A REVIEW ON THE PHARMACOLOGICAL STUDIES OF TALINUM TRIANGULARE

Seethal James M.*1 and Emily James2

1M. Pharm Student, Department of Pharmacology, Pushpagiri College of Pharmacy, Tiruvalla, Kerala, India.
2Associate Professor, Department of Pharmacology, Pushpagiri College of Pharmacy, Tiruvalla, Kerala, India.

ABSTRACT

Talinum triangulare (Jacq.) Willd. is a terrestrial succulent herbaceous plant widely used as an ornamental plant and green leafy vegetable, in India, Africa and America. This plant has been proven as a nutritional source and hence been useful in the treatment of various diseases including asthma, gastrointestinal disorders, anaemia, schistosomiasis and various other diseases. The phytochemical studies confirmed the presence of great number of potentially active biomolecules and their multi-functional properties make this plant a rich source of health promoter. This review article aims to provide brief information on this not so popular yet important herb along with the pharmacological activities it exhibits.

KEYWORDS: Talinum triangulare, antioxidant, phytochemicals, anti-diabetic activity.

INTRODUCTION

Medicinal plants have been a part of healthcare since time immemorial. They serve as a remedy that constitute the ingredients in modern medicine, nutraceuticals and food supplements. Various studies carried out globally have validated their safety and efficacy and some of the findings have led to the development of plant-based medicines.

Talinum comprises of almost 40 species, most of them are found in Mexico and US and about seven of them are found in tropical Africa.[1]
Talinum triangulare (Jacq.) Willd commonly called as waterleaf belongs to the family Talinaceae (Portulacaceae), is a nutritious leafy vegetable that originates from tropical Africa, is now widely cultivated as a medicinal and food crop in Western Africa (Nigeria), Asia, and South America. It is also known as Talinum fruticosum (L.) Juss. It is an annual, coalescent and glabrous herb which is an important source of some minerals (calcium, magnesium, potassium) and vitamins (ascorbic acid, pyridoxine).[2] The plant is well-known for its antioxidant and medicinal values. The propagation is through stem cuttings which produce adventitious roots extensively in hydroponic medium. It is used as a substitute for spinach in some places. It is well adapted to the hot and humid weather and the low fertile soil, which makes its cultivation an important economic activity for small growers. It is also used in traditional medicine as an alimentary tonic.[3]

Several papers concerning the pharmacognostic, preliminary phytochemical studies and pharmacological studies of this plant have been published, revealing its great therapeutic value in traditional medicine.

Fig:- a – A twig showing leaf arrangement, bearing flower and fruits; b – Enlarged portion of flower[4]

- Common name: - Waterleaf, Ceylon spinach.
- An erect, succulent, fast growing, perennial herb with soft and highly nutritious fleshy leaves. The leaves are spirally arranged with often crowded leaves at the top of the stem and bright pink flowers.

**Taxonomical hierarchy**

- Kingdom- Plantae
• Phylum - Tracheophyte
• Class - Magnoliopsida
• Order - Caryophyllales
• Family - Talinaceae (portulacaceae)
• Genus - Talinum
• Species - Talinum triangulare (Jacq.) Willd.

Synonyms
• English - Waterleaf, Surinam purslane, sweetheart
• Kannada - Nela basale
• Telugu - Sima bachchali
• Malayalam - Sambarcheera

Distribution
Talinum triangulare is grown widely in the humid countries as a leaf vegetable for culinary purpose. It is native to Mexico the Caribbean, Africa and South America.\cite{5} Waterleaf is characterized as tolerant to various soil types, temperatures and moisture levels, and grows well under shade. In India, it is found mostly in Assam, Tamil Nadu and Kerala.

Botanical description
Growth form: erect, glabrous perennial herb with swollen roots and obtuse-angular to terete, glabrous, succulent stems, 30-100 cm tall. Branches with 2 lateral, basal buds.

Leaves spirally arranged to nearly opposite, often crowded at the top of the stem, indistinctly or shortly petioled; leaf-blades usually spatulate, 3-15 cm long, 1-6 cm wide, entire and succulent, obtuse to rounded and occasionally notched at the apex.\cite{5,6}

Inflorescence, a long peduncled, terminal, corymbose thyrsus, 5-30 cm long, with 2-5 erect, sharply triangular axes, each 8-28 flowered; flowers bisexual, 0.5-2.5 cm in diameter; pedicels elongate after anthesis; sepals 2, free, green, persistent; petals 5, obovate, up to 10mm x 4 mm, pink; stamens 20-40; style 2-3 fid, ovary superior.

Fruits are dry, dehiscent and known as capsules. They are ellipsoid to globular and split into 2-3 compartments bearing tiny seeds.
Seeds numerous, compressed globose reniform, 0.8-1.2 mm long, granulate, glabrous, shining black.

Cultivation: Leaves can be harvested for consumption from 40-55 days after sowing to 6 months with intervals of 2 weeks between harvests.

Waterleaf is fast growing, and once established it easily reseeds itself. It flowers early and year-round, and is mainly self-pollinating.

**Growth and Development**

The onset of flowering does not appear to affect leaf or shoot production. Plants take 40–75 days to flower from stem planting, and at flowering they have 4–9 branches and 25–90 leaves. Waterleaf is recorded as being self-pollinated with a limited degree of out-crossing. Fruiting takes 75–80 days from stem planting. Under natural conditions, plants will live for 4–6 months. Waterleaf is relatively tolerant to drought.

**Traditional uses**

The extract from the leaves and roots is used to cure asthma. In Nigeria, it is used as diuretic and for the management of gastrointestinal disorders. Roots are used as a diuretic agent.[7]

In some countries, it is used to treat Schistosomiasis, scabies, fresh cuts, high blood pressure, and anemia.[8] The leaves are used for the treatment of edema, dropsy, scabies.

In Africa, *T. triangulare* is used intensively and concomitantly with allopathic medicines in the treatment of opportunity diseases by patients or by healthy people to prevent diseases, with the function of increasing stamina and immunostimulant.

In Taiwan province, the People’s Republic of China, *T. triangulare* has been used in the treatment and prevention of hepatic ailments and cancer in folk medicine.

In Cameroon, it is used for the treatment of measles.

In Assam (India), it is used for the treatment of diabetes.

**Phytochemical constituents**

An aqueous leaf extract of *Talinum triangulare* was screened for the presence of bioactive molecules, using gas chromatography coupled with pulse and flame ionization detectors. It
showed the presence of high content of carotenoids; moderate benzoic acid derivatives, hydroxycinnamates and flavonoids; and low terpenes, alkaloids, phytosterols, allicins, glycosides, saponins, and lignans contents. Ten known carotenoids (mainly 50.42% carotene and 33.30% lycopene), nine benzoic acid derivatives (mainly 84.63% ferulic acid and 11.92% vanillic acid), and six hydroxycinnamates (55.44% p-coumaric acid and 44.46% caffeic acid) were detected along with eight lignans (88.02% retusin) and thirty flavonoids (50.35% quercetin and 39.36% kaempferol).

Pharmacological activities

Antioxidant activity
Several studies have established the strong antioxidant activity of *Talinum triangulare*.

A study evaluated the in vitro antioxidant potential of betalains from *T. triangulare*. Two betacyanins and two betaxanthins were identified in aqueous methanolic extract of flower, stem and leaf. The total betalain content was estimated by photometric analysis. In vitro antioxidant activity for the betalain extract determined by various methods revealed potent scavenging ability. The current work may possibly be considered beneficial in utilisation of the plant *T. triangulare* as a natural colourant in food and beverage industries. Various in vitro antioxidant assays revealed that betalain extracts possessed potent antioxidant abilities which might be helpful in preventing or slowing the progress of various oxidative stress-related disorders. This study has proven its suitability for screening of betalain-containing plants as potential sources for natural food colours.

In another study titled ‘Elucidation of lead-induced oxidative stress in *Talinum triangulare* roots by analysis of antioxidant responses and DNA damage at cellular level, *T. triangulare* showed good tolerance mechanism against Pb toxicity through the increased activity of SOD, CAT, and APX and accumulation of free proline in Pb-treated roots. The increase in Pb treatment caused reduction in total protein contents, which may, be possible due to increased protein oxidation. In conclusion, hydroponically cultivated adventitious roots of *T. triangulare* were useful for rhizofiltration. Further research on the molecular mechanism of Pb detoxification in plant is required to improve our understandings.

Anti-diabetic activity
The study, ‘Anti-diabetic effects of polysaccharides from *Talinum triangulare* in streptozotocin (STZ)-induced type 2 diabetic male mice’ evaluated the anti-diabetic effects of
the polysaccharides obtained from *T. triangulare* (TTP). Two TTP doses (150 mg/kg and 300 mg/kg·bw/d) were administered orally to normal and streptozotocin (STZ)-induced type 2 diabetic male mice, respectively. The TTP hypoglycaemic and hypolipidemic effects were evaluated by testing the fast blood glucose (FBG) level, fasting serum insulin (FINS), and serum lipids (TC, TG, HDL, LDL) as well as the body and kidney weights. After four weeks administration, the low-dose group (150 mg/kg·bw/d) and high-dose group (300 mg/kg) showed a marked FBG fall rate of 29.85% and 41.18%. The results of FBG and serum lipids indicate that TTP possess significant hypoglycaemic effect, but no significant hypolipidemic effect.). The current study indicated that the dose of TTP played a vital role in FBG reduction and the improvement of glucose tolerance and insulin resistance in STZ-induced type 2 diabetic mice, thus proving the hypoglycemic effects of TTP. However, the hypolipidemic effect of TTP was less intensive and immediate than that of metformin in mice. These results suggest the potential use of TTP as a functional food for the treatment of type 2 diabetic mellitus (T2DM).[12]

The study titled ‘Hypoglycemic and Hypolipidaemic Activities of Methanolic Extract of *Talinum triangulare* Leaves in Wistar Rats.’[14] sought to investigate the hypoglycemic and hypolipidemic activities of methanolic extract of *T. triangulare* leaves in Wistar rats. Fresh plants of *T. triangulare* were purchased from a local market in Ibadan. The leaves were dried and milled into powder. Ten adult Wistar rats were divided into two groups of five rats each. Group A was administered saline solution while group B was administered *T. triangulare* extract. After fourteen days of administration, the animals were fasted overnight, fasting blood sugar and lipid profile were determined. *T. triangulare* leaves was observed to significantly lower fasting blood sugar, total cholesterol, LDL-cholesterol and triglyceride but increased HDL-cholesterol and HDL/LDL-cholesterol ratio significantly when compared to those of the control group at p<0.05. The result of this study implies that *T. triangulare* leaves are of significant health importance as far as hyperglucoeemia and hyperlipidaemia is concern. It could also be exceedingly helpful in the control of obesity. This pharmacological study is a useful tool for further drug development from the natural plant products.

**Hepatoprotective activity**

A study on the antioxidant and hepatoprotective activities of polysaccharides from *Talinum triangulare* evaluated its hepatoprotective activity.[15] The antioxidant activities of 40%, 60%, 80% and crude TTP were evaluated using three different models in vitro, including reducing
power, hydroxyl radicals, superoxide anion. To investigate the hepatoprotective potential, mice were treated with crude polysaccharides (50, 100 and 200 mg/kg,p.o.) for 7 days. Liver injuries were induced by CCl4 (0.1% in arachis oil, 10 mg/kg, i.v.) 1h after the drug administration on day 7. Mice were sacrificed at 24 h after the CCl4 injection. The levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT) in serum, and glutathione (GSH), superoxide dismutase (SOD), malondialdehyde (MDA) in liver tissues were measured. In in-vitro assays, TTP showed remarkably different degrees of antioxidant activities in dose-dependent manners. The crude TTP demonstrated a relatively strong antioxidant activity, while the 40% TTP showed the strongest antioxidant activity, and the 60% TTP had the weakest antioxidant ability. In in-vivo assay, pre-treatment with TTP had significantly decreased the levels of AST, ALT and MDA against CCl4 injures, and restored the activities of defense antioxidant substances SOD and GSH towards normalization. These results supported the effect of *T. triangulare* in fork use with scientific evidence.

Another study named ‘Ameliorative effects of aqueous water leaf extract (*T. triangulare*) against Carbon tetrachloride induced hepatotoxicity in adult wistar rats was also conducted.’[16] In this, 25 wistar rats were divided into five groups of five rats each. Group A served as control, group B rats were given 0.5ml/kg of carbon tetrachloride, group C (withdrawal) was given 0.5ml/kg of carbon tetrachloride and withdrawn for a week, group D and E was 500mg/kg and 1000mg/kg of aqueous extract of *T. triangulare* respectively and 0.5ml/kg of carbon tetrachloride intraperitoneally once daily for seven days. The findings revealed the adverse effects of carbon tetrachloride, the recovery effect of the withdrawal and it also showed a dose dependent suppression of oxidative damage in the liver following the administration of aqueous extract of *T. triangulare* at high dose (p<0.05). The serum hepatic marker enzymes significantly reduced in the treated rats which corroborated the improvement in hepatic histology of the distorted hepatic tissue following carbon tetrachloride exposure. This study indicated the hepatoprotective effects of *T. triangulare* against carbon tetrachloride induced hepatic damage in wistar rats.

**Anti-tumor activity**

‘Antitumor efficacy in H22 tumor bearing mice and immunoregulatory activity on RAW 264.7 macrophages of polysaccharides from *Talinum triangulare*’ was carried out to study the antitumor and immunoregulatory activities of a polysaccharide (TTP) from *T. triangulare*. The results of the in vivo study showed that TTP (200 mg/kg) significantly inhibited the
growth of tumor by 49.07% in H22-bearing Kunming mice. In vitro, the growth of primary murine macrophages was promoted by TTP in a dose- and time dependent manner significantly. Besides, RAW 264.7 cells were activated by TTP to produce NO and the toxicity of RAW 264.7 supernatant was markedly enhanced in vitro. The levels of iNOS, TLR2, TLR4 and IL-1β were obviously increased by TTP. Therefore, it is suggested that TTP can be utilized as a potent antitumor and immunoenhancing material in functional food. Simultaneously, our results indicated that TTP could stimulate the excretion of cytokines in H22-bearing mice, which implied that the anti-tumor activity might be associated with immunopotentiation.

Anti-ulcer activity

In the study entitled ‘Antiulcer Properties of Aqueous Extract of Talinum Triangulare Leaves In Experimentally Induced Gastric Ulceration In Mice’, anti-ulcer properties were evaluated using acetyl salicylic acid (ASA), HCl-ethanol and cold restraint stress (CRS)-induced ulcer models and charcoal meal to study small intestinal transit (SIT). In the ASA-induced ulcer, ATT produced a dose-dependent decrease in both mean number of ulcers (MNU) and mean ulcer index (MUI) which was significant (P<0.05, P<0.01) at 500 and 1000 mg/kg, respectively when compared with control. In the HCl-ethanol-induced ulcer, there was a dose-dependent decrease in both MNU and MUI which was significant (P<0.05, P<0.01) when compared with control. Comparing the MNU of ATT treated groups with that of Famotidine (12 mg/kg) showed that only that of 1000 mg/kg extract was significantly (P<0.01) lower, while all the ATT treated groups had significantly (P<0.01) lower MUI than Famotidine (12 mg/kg). In the CRS there was also a significant (P<0.05, P<0.01) decrease in both MNU and MUI respectively compared with control while the decrease in MNU and MUI were significant (P<0.05, P<0.01) at 500 and 1000 mg/kg ATT respectively compared with Famotidine. The SIT was increased by all doses of ATT used compared with control and diphenoxylate (5 mg/kg). Hence, ATT showed significant and promising anti-ulcer properties, thus justifying its use in the traditional treatment of peptic ulcer in different parts of Nigeria.\[19]\n
Another study ‘Ulcer Healing Mechanism of Ethanolic Extract of Talinum triangulare in Male Wistar Rats’ investigated the role of methanolic extract of Talinum triangulare (METT) in gastric ulcer healing and the possible mechanisms involved. Twenty-eight male wistar rats (160-180gm, n=7) were grouped into; A-control, B-ulcerated untreated, C-ulcerated treated
with Omeprazole (20 mg/kg b.w.) and D-ulcerated treated with METT (100 mg/kg b.w.). Gastric ulcer was induced by injecting 0.2 MLs of 40% acetic acid into the glandular part of the stomach for 45 seconds after which it was withdrawn, and the stomach surface cleaned with normal saline. Stomach samples were collected by day 14 post ulceration and assessed for ulcer score; a section of it was fixed for histological evaluation and immunohistochemical analysis. Stomach tissue homogenates were used for enzymatic activities. There was a significant reduction in the ulcer area of the METT treated group compared with other ulcerated treated and untreated groups. Malondialdehyde concentration of the gastric tissue homogenate was significantly lower in METT treated group compared to other groups. The METT treated group significantly increased the level of superoxide dismutase and catalase compared to other test groups. Histological study showed that only METT treated rats produces predominantly normal mucosa, METT treated rats also expressed CD31 (a marker of angiogenesis) and EGFR (a marker of proliferation) more than the other rats, while the expressions of Ki67 (proliferation) and p53 (Apoptosis) by METT group were not different from other groups. Methanolic extracts of *T. triangulare* accelerated the healing of gastric ulcers in rats probably through reduced oxidative stress, increased cell proliferation, and angiogenesis.\[20\]

**Enhancement of cerebral function**

The study titled ‘Waterleaf (*Talinum triangulare*) Enhances Cerebral Functions in Swiss Albino Mice’ was carried out to verify the effect of aqueous extract of waterleaf commonly used as food supplement on the cerebrum of swiss albino mice. Forty mice of both sexes were randomly assigned into three treatments (n=30) and control (n=10) groups. The mice in the treatment groups-B, C and D respectively receive 20mg, 30mg and 40mg of waterleaf extract for fourteen consecutive days, while the control mice (group A) received equal amount of normal saline. The cerebral tissues were assayed for Malondialdehyde (MDA) and catalase activities while some were fixed in 10% formol calcium for routine histological study. The histological findings indicated that the treated sections of the cerebrum showed no degenerative changes and no intercellular vacuolations in the stroma. There was also a dose dependent reduction (p<0.05) in MDA activities in the treated groups demonstrating the ability of waterleaf to inhibit oxidative stress thus preventing neuronal injury. These findings indicate that waterleaf consumption has benefiting effects on the neurons of the cerebrum and may probably enhance the cognitive ability in Swiss albino mice.
T. triangulare extracts also showed significant immunomodulatory activities that can inhibit leukemic U937 cancer cells. Based on these results, we suggest that T. triangulare extracts can be used as healthy foods because of their antioxidant activities and immunomodulatory potential.

CONCLUSION
The phytochemical studies along with the ethnobotanical relevance of Talinum triangulare makes it an important health promoter which could suggest its usage as an adjuvant in the prevention and treatment of various diseases. Further in-depth studies on various phytoconstituents could prove a useful way for potentially evaluating its development and use as a nutraceutical.

ACKNOWLEDGEMENT
I thank Dr Santhosh M Mathews, Principal, Pushpagiri College of Pharmacy (Kerala University of Health Sciences), Tiruvalla, Mrs. Anjana George (Assistant Professor, Department of Pharmacology, Pushpagiri College of Pharmacy, Tiruvalla) Mrs Preethu P John (Assistant Professor, Department of Pharmacology, Pushpagiri College of Pharmacy, Tiruvalla) and all the other faculties of Department of Pharmacology, Pushpagiri College of Pharmacy for their continuous support and encouragement.

REFERENCES
2. Oguntona, T. Green leafy vegetables. In A. U. Osagie, & O. U. Eka (Eds.), Nutritional quality of plant foods Nigeria: Post harvest research unit, Department of Biochemistry, University of Benin, Benin city, 1998; 120–133.
5. Talinum triangulare (Jacq.) Willd. [online] India Biodiversity Portal, Species. Available at: https://indiabiodiversity.org/biodiv/species/show/264227.


