AN ANTI-ASTHMATIC PLANT: TYLOPHORA INDICA BURM. F. MERRILL - A REVIEW

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ABSTRACT

India has been known to have rich diversity of plants since time immemorial. There were various ailments cured with the help of plants. This review has been prepared keeping in mind respiratory disease i.e. asthma, it is characterized by reversible airway obstruction, airway hyper responsiveness and airway inflammation. The goal of this article is to increase the awareness about importance of plants in medical field and prepare a list of plants used for treating asthma with special reference to Tylophora indica.

Key words: Tylophora indica, Botany, Medicinal, Therapeutic uses, Alkaloids.

Globally, plants have been used throughout the known civilizations as a valuable and safe natural source of medicine and agents of therapeutic, industrial and environmental utilities. Medicinal plants are being used at the household level by women taking care of their families, at the rural level by medicine men or tribal shamans and by the practitioners of classical traditional systems of medicine i.e. Ayurveda. According to the World Health Organization, over 80% of the world’s population or 4.3 billion people rely upon such traditional plant based systems of medicine to provide them with primary health care (Lawal et al., 2010).

Current trends all over the world have shown that for one reason or the other, people are not only willing to try natural medicines especially those of plant origin but also seeking non conventional or alternative remedies. As a result, there is a global resurgence in the trade of herbal medicines. International market of medicinal plants is reported to be over 62 billions US dollars per year during 2000-2001, which is growing at the rate of 7% annually. The botanical retail market, inclusive of herbs and medicinal plants, in USA, is approximately US$1.6 billion annually (Debnath et al., 2006). It is estimated that Europe annually imports about 4, 00,000 tonnes of medicinal plant material with an average market value of US$1 billion from Africa and Asia. A growing awareness of this new contributor to the foreign exchange reserves of several national treasuries has begun to emerge (Wakdikar, 2004).

To satisfy the growing market demands, surveys worldwide are being conducted by the pharmaceutical industries and research organizations to unearth new plant sources as herbal remedies, medicines and biomolecules (Khanuja, 2003).

Though, India has rich biodiversity and one among the twelve mega diversity centres, the growing demand is putting a heavy strain on the existing resources causing a number of species either falling in threatened or endangered. However, about 90% of medicinal plants used by industries are collected from the wild, while over 800 species are used in the production by industry, less than 20 species of plant are under commercial cultivation (Mills and Lee, 2008). Over 70% of the plant collections involve destructive harvesting because of the use of their parts like roots, bark, wood, stem and the whole plant

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in case of herbs (Sharma et al., 2010). This poses a definite threat to the genetic stocks and to the diversity of medicinal plants, if biodiversity is not sustainably used. Recently some rapid assessment of the threat status of medicinal plants using IUCN designed CAMP methodology revealed that about 112 species in southern India, 74 species in Northern and Central India and 42 species in the high altitude of Himalayas are threatened in the wild (Kumar et al., 2011). The need of the hour, then, is to replan India's participation in expanding global market, in light of the interest of all the stakeholders, who are affected and who play a role in this sector. There is a need to collect all the available information regarding medicinal plants development in the country in order to obtain a comprehensive overview, which will provide the necessary insight for coordinated and effective action (Holly et al., 1999). Such an overview could form the basis of a renewed development of India's medicinal plant sector, and a strategic exploitation of its comparative advantage in the global market on a sustainable and equitable basis (Sharma et al., 2010).

**Description of the plant**

*Tylophora indica* Burm. F. Merrill

**Synonyms**


**Other species of Tylophora**:


**Chromosome number:**

N = 8-11 or 12. Ploidy levels recorded 2-12 (Meve, 1996).

**Nomen number:** 416052

<table>
<thead>
<tr>
<th>Language</th>
<th>Vernacular Names</th>
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<tr>
<td>Bengali</td>
<td>Antamul</td>
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<td>Hindi</td>
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<td>Malayalam</td>
<td>Vallippala</td>
<td>Telugu</td>
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*Tylophora indica* (Asclepiadaceae) is a perennial, branching climber. It is indigenous to India and native to the plains, forest and hills of southern and eastern India and grows up to an altitude of 1,000 m in Bengal, Assam, Cachar and Orissa (Aurora Health Care, 2005; Ali, 2008). The description of various parts of this plant has been given in as under.

**Leaves:** Leaves are 2-4 cm broad and 4-6 cm long, simple, opposite, ex-stipulate, petiolate, with 2 small stipular glands. Leaves grooved along top, the two margins are lined with flexuous, 50-100 µm long, brownish, wingless and pubescent trichomes are also present. Stomata are present on both the surface of leaf. Leaf blades are broadly ovate-oblong to elliptic-oblong, blade margins are entire or regular.

**Stem:** Stems are elongated, glabrous but not much branched, sap yellowish in colour, slender, twining, densely pubescent (at least when young) reaching 10-12 feet in length. Trichomes are present.

**Root:** A short, knotty, slender, descending rootstock about 2.5-5.0 cm thick, emitting 2 to 3 aerial stems, and giving off numerous, long, fleshy, wiry roots. These roots are often 6 or more inches in length, very brittle, stout, cord like, covered with light brown corky bark i.e. longitudinally fissured.

**Inflorescence:** Flowers are aggregated in umbel inflorescences, rarely solitary, one per node.

**Flower:** Flowers are minute and greenish yellow colour in outside and purple inside. Flowers are hemaphrodite, regular, pentameric, actinomorphic and tetracyclic, occur on a long bristly pedicelled cyme. Flowering season of *Tylophora* starts from July and remained upto December.

**Calyx:** 5 sepals in one whorl, gamosepalous, hairy with basal glands.

**Corolla:** 5 petals in one whorl, gamopetalous, deeply 5-lobed, abaxially yellowish green, adaxially bright yellow to green. Corona lobes are triangular, turgid, oblong, acute and distinctly veined. Corona usually presents, inserted on corolla, stamens, or both.

**Androecium:** 5 stamens, usually inserted at the base of corolla tube, similar in shape, isomeresous with
the perianth. Anther wings 0.2 mm long, straight, adjacent anther wings parallel to one another. Pollens are shed in aggregates. Pollen tetrads contained loosely on a spatulate translator with a basal corpusculum, or pollen united into waxy pollinia, each attached through a stalk to the retinaculum (gland) between adjacent anthers to form a pollinium. Pollinium corpusculum is small elliptic, sub-apically attached to the pollinia. Pollinia are pendulous, ovoid but slightly flattened. Follicles occur one per flower, hanging, slightly winged pollinia 2 per pollinarium.

**Gynoecium:** Gynoecium is bicarpellary, syncarpillary, stylate, styles-2, synstylous. Ovary superior, pluri-locular, ovules 30-50 per locule, ovaries and styles distinct, connate, apical, partially joined (at the style head). Stylar head is slightly convex, yellowish green in colour. Stigma single, capitate with a rounded prominent centre and 5 radiating lobes in contact with the anther cells.
<table>
<thead>
<tr>
<th>Type of research work on <em>Tylophora indica</em></th>
<th>Explant/extract type used</th>
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<td>Thidiazuron-induced high-frequency shoot organogenesis from leaf-derived callus of a medicinal climber, <em>Tylophora indica</em> (Burm. f.) Merrill.</td>
<td>Immature leaf</td>
<td>Dennis and Philip, (2005)</td>
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<td>Hepatoprotective activity of the methanolic extract of <em>Tylophora indica</em> leaves (Burm. f.) Merrill.</td>
<td>Methanolic extract of leaf</td>
<td>Mujeeb et al., (2009)</td>
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<td></td>
<td>All plant parts</td>
<td>Sunanda et al., (1979); Ganguly et al., (2001)</td>
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</table>

Stigma head fleshy, depressed and globose in shape. Placentation axile type.

**Fruit**: Fruit 40-120 mm long; dehiscent; unilocular (in 2 follicles, with one often aborting), acuminate smooth follicles, 3 to 4 inches long and widely spreading. Dispersal unit is seed (Savithramma, 2003).

**Seed**: Seeds numerous, oval with a coma (a prominent basal tuft of silky hairs), dark brown colored. Wings present are glabrous or hairy with tufts of short hairs scattered over the whole surface of seeds. Seeds are endospermic with two cotyledons.

**Seed germination**: *T. indica* is propagated by seeds and as a cross-pollinated species it is highly heterozygous. Germination of seeds is phanerocotylar (cotyledons exposed i.e., free from seed coverings) or cryptocotylar (cotyledons enclosed within seed coverings).

**Propagation methods**: There are number of constraints for the propagation and conservation through conventional methods like vegetative and
### TABLE 3: Anti-asthmatic herbs of India.

<table>
<thead>
<tr>
<th>Botanical Names</th>
<th>Family</th>
<th>Common Names</th>
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<td><em>Acacia catechu</em></td>
<td>Fabaceae</td>
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<td><em>Adhatoda vasica Nees</em></td>
<td>Acanthaceae</td>
<td>Adathodai</td>
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<tr>
<td><em>Apium graveolens</em></td>
<td>Umbelliferae</td>
<td>Celer-y-keerali</td>
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<tr>
<td><em>Anethum graveolens</em></td>
<td>Apiaceae</td>
<td>Dill, Kapor, kerwya amya, koper, sadapa, sadhab</td>
</tr>
<tr>
<td><em>Atropa belladonna</em></td>
<td>Solanaceae</td>
<td>Belladonna, Devil’s Berries, Death Cherries</td>
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<tr>
<td><em>Boerhavia diffusa L.</em></td>
<td>Nyctaginaceae</td>
<td>Muka-ratee</td>
</tr>
<tr>
<td><em>Caesalpinia bonducella L.</em></td>
<td>Caesalpinaceae</td>
<td>Kali-ikkai</td>
</tr>
<tr>
<td><em>Callicarpa macrophylla</em></td>
<td>Verbenaceae</td>
<td>Velvety Beauty Berry</td>
</tr>
<tr>
<td><em>Calotropis procera, Calotropis gigantea L.</em></td>
<td>Asclepiadaceae</td>
<td>Giant Swallow Wort, Milkweed</td>
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<tr>
<td><em>Cinnamomum camphora</em></td>
<td>Lauraceae</td>
<td>Giant rubber bush, King’s crown</td>
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<tr>
<td><em>Cissampelos pareira</em></td>
<td>Menispermaceae</td>
<td>Velvet Leaf, Abuta, Pereira Root, Barbasco</td>
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<tr>
<td><em>Crocus sativus L.</em></td>
<td>Iridaceae</td>
<td>Kungumapu</td>
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<tr>
<td><em>Embelia ribes</em></td>
<td>Myrsinaceae</td>
<td>Embelia, False Black Pepper and Flase Pepper</td>
</tr>
<tr>
<td><em>Euphorbia hier L.</em></td>
<td>Euphorbiaceae</td>
<td>asthma weed</td>
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<tr>
<td><em>Inula racemosa</em></td>
<td>Asteraceae</td>
<td>Inula</td>
</tr>
<tr>
<td><em>Lepidium sativum</em></td>
<td>Cruciferae</td>
<td>Garden Cress, Pepper Grass, Garden Pepper</td>
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<tr>
<td><em>Leptadenia reticulata</em></td>
<td>Asclepiadaceae</td>
<td>Cress, Pepper Wott</td>
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<tr>
<td><em>Nerium indicum</em></td>
<td>Apocynaceae</td>
<td>Jwanti, Dodi</td>
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<td><em>Ocimum sanctum L.</em></td>
<td>Lamiaceae</td>
<td>Indian Oleander, Exile Tree</td>
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<tr>
<td><em>Pinus roxburghii</em></td>
<td>Pinaceae</td>
<td>Chir Pine, Three Leaved Pine, Himalayan Long Leaved Pine</td>
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<tr>
<td><em>Piper longum L.</em></td>
<td>Piperaceae</td>
<td>Thippili, Long Pepper, Pipli</td>
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<tr>
<td><em>Piper nigrum L.</em></td>
<td>Piperaceae</td>
<td>Milagu, Black Pepper, Peppercorns</td>
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<tr>
<td><em>Premna obisifolia</em></td>
<td>Verbenaceae</td>
<td>Headache Tree, Premna, False Elder</td>
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<tr>
<td><em>Saussurea lappa</em></td>
<td>Asteraceae</td>
<td>Costus, Kut Root</td>
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<tr>
<td><em>Semecarpus anacardium</em></td>
<td>Anacardiaceae</td>
<td>Marking Nut, Oriental Cashew</td>
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<tr>
<td><em>Solanum nigrum L.</em></td>
<td>Solanaceae</td>
<td>Manathakali</td>
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<tr>
<td><em>Solanum trilobatum L.</em></td>
<td>Solanaceae</td>
<td>Thathuvalai</td>
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<tr>
<td><em>Solanum xanthocarpum</em></td>
<td>Solanaceae</td>
<td>Kandankatthiri</td>
</tr>
<tr>
<td><em>Symplocos racemosa</em></td>
<td>Symplococeae</td>
<td>Symplocos Bark</td>
</tr>
<tr>
<td><em>Terminalia bellirica Roxb</em></td>
<td>Combretaceae</td>
<td>Thandrikkai</td>
</tr>
<tr>
<td><em>Tylophora indica ( T. asthmatica)</em></td>
<td>Asclepiadaceae</td>
<td>Antmul</td>
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</tbody>
</table>

Seed propagation. The major ones are variations in edaphic and climatic factors, low percentage of fruit set; low-seed viability, seasonal dormancy and low-germination rate make it unsuitable for propagation of this plant through seeds.

Vegetative propagation of this plant through stem cuttings failed to root with the application of different hormones. Above-mentioned causes of fail in natural regeneration provoked us to review about the nature of plant, its importance in medical science, alternative methods of rapid micropropagation, pharmacological activities and biochemical assays of this plant species.

**Morphological variations:** The shape and orientation of pollinial sacs of members of this family are mostly oval and horizontal & pendulous but in
Tylophora indica it is of globular type and orientation of the pollinia reported is erect type (Sinha and Monda, 2011).

Climate and soil: About 1000–1500 mm annual rainfall is ideal for the growth of Tylophora plant. It prefers partial shade conditions of the forests and soil rich in humus. It desires the support for climbing to a sunny location. Loamy soil rich in organic matter is preferable for its cultivation. However, it can grow on sandy to clayey soil along with farmyard manure (FYM).

Chemical composition: The immense pharmacological importance of this plant is mainly due to the presence of 0.2-0.3 % of alkaloids such as Tylophorine and tylophorine, are important alkaloids encountered and the percentage is not affected by seasonal variations (Gopalkrishnan et al., 1980). The extract of Tylophora indica marketed by pharmaceutical companies is standardized to contain 0.1% of the total alkaloids. These alkaloids have phenanthroimidazidine framework and have anti-inflammatory activity.

Plant also contains cetyl alcohol, a phytosterol, wax, resin, coushone, pigments, glucose, mineral salts, tannins, tetra-triacontanol, octa-cosanyl, octa-cosanoate, flavonoids, α-amyrin, β-amyrin, quercetin, kaempferol; sterols, β-sitosterol and stigmasterol. Besides, root contains a potential anti-tumor alkaloid tylophorinidine, p-methoxysalicyldehyde and essential oil (Mulchandani et al., 1971; Ghani, 2003). An important natural compound i.e. tyloindane has also been identified from this plant (Ali et al., 1991).

A vast survey of literature reveals the presence of tylophorine, tyloindicine A.D.F,G,H, and I, 14-hydroxy tylophorine, skimmianide, tylophorine, tannins, saponins, flavonoids in Tylophora indica (Govindachari et al., 1959; Saxena and Lycydia, 1975; The Wealth of India 1995; Indian Medicinal Plants, 1996; Rastogi and Malhotra, 1999; Kiritkar and Basu, 2009). Further, chemical structures, molecular formulas and CAS numbers of some important natural compounds present are depicted here in Table 1.

Therapeutic: It is used in the treatment of emetic, cathartic, expectorant, diaphoretic, asthma, whooping cough, dysentery (Kiritkar and Basu, 1918). The anti-allergic effect was reported (Nayampalli and Sheth, 1979). Hepato-protective activity of alcoholic and aqueous extract of leaves of Tylophora indica (Linn.) in rats was reported (Gujrati et al., 2007). Besides, anticancer activity of tylophorine has also been reviewed (Gopalkrishnan et al., 1980).

Keeping in view its immense uses in various ailments, several pharmaceutical companies viz., Actron Chemicals, Mumbai, India; Sabinsa Corporation, Piscataway, NJ, USA etc. are marketing T. indica extracts as antiasthmatic herbal drugs and other type of medicinal products.

Medicinal uses: Extensively, the leaves and roots are being used medicinally. Roots are reported to have emetic, cathartic, laxative, expectorant, antidyseretic, purgative, anti-anaphylactic, diaphoretic, vulnerary, stomachic, anti-histamine, antiviral properties (Ratnagiriswaran and Venkatachalam 1935; ICMR report, 1955; Ganguly and Sainis, 2001). It has also been used for the treatment of allergic rhinitis, cold, whooping cough, hay fever, hydrophobia, wounds, ulcers, dyspepsia, flatulence, hemorrhoids, gout, viti ated conditions of vata, and arthritis (Shivpuri et al., 1977; Thomas, 2006).

It has reputation as an alternative and as a blood purifier. The roots are said to possess bacteriostatic properties and have been suggested to be a good natural preservative of food. The roots and leaves are also reported to be used in hydrophobia (Anonymous, 1976). The leaves are employed to destroy vermin. T. indica may be given in rheumatic and gouty pains.

Apart from these above mentioned qualities, it is also used as good remedy in traditional medicine as anti-psoriasis along with the following activities.

Antispasmodic action: Singh (2005) reported that standardized extract of T. indica produces a non-specific antispasmodic action on isolated tissues with a fall of blood pressure and prolonged relief in bronchial asthma (Haranath and Shyamalakumari, 1975).

Antiallergic activity: Tylophora may improve immunity by stimulating the immune cells that destroy allergy-causing substances, while controlling the allergy antibody's (called immunoglobulin E/IgE) that contribute to allergic reactions. Pharmacologically, it is proven that the alkaloid tylophorine isolated
from *T. indica* produces antiallergic activity, which is comparable to that of disodium cromoglycate on perfusion of sensitized rat lungs. The action of Tylophora may be due to direct bronchodilator property and membrane stabilizing and immune-suppressive effects (Nayampalli et al., 1977; Sunanda et al., 1979).

**Effect on CNS:** Tylophorine produces depression of the central nervous system (CNS); the extract and the total alkaloids produce myocardial depression and a fall of blood pressure in near lethal doses. Preliminary toxicity study of *T. indica* at the dose of 0.5 ml/10 g on mice shows no observable effect on morality (Singh and Verma, 1984).

**Anti-Inflammatory action:** Alkaloid tylophorine is able to interfere with the action of mast cells, which are key components in the process of inflammatory action. Laboratory research has shown this isolated plant extract exerts a strong anti-inflammatory action. Tylophora may also relieve inflammation by blocking the mast cell release of histamine and other pro-inflammatory effects. These actions seem to support its traditional use as an anti-asthmatic and anti-allergic medication by traditional healers. According to Bone (1996), the dose should not exceed 200-400 mg dried leaf powder per day or 1 to 2 ml of tincture per day for the treatment of asthma (Patel et al., 2008).

**Cellular immune response:** The plant shows inhibitory effect on cellular immune response such as contact sensitivity, delayed hypersensitivity (DTHR) and indirectly suppressing IgE activity. Crude extract of *T. indica* was examined for its immunosuppressive activity to assess whether the plant immunomodulation is humoral or cell mediated. The extract was found to be effective in attenuating DTHR via both immunization and post antigen treatment. Tylophora extract dampens the inflammation cascade by direct effect on mast cell degranulation and T-cell mediated responses, while indirectly by suppressing IgE activity. Due to this effect, the cytokine activity would be significantly reduced this being for specific use in the inflammatory condition of asthma, contact dermatitis, asthma and systemic anaphylaxis (Ganguly and Sainis, 2001).

The other aspect of the extract’s ability is to reduce inflammation in dinitrofluorobenzene induced contact sensitivity in mice. The preparation was found to significantly reduce contact inflammation, when the mice were pretreated via oral administration (Sarris and Flaherty, 2002).

**Antitumor activity:** The leaf extracts act as antitumor (Stephen and Vijayammal, 2000). Their molecular mechanisms of action of antitumor activity include inhibitory effect on protein synthesis and nucleic acid synthesis (Gao et al., 2004). In tests with Tylophora extract, both adrenal weight and plasma steroid levels increased. Use of Tylophora alkaloids for the preparation of medicament for treating tumours involves inhibition of growth of both animal and human tumor cells by upregulating proapoptotic proteins, trail receptor and downregulating antiapoptotic protein.

**Antidiarrhoeal activity:** An investigation with alcoholic and aqueous extracts of roots of *T. indica* for their antidiarrhoeal activity was carried out in rodents, in which AQR showed beneficial effects in the treatment of diarrhoea. The effect of ALRT and AQR may be due to the inhibition of prostaglandin biosynthesis, with decrease in the peristaltic movement (Patel et al., 2006).

**Antimicrobial activity:** Phytochemical studies revealed the presence of alkaloids, phenols, flavonoids, tannins, sterols, saponins, are responsible for the antimicrobial activity against the majority of microorganisms, such as *E. coli*, *S. aureus*, *Panicum chrysosporum*, *Fusarium spp.*, *Aspergillus spp.*, *Salmonella* etc. Hence, it is concluded that these plants would serve as sources of novel antimicrobial agents (Reddy, 2009).

**Hepatoprotective activity:** There is a paucity of scientific evidence regarding its usage in liver disorders. Gujrati et al. (2007) investigated the hepatoprotective activity of alcoholic and aqueous extracts of leaves of *T. indica* against ethanol-induced hepatotoxicity in rats. *T. indica* leaf extracts possess a protective effect against ethanol-induced hepatotoxicity in rats, as evidenced by the physical, biochemical, functional and histological parameters.

The extract of plant has shown good smooth-muscle relaxant activity in *vitro*. In *vivo* testing established antihistamine and hypotensive activities of the extract and also antitumour activity in the L 1210 and P 388 lymphocytic leukemia test system (Hatanath and Shyamalakumari 1975). The
anticancer activity of Tylophora alkaloids has been reviewed. The marginal antitumor activity in active systems, narrow spectrum of activity, and toxicity encountered in the brief clinical study conducted have discouraged further consideration of Tylophora alkaloids for the development of anticancer drugs (Suffness and Cordella, 1985).

**Antioxidant activity:** The extract of this plant has shown significant antioxidant activity (Malathi and Gomez 2007; Gujrati et al., 2007). Its protective competence can be compared favorably with the effects of the chelating agent EDTA and with those of the natural antioxidant vitamin E. These results suggest that Tylophora is a plant having potent antioxidant activity.

**Toxicity of plant:** Besides having positive advantages in various therapeutic functions, it may produce some side effects like drowsiness or giddiness (Gupta et al., 1979). Loss of taste for salt, mouth pain, upset stomach, temporary nausea and vomiting are some other side effects. Tightness in throat or chest, chest pain, skin rashes or itchy or swollen skin may occur in some cases. Earlier studies showed that extract of Tylophora is toxic only in extremely high doses; these extracts were apparently safe in the smaller doses, needed to produce a therapeutic effect.

Patients using Tylophora may experience temporary nausea and vomiting, soreness of the mouth, and loss of taste for salt, particularly with the fresh leaf and tincture. The herb’s safety for use during pregnancy and breast-feeding has not been established. In large doses, the dried leaves may cause fatal poisoning.

Keeping in view its enormous worth in various sectors, a literature survey has been made to review about Tylophora indica concerning its major research work done by various researchers regarding regeneration, biochemical estimation and bioassays of the isolated compounds in Table 2.

In addition to Tylophora indica, there are lots of Indian herbs that are commonly used as anti-asthmatic herbs. However, major anti-asthmatic herbs, their families, botanical and common names are mentioned in the Table 3.

**Future prospects:** The plant has immense importance in all the available systems of medicine in India, due to which it has been harvested indiscriminately from its natural habitat and poses a serious threat to its existence in the wild natural form. At the same time, lack of proper cultivation practices has made its deficiency in nature.

Further, propagation either by seeds or vegetative cuttings is rather difficult. Stem cuttings failed to produce proper roots, when treated with different growth regulators. T. indica is rapidly disappearing and is now listed as one of the plant species in India vulnerable to extinction. Therefore, it is necessary to devise a method for its regeneration at commercial scale of this endangered species. Otherwise important part of our natural wealth will disappear like this, so it’s a matter of great concern that such type of plants should be conserved at any cost by hook or by crook. However, authors have made attempts to explore this plant in *in vitro* conditions and published the protocols. We have also been able to produce successful regeneration protocol in *in vitro* conditions.

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