealed that the ethanolic extract of the aerial parts of *T. purpurea* showed a dose-dependent, significant reduction in mast cell degranulation as compared to the clonidine-treated animals, however its effect was less than dexmethylasone and disodium cromoglicate, which are potent mass cell stabilizers, thus *T. purpurea* possesses good mast cell stabilizing properties, and hence can be a candidate of asthma management.

**Anti-tuberculosis activity [32]**

Mammalian host defense against the pathogen involves restricting access of the organism to iron. *In vitro* growth studies using standard culture media indicate that siderophore-mediated iron acquisition plays a critical role in the growth and metabolism of *Mycobacterium tuberculosis*. In response to iron starvation, mycobacteria produce siderophores, iron-storage proteins or receptors. However, exochelins (siderophores) of *M. tuberculosis* are capable of removing iron from the transferrin and lactoferrin, and transferring it to the cell wall of *Mycobacterium*.

Recently a compound was isolated from a root extract of *T. purpurea* that solubilizes the compound rock iron [Fe(OH)₃] and helps in plant metabolism. This compound is also capable of inhibiting the growth of *M. tuberculosis* under *in vitro* conditions. The mechanism of action of this compound is through competition with the bacteria for iron in the environment.

**Antioxidant activity [33-34]**

The therapeutic effects of tannins and flavonoids can be largely attributed to their antioxidant properties. The results of antioxidant activity of *T. purpurea* revealed that the leaves of this plant have antioxidant potential. Antioxidant activity of ethanol extract and ethyl extract of *T. purpurea* were studied for CCl₄-induced lipid peroxidation and superoxide generation. Results indicate that ethyl acetate extract has improved antioxidant activity as compared to ethanol extract.

**Cytotoxic activity [35-37]**

The chloroform extract of the powdered root of *T. purpurea* were subjected to preliminary chemical screening, and brine shrimp hatchability and lethality testing. The investigation was extrapolated to animal cell lines, Daltons lymphoma ascites and Ehrlich ascites carcinoma. The Trypan blue exclusion method was used for this screening and confirmed the potent cytotoxic activity of *T. purpurea*.

The chemopreventive potential of *T. purpurea* extract was assessed in N-nitrosodiethylamine-induced hepatocellular carcinoma in Wistar rats. Hepatocellular carcinoma was induced by a single intraperitoneal injection of N-nitrosodiethylamine (200 mg·kg⁻¹) followed by subcutaneous injections of CCl₄ (3 mL·kg⁻¹ per week) for six weeks. After administration of the carcinogen, 200 and 400 mg·kg⁻¹ *T. purpurea* extract were administered orally once a day throughout the study. The levels of liver cancer markers, including α-fetoprotein and carcinoembryonic antigen, were substantially increased by *N*-nitrosodiethylamine treatment. *T. purpurea* extract treatment significantly reduced liver injury and restored the entire liver cancer markers. Additionally, *T. purpurea* extract normalized the activity of antioxidant enzymes, namely lipid peroxidation, reduced glutathione, catalase, superoxide dismutase, glutathione peroxidase, and glutathione-S-transferase in the liver of *N*-nitrosodiethylamine treated rats. Treatment with *T. purpurea* significantly reduced the node incidence and multiplicity in the carcinogen-bearing rats. Histological observations of the liver tissues correlated with the biochemical observations.

Cytotoxic activity of different fractions of *T. purpurea* was tested in the human MCF-7 cancer cell line by trypan blue exclusion method. Two fractions of *T. purpurea* showed IC₅₀ values of 152.4 and 158.71 μmol·L⁻¹.

**Antiviral activity [38]**

The methanol extract of *T. purpurea* flowers was studied for antiviral activity by using virus cultures namely, HEL cell
cultures, HeLa cell cultures and Vero cell cultures. The results indicate good antiviral activity of the flowers extract of *T. purpurea*.

**Spasmyloitic Activity**[^39]

Investigation revealed the spasmylocytic activity of the ethanol extract of the leaves of *T. purpurea* on guinea pig trachea. The results showed the spasmylocytic activity of the drug. Preliminary phytochemical investigation showed that the presence of glycosides and saponins may be responsible for this activity.

**Antiepileptic Activity**[^40]

Research revealed the anti-epileptic activity of *T. purpurea* in status epilepticus induced in rats by administration of pilocarpine after lithium chloride. The results of the lithium-pilocarpine-induced status epilepticus model demonstrated that the ethanolic extract of *T. purpurea* has significant ability in reducing the severity of status epilepticus, and also possesses both in vitro and in vivo antioxidant activity.

**Nephroprotective activity**

Studies revealed nephroprotective activity of the alcohol extract of *T. purpurea* in gentamicin-induced kidney cell damage and in vitro hydroxyl radical scavenging activity. The hydroxyl radical scavenging effect of the extract was enhanced with increases in drug concentration, suggesting the role of free radical scavengers in minimizing gentamicin-induced kidney cell damage[^41]. An investigation was conducted of the chemopreventive efficacy of *T. purpurea* against N-diethylamino-cinitomine-initiated and potassium bromate-mediated oxidative stress and toxicity in rat kidney. The data indicate that *T. purpurea* is a potent chemopreventive agent against renal oxidative stress and carcinogenesis induced by N-diethylamino-cinitomine and KBrO₃ by reducing lipid peroxidation and xanthine oxidase activities and enhancing antioxidant enzyme activity[^42].

In another study, aqueous extract of *T. purpurea* roots was examined for its antihistitamic activity in two models of urolithiasis. The aqueous extract of *T. purpurea* was found to be effective in reducing the formation of, and dissolving existing, calcium oxalate (gentamicin and 5% ammonium oxide) and magnesium ammonium phosphate stones (zinc disce)[^43].

**Antimalarial activity**[^44]

The stem extract of *T. purpurea* showed antimalarial activity against the D6 (chloroquine-sensitive) and W2 (chloroquine-resistant) strains of *Plasmodium falciparum* with IC₅₀ values of (10.47 ± 2.22) and (12.06 ± 2.54) μg mL⁻¹, respectively. A new prenylated flavone, terpurinflavone, isolated from *T. purpurea* extract showed antimalarial activity with IC₅₀ values of (3.12 ± 0.28) μmol L⁻¹ (D6) and (6.26 ± 2.66) μmol L⁻¹ (W2).

**Conclusions**

According to the World Health Organization, plant-based medicine is still the mainstay of about 80% of the population in the developing countries[^45], hence extensive investigation is very much needed to standardize and validate the accrued knowledge of traditional medicine. The genus *Tephrosia* contains more than 400 species of flowering plants distributed worldwide. Most of the species of the genus *Tephrosia* including *T. pondoensia*, *T. odorata*, *T. socotrana*, *T. rosea*, *T. clementii*, *T. densiflora*, *T. pumila*, and *T. tinctoria*, etc. are poisonous due to the high content of flavonoids and are used as fish poisons. Antibacterial and antifungal activities of *T. pumila* are reported due to the presence of steroids and flavonoids. Apart from common phytochemicals like purpurin, tephrosin, karanjin, pongamol, etc., which were isolated from *T. purpurea*, new phytochemicals belonging to the flavonoids, like rare prenylated flavonoids, a new class of novel flavonoids, and polyphenols were investigated recently, thus elevating the potential of research in new drug discovery and ultimately paving the way in determining cytotoxic activity, immunomodulatory activity[^46], mast cell stabilizing activity, inhibition of late phase allergic reaction, analgesic activity, anti-diabetic activity, antimicrobial activity, anti-*Helicobacter pylori* activity[^47], etc. of *T. purpurea*. A new prenylated flavone, terpurinflavone isolated from *T. purpurea* showed antiparasomial activity. Thus, *T. purpurea* is the plant of choice for future research purposes, and will surely attract the attention of research scholars in the fields of pharmacology, drug discovery, and phytochemistry.

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**References**


Wanyama PJ, Fredrick LE, Hoseah MA. Terpurinflavone: an


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**Corrigendum**