Phytochemistry and Pharmacological Properties of *Thunbergia laurifolia*: A Review

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**ABSTRACT**

Commonly known as blue trumpet vine or laurel clock vine, *Thunbergia laurifolia* is a popular ornamental vine in the tropics. Flowers are attractive with pale purplish-blue petals and a yellow throat. Leaves are heart-shaped with a pointed tip and slightly serrated leaf margin. In Thailand, leaves of *T. laurifolia* are believed to have detoxifying effects. They are used as an antidote for poisons and drugs, including the treatment of drug addiction. The plant has also been reported to have antioxidant, anti-diabetic, anti-inflammatory, and antipyretic properties. Local herbal companies are producing herbal teas and capsules of *T. laurifolia*, known as Rang Jeud in Thai. Compounds isolated from the leaves included iridoid glucosides, grandifloric acid, glucopyranosides, and derivatives of apigenin. Other compounds found in leaves and flowers were delphinidin derivatives, and phenolic acids of chlorogenic, caffeic, gallic, and protocatechuic. Current knowledge on the pharmacological properties of the species is reviewed. Properties reviewed include antioxidant, antimicrobial, antiproliferative, hepatoprotective, and anti-inflammatory activities, as well as detoxifying, anti-diabetic, and non-toxic effects.

**Key words:** Antioxidant, detoxifying, hepatoprotective, anti-diabetic, anti-inflammatory, non-toxic

**INTRODUCTION**

*Thunbergia laurifolia* Lindl. (Thunbergiaceae), or commonly known as blue trumpet vine or laurel clock vine, is native to India. The species is grown as an ornamental plant and being a fast-growing vine, it has become an exotic weed in some countries. Its leaves are dark green, opposite, heart-shaped, with a pointed tip and slightly serrated leaf margin. The leaf blade can grow up to 20 cm in length and 16 cm in width with a petiole up to 6 cm in length. Leaves are thin and bright green in colour when young, and tend to be darker green, thicker and slightly variegated as they mature. Borne on pendulous inflorescences, flowers are attractive, trumpet-shaped, with 5-7 rounded and pale purplish-blue petals, and a yellow throat. The flower is up to 8 cm long and 6-8 cm across. The plant produces round green stems and a tuberous root system. Propagation is from stem or root cuttings.

The plant flowers continuously throughout the year with flowers opening early in the morning and aborting in the evening of the same day. Flowers are not scented. Carpenter bees are frequent visitors, creeping into the flowers for the pollen and nectar while black ants are present probably as nectar scavengers.

In Thai traditional medicine, leaves of *T. laurifolia* are used as an antidote for poisons and drugs including the treatment of drug addiction. The plant has also been reported to have anti-inflammatory, anti-diabetic, and antipyretic properties. Local herbal companies are producing and marketing herbal teas and capsules of *T. laurifolia*, known as Rang Jeud in Thai.

**PHYTOCHEMISTRY**

The phytochemistry of *T. laurifolia* leaves has been studied. Two novel iridoid glucosides of 8-epi-grandifloric acid and 3′-O-β-glucopyranosyl-stilberricoside have been isolated, along with seven known compounds of grandifloric acid, benzyl β-glucopyranoside, benzyl β-(2′-O-β-glucopyranosyl)-glucopyranoside, 6-C-glucopyranosyl apigenin, 6,8-di-C-glucopyranosyl apigenin, (E)-2-hexenyl-β-glucopyranoside, and hexanol-β-glucopyranoside.

Leaves and flowers of *T. laurifolia* have been found to contain other bioactive phenolic constituents including delphinidin-3,
A phenolic profiling of water extract of leaves of *T. laurifolia* showed the presence of apigenin and apigenin glucosides, as well as phenolic acids of caffeic, gallic, and protocatechuic.

Proximate analysis of the contents of fibre, ash, protein, fat, and carbohydrate in leaves of *T. laurifolia* (dry weight) were 16.8, 18.8, 16.7, 1.68, and 46.0%, respectively.

**PHARMACOLOGY**

**Antioxidant activity**

Water, ethanol, and petroleum ether extracts of dried leaf powder of *T. laurifolia* were evaluated for total phenolic content (TPC), free radical scavenging, and ferric reducing power (FRP). Based on TPC, it was found that water extraction (2430 mg GAE/100 g) was the most efficient compared to ethanol (565 mg GAE/100 g) and acetone (142 mg GAE/100 g) extraction. The water extract also yielded the highest free radical scavenging with EC$_{50}$ value of 0.13 mg GAE/ml, whereas ethanol and acetone extracts had EC$_{50}$ values of 0.26 and 0.61 mg GAE/ml, respectively.
The water extract also showed the highest FRP (0.93 mmol/g), compared to extracts of ethanol (0.18 mmol/g) and acetone (0.04 mmol/g).

Screening of ethanol extracts from 134 species of edible Thai plants for superoxide inhibitive activity, leaf extract *T. laurifolia* was found to have moderate inhibition rates of 50-69% for total activity and xanthine oxidase inhibition.[10]

A study on the optimum time and efficiency of methanol extraction for leaves of *T. laurifolia* demonstrated that 1 h was the optimum extraction time.[13] TPC values for 0.5, 1.0, and 2.0 h were 418 ± 57, 721 ± 105, and 636 ± 71 mg GAE/100 g, respectively. Based on TPC, the first extraction extracted about 88% of the phenolic compounds. Yields of the second and third extractions were only 10.5 and 3.5%, respectively, suggesting that methanol is efficient in extracting leaves of *T. laurifolia*.

Variations in TPC between *T. laurifolia* leaves of different ages, collection times, and locations were also reported.[13] Developing leaves had the highest TPC of 513 ± 8 mg GAE/100 g, followed by young and mature leaves with values of 407 ± 11 and 298 ± 9 mg GAE/100 g, respectively. TPC values varied from 532 ± 8 to 795 ± 16 mg GAE/100 g for four batches of leaves collected from the same source in April and May 2004. Leaves collected from plants located in three different locations on the same day had significantly different TPC values of 543 ± 15, 734 ± 13, and 892 ± 8 mg GAE/100 g, suggesting variation between plants. Within plants, leaves and flowers had comparable phenolic content and free radical scavenging ability.

The effects of different drying methods on the antioxidant properties of *T. laurifolia* leaves have been reported.[3,4] Antioxidant properties investigated were TPC and ascorbic acid equivalent antioxidant capacity (AEAC). Leaves (2 g each) were each subjected to three different drying methods. Oven drying involved drying for 5.5 hours in an oven set at 50°C. Sun and microwave drying was for 16 h and 4 min, respectively. For oven and sun drying, TPC and AEAC declined 73 and 76%, and 80 and 89%, respectively. For microwave drying, TPC and AEAC gained 38-41 and 50-51%, respectively. Microwave-dried leaves remained green with a faint fragrance and when ground, the aromatic green-coloured tea produced a mild tasting green infusion. For the microwave-dried tea, hot water extraction yielded TPC and AEAC values that were 1.7-1.9 and 2.0-2.1 times higher than those of methanol extraction. When compared to other commercial teas, TPC, AEAC, and FRP values of the microwave-dried tea were 6.4, 8.7, and 9.3 times those of the commercial *T. laurifolia* tea, and were superior to teas of *Orthosiphon aristatus* and *Aspalathus linearis*.

Antioxidant properties of 13 commercial tropical herbal teas based on screening of their TPC, AEAC, and FRP have been reported.[16] Herbal tea of *T. laurifolia* was among the low antioxidant category together with herbal teas of *Alpinia zerumbet*, *Garcinia atroviridis*, and *Cymbopogon citratus*. Values of herbal tea of *T. laurifolia* (Rang Jeud) were 805 ± 50 mg GAE/100 g, 591 ± 29 mg AA/100 g, and 43 ± 5 mg GAE/100 g, respectively.

A study on the effects of various thermal and non-thermal drying methods on the antioxidant properties of leaves and teas of *T. laurifolia* showed remarkable differences.[17] Leaves of *T. laurifolia* (15 g) were shredded, and microwave-dried (1.5 min), oven-dried (3 h), freeze-dried (overnight), and freeze-withered (2 h). Dried leaves were extracted by steeping in hot water (1 h) to obtain the tea infusions. Freeze withering and oven drying led to declines in TPC (85 ± 0.6 and 36 ± 2.3%) and AEAC (96 ± 2.4 and 25 ± 2.8%), respectively, compared to fresh leaves (Table 1). Values of freeze-dried leaves remained unchanged i.e. comparable to those of fresh leaves. Interestingly, values of microwave-dried leaves were 38 ± 3.2 and 84 ± 6.1% higher than those of fresh leaves, respectively.

Antioxidant properties of all *T. laurifolia* teas produced were significantly higher than those of the commercial Rang Jeud tea, with the exception of freeze-withered tea which had comparable properties.[17] Freeze-dried, microwave-dried, and oven-dried teas had TPC values

| Table 1: Percentage water loss and gain/loss in total phenolic content (TPC) and ascorbic acid equivalent antioxidant capacity (AEAC) of dried leaves in comparison with fresh leaves (fresh weight) |
|-----------------|-----------------|-----------------|-----------------|
| **Drying method** | **Water loss (%)** | **Gain/loss (%)** | **TPC (mg GAE/100 g)** | **AEAC (mg AA/100 g)** |
| Freeze withering | 79 ± 0.9 | -85 ± 0.6 | -96 ± 2.4 |
| Oven drying | 78 ± 1.2 | -36 ± 2.3 | -25 ± 2.8 |
| Freeze drying | 80 ± 1.1 | +0.4 | -0.7 |
| Microwave drying | 79 ± 0.6 | +38 ± 3.2 | +84 ± 6.1 |

TPC and AEAC are means ± SD (n = 3). Abbreviations: GAE = gallic acid equivalent and AA = ascorbic acid.
Antiproliferative activity

Ethanolic extracts of nine Thai medicinal plants were screened for antiproliferative activity against SKBR3 human breast adenocarcinoma cells using the methylthiazoletetrazolium (MTT) assay. Leaf extract of *T. laurifolia* did not show positive antiproliferative activity. Similarly, dried leaf powder extract of *T. laurifolia* showed very weak or no cytotoxic activity against BHK and L929 normal cells, and HepG2 and Caco-2 cancer cells using the MTT assay.

Hepatoprotective activity

Leaf extract of *T. laurifolia* protected mice from hepatic injury induced by ethanol. The hepatoprotective activity of aqueous extracts of *T. laurifolia* against ethanol induced liver injury in rats and in primary cultures of rat hepatocytes has also been reported. The extract at appropriate doses increased cell viability of primary cultures of ethanol-treated rat hepatocytes by 2-3 folds and decreased release of alanine transaminase (ALT) and aspartate transaminase (AST). It also promoted rat liver recovery after 14 days of ethanol treatment as reflected by the decrease in severity of rat liver injury and the normalization in hepatic triglyceride, ALT, and AST levels.

Detoxifying effects

The effects of *T. laurifolia* on endogenous dopamine release from rat striatal slices in comparison with those of amphetamine have been investigated. The effect of hot water extracts of dried *T. laurifolia* leaves on K⁺ stimulated dopamine release from rat striatal slices were compared with amphetamine using HPLC with electrochemical detection. Results showed that *T. laurifolia* may stimulate dopamine release in a similar manner to amphetamine.

A follow-up study was conducted to determine whether *T. laurifolia*, which has been used in the treatment of toxicity and addiction, can alter rat brain region activity using *in vivo* functional nuclear magnetic resonance imaging. It was reported that the methanolic leaf extract of *T. laurifolia* did not have any antibacterial or antifungal activities with the exception of UV light-activated activity against *B. subtilis*.

### Table 2: Total phenolic content (TPC) and ascorbic acid equivalent antioxidant capacity (AEAC) of tea infusions of *Thunbergia laurifolia* in comparison with the commercial tea (dry weight)

<table>
<thead>
<tr>
<th>Tea Infusion</th>
<th>TPC (mg GAE/100 g)</th>
<th>AEAC (mg AA/100 g)</th>
</tr>
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<tbody>
<tr>
<td>Freeze-dried</td>
<td>3850 ± 127 a</td>
<td>4520 ± 100 a</td>
</tr>
<tr>
<td>Microwave-dried</td>
<td>3080 ± 202 b</td>
<td>3450 ± 273 b</td>
</tr>
<tr>
<td>Oven-dried</td>
<td>1800 ± 57 c</td>
<td>1590 ± 55 c</td>
</tr>
<tr>
<td>Commercial tea</td>
<td>577 ± 39 d</td>
<td>398 ± 22 e</td>
</tr>
<tr>
<td>Freeze-withered</td>
<td>488 ± 44 e</td>
<td>219 ± 63 e</td>
</tr>
</tbody>
</table>

TPC and AEAC are means ± SD (n = 3). Abbreviations: GAE = gallic acid equivalent and AA = ascorbic acid.

Antimicrobial activity

A total of 41 types of Thai medicinal teas were analysed for UV light-activated antimicrobial activities against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Candida albicans*, and *Aspergillus fumigatus*. Results showed that the ethanolic leaf extract of *T. laurifolia* did not have any antibacterial or antifungal activities with the exception of UV light-activated activity against *B. subtilis*.

Figure 3: Infusions of *Thunbergia laurifolia* herbal teas
increased signal intensity in various parts of the brain, similar to the effects of cocaine or amphetamine. There was a slight decrease in arterial blood pressure. Results showed that T. laurifolia can stimulate brain activity in a manner similar to addictive drugs such as amphetamine and cocaine. However, it remains to be confirmed whether T. laurifolia itself can cause addiction or not or whether the effects are indeed relevant to reports that the plant can treat drug addiction.

The effects of aqueous leaf extract of T. laurifolia in alleviating lead poisoning in the brain of mice have been studied.\[23]\ Results showed that the extract can reduce neuronal cell death and memory loss caused by lead uptake in mice. The extract was found to restore the levels of caspase-3 activity, and maintain total antioxidant capacity and antioxidant enzymes in the brain.

The protection of T. laurifolia ethanolic leaf extract against lead toxicity in the Nile tilapia (Oreochromis niloticus) has been reported.\[25,26]\ When supplemented in fish food, the extract had the ability to protect the fish against lead toxicity after 28 days of treatment. The fish had reduced levels of lead in the liver and muscle, and showed improved growth performance, blood chemistry, hematology, and histology.

The detoxifying effects of aqueous T. laurifolia leaf extract on cadmium-induced toxicity in rats have been investigated.\[25]\ Two groups of six rats each were injected with cadmium chloride solution at 1.0 mg/kg body weight for 20 days. Injected rats fed with drinking water with 0.1 mg/ml of T. laurifolia leaf extract (group 2) had significantly higher body weight than those fed with only drinking water (group 1 as control). The rats in group 2 did not show histopathological changes in the kidney that were observed in the control group. The study demonstrated that T. laurifolia leaf extract can protect against cadmium-induced structural damage of rat kidney.

Another related study investigated the detoxifying effects of aqueous T. laurifolia leaf extract on paraquat-induced toxicity in rats.\[26]\ It was reported that the rats treated with the plant extract had higher survival rates and lower levels of plasma malonaldehyde.

**Anti-diabetic effects**

The anti-diabetic effects of aqueous leaf extract of T. laurifolia have been studied.\[10]\ Results showed that a 15-day treatment with the extract (60 mg/ml/day) decreased levels of blood glucose in diabetic rats. The recovery of some β-cells was found in diabetic rats. Whether T. laurifolia leaf contains insulin-like substance(s) which directly act as hypoglycemic agents, or contains substances that induce the regenerative process of β-cells remains to be investigated.

**Non-toxic effects**

A chronic toxicity study on T. laurifolia aqueous leaf extract on Wistar rats showed the extract at doses ranging from 20 to 2,000 mg/kg/day did not affect their body weight, food consumption, behavior, and general health.\[9]\ The extracts did not produce cumulative toxic signs and fatal effects. It was suggested that effects of prolonged oral administration of the extract need to be monitored. In an earlier toxicity study of aqueous leaf extract of T. laurifolia in mice at 1, 2, 4, and 8 g/kg/day, it was reported that no mice died during the first month, suggesting that the extract is non-toxic, effective, and safe for consumption.\[27]\

**Anti-inflammatory activity**

The anti-inflammatory efficacy dose of the aqueous leaf extract of T. laurifolia (2.5 g/kg) has been reported to be two-fold that of Garcinia mangostana rind extract (5.5 g/kg).\[27]\ Alcohol and hexane leaf extracts of T. laurifolia possess anti-inflammatory activity against carageenin-induced paw edema in mice.\[28]\

**CONCLUSION**

The growing scientific interest in T. laurifolia, a medicinal plant in Thailand, stems from traditional belief that the species has detoxifying effects, and can used as an antidote for poisons and drugs, including the treatment of drug addiction. Local herbal companies are producing and marketing herbal teas and capsules of T. laurifolia, known as Rang Jeud in Thai. In recent years, scientists in Thailand have conducted much research on the phytochemistry and pharmacological properties of the species. Properties included antioxidant, antimicrobial, antiproliferative, hepatoprotective, and anti-inflammatory activities, as well as detoxifying, anti-diabetic, and non-toxic effects. Some research interest has also been generated in Malaysia on the antioxidant properties of leaves and herbal teas of T. laurifolia. Recently, analyses of the infusion characteristics, sensory attributes, and consumer acceptability of T. laurifolia herbal teas produced by microwave drying, oven drying, freeze drying and freeze withering have been conducted, with comparisons to the commercial Rang Jeud tea from Thailand. To date, this report represents the first review of the phytochemistry and pharmacological properties of T. laurifolia.

**ACKNOWLEDGEMENTS**

This review forms part of the research project on the effects of different drying methods on the antioxidant properties of leaves and herbal teas of T. laurifolia conducted by three final year students of the Faculty of Applied Sciences, UCSI University. The project also included evaluations of the infusion characteristics, sensory
attributes, and consumer acceptability of *T. laurifolia* herbal teas. The support of the faculty and university is gratefully acknowledged.

REFERENCES


