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Editorial

Review article on *Calotropis* (Wara): Is it a miracle shrub or just a plant?

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Apocynaceae Juss. (The Angiosperm Phylogeny Group, 2016) commonly called as the dogbane family, comprises 357 genera and about 5100 species (Nazar et al., 2013) of flowering plants including herbaceous or shrubby climbers (Wong et al., 2013; Chan et al., 2016: Lu et al., 2014). The *Calotropis* (Wara, hela-wara in Sinhala and errukalai, manakkovi, mannakovi, urkkovi in Tamil) which is a small genus belongs to this family consisting of two species, *Calotropis gigantea* (L.) R. Br. and *C. procera* (Aiton) Dryand. *Calotropis* is a succulent and xerophytic shrub or small laticiferous tree up to 2.5 m, commonly known as "milkweed" or "Crown flower" (Kumar et al., 2011; Hindi, 2013; Wong et al., 2013; Muriira et al., 2015; Moustafa and Sarah, 2017). The stem usually simple and branched at the base, woody covered with a corky bark, leaves simple, opposite, sub-sessile, white and purple-colored flowers and not scented (Sharma, 2011; Joseph et al., 2013). Inflorescence is a dense, multi-flowered, umbellate cyme, highly cross-pollinated through insects such as monarch butterflies, simple, follicle fruit (Endress et al., 2007; Joseph et al., 2013). Following figure shows the purple and white colored flowers and follicle fruit of *Calotropis* found in Sri Lanka. *Calotropis* species are most diverse in tropical and subtropical parts of Asia and South East Asia (Bangladesh, Cambodia, Burma, China, India, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand) and extend into temperate areas (Nasser et al., 2012; Nazar et al., 2013). *Calotropis* is a versatile tree used for different purposes. The importance of *Calotropis* can be explained: (a) uses of the plant in traditional medicine (b) research performed on the isolation of compounds and their scientific value (c) commercial values of the plant.

(a) Uses of the plant in traditional medicine

Calotropis is planted as a medicinal plant in Malaysia (Wong et al., 2013). Not only in Sri Lanka (Solohokara et al., 2015) but also in other countries, like India (Meena et al., 2010; Kumar et al., 2010a; Gaur et al., 2013; Joseph et al., 2013; Harsimran and Shikha, 2015) Bangladesh (Haque et al., 2012) almost all parts of the plant (leaf, bark, root, latex, flower etc.) are used for treatment of a number of diseases or cure several illnesses such as toothache, caries, ear ache, stings, sprain, ringworm, syphilis, anxiety, rheumatism, pain, epilepsy, leprosy, diarrhoea, skin diseases, boils and sores, ulcers, piles, malaria, rheumatism, mental and dental disorders and several other ailments of spleen and liver (Sharma and Sharma, 2000; Setty et al., 2007; Bharti et al., 2010; Singh, 2002; Gaur et al., 2013; Aarti, 2014). Analgesic activity, pro-coagulant activity, wound healing activities have been observed (Qari, 2008; Kumar et al., 2010b; Kumar et al., 2011; Meena et al., 2010; Pandey et al., 2016; Gaur et al., 2013; Joseph et al, 2013; Aarti, 2014). The powdered flowers are given for coughs, colds and asthma (Gaur et al., 2013). The crushed and warmed leaves are applied on burns, headaches and rheumatic pains, used as a tincture for intermittent fever, used as a tonic, used as a purgative in small doses, used as an emetic in larger doses, (Gaur et al., 2013, Chitme et al., 2005; Saratha et al., 2009).

In Bangladesh by folk medicinal practitioners use leaves for treatment of high blood sugar and pain. Research carried out by Haque et al., (2012) strongly showed that of leaves of *C. gigantea* is a potential source of obtaining newer anti-hyperglycemic and anti-nociceptive drugs for treatment of pain and high blood sugar levels in diabetic patients. The roots of

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the plant is reported to have properties of pregnancy interceptive (Srivastava et al., 2007).

(b) Research performed on the isolation of active compounds and their scientific value

Antimicrobial activity of latex against pathogenic microorganisms (Kumar et al., 2010a; Kumar et al., 2011; Kovendan et al., 2012; Gaur et al., 2013). *In vitro* antimicrobial activity of the aqueous extract of the *C. gigantea* against *Staphylococcus aureus*, *Escherichia coli*, *Bacillus cereus*, *B. subtilis*, *Pseudomonas aeruginosa*, *Micrococcus luteus*, *Klebsiella pneumonia*, *Salmonella typhi* and *Micrococcus luteus* strains has been conducted and the extract has been shown significant effect on the tested organisms (Kumar et al., 2010a, b, c; Aarti, 2014). The antifungal activity of *C. gigantea* was also reported in some studies and it provides an important option for the biological control of *Fusarium mangiferae*, a plant pathogenic fungus that causes serious threat in mango cultivation in various countries (Usha et al., 2009). Antifungal activity and lethal effect of *Aspergillus terreus*, A. *flavus*, A. *niger*, A. *fumigates* have been studied (Qari, 2008). *C. gigantea* is scientifically reported for its anti-Candida activity (*Candida albicans*, C. *parapsilosis*, C. *tropicalis* and C. *krusei* - Aarti, 2014). Latex of *Calotropis* can be applied over the infected area. This could be used in swellings or rat bitten areas or other disorder infected area.

Cytotoxic effect on several human cancer cell lines (Ramos et al., 2006; Bekhit et., 2008; Kumar et al., 2011; Quazi et al, 2013; Aarti, 2014), chromosomal aberrations and genotoxicity of *Allium cepa*, *Vicia faba* (Qari, 2008), antipyretic activity (Gaur et al., 2013; Aarti, 2014; Pandey et al., 2016), insecticidal activity (Sharma et al., 2016), anti-oxidant activities (Sharma et al., 2011; Elakkiya and Prasanna, 2012; Aarti, 2014; Kazemipour et al., 2015), pro-coagulant activity (Gaur et al., 2013) have been reported. Anti-venom activity of *Calotropis gigantea* extract was evaluated against *Vipera russelli* snake venom. The roots of the plant are crushed and applied over the snake bitten area (Jain et al., 2011; Gaur et al., 2013; Aarti, 2014). The medicinal properties of this plant represents as a valuable source of medicinal compounds. In last few decades, *Calotropis* has been extensively studied for its medicinal properties with the aid of advanced scientific techniques. As a result of, a variety of bioactive compounds has been isolated from different parts of the plant and has analysed pharmacologically (Meena et al., 2010; Sharma et al., 2016). The latex can also be applied over the dental area for any tooth related problems, over the body to cure nerve disorders (Gaur et al., 2013). Latex contains alkaloids, tannins, gum, sugars, starch, resins and protein osmotin and lupeol (Aarti, 2014). The other plant parts contain cardiac glycosides, flavonoids, phenolic compounds, and terpenes/terpenoides alkaloids, tannins, saponins, flavnoid, steriods, terpeniods reducing sugars resins osmotin and etc. (Khan and Malik, 1989; de Freitas et al., 2011; Aarti, 2014; Mueen et al., 2015). Cardiac glycosides which is present in *Calotropis* have also proven anticancer properties (Van Quaquebek et al., 2005;), increased heart beats and heart contractions, increased the motility of smooth muscles, relaxing effect on the contracted skeletal muscles (Moustafa and Sarah, 2017).

Figure 1: **Purple coloured flowers, white coloured flowers and fruit of *C. gigantea***

Mosquitocidal, larvicidal and pupicidal properties of medically important mosquito vector species; *Anopheles stephensi*, *Aedes aegypti*, and *Culex quinquefasciatus* have been studied (Neraliya and

Srivastava, 1996; Moustafa and Sarah, 2017). A study revealed the ethanol extract of leaf of *C. gigantea* is an ideal eco-friendly approach for the control of vector (Kovendan et al., 2012). A decoction of leaf along with soap is an effective remedy for white ants (Ranade and Acharya, 2014). Stem of this plant possess hepato-protective effects as demonstrated by protection of liver of rats against carbon tetrachloride induced liver injury, effects against hepato-carcinogenesis without any harmful effects in treated animals (Wong et al., 2013). Toxic effect of *Calotropis* on the heart and testis of male albino rats has been tested, proven high toxicity and recommended the use of *Calotropis* as rodent control without leaving harmful chemical traces (Moustafa and Sarah, 2017).

(c) Commercial values of the plant

Due to its potential economic importance, *Calotropis* has been introduced to the Pacific Islands, Australia, as well as to Central and South America as an ornamental plant (Maji et al., 2013; Hindi, 2013; Joseph et al, 2013, Payal and Sharma, 2015). *Calotropis* stem and seed coat produces fine, white, silky, durable, strong, cylindrical, flexible and high-quality fibre which has created great interest in many countries for industrial applications; useful for making ropes, carpets, fishing nets, cheap cots, gunny bags, bow strings, in the manufacture of paper, pulp, duplicating stencils, sewing threads (Gaur et al., 2013; Muriira et al., 2015; Akhtar et al., 2014; Payal and Sharma, 2015; Priya et al., 2015). Strong inner bark fibres produce a binding material and are processed into fabrics. Due to presence of high quality fibre, fibre gene *CpTIP1*, isolated from the wild plant *Calotropis* and transferred into cotton variety NIAB-846 for one generation (Akhtar et al., 2014). The white, strong and silky floss which is from the fruit (seed capsules) is used as an inferior stuffing material in mattresses and pillows as well as for weaving into a strong cloths, shawls, handkerchiefs, packing material since it is too short and too light for spinning (Ranade and Acharya, 2014; Payal and Sharma, 2015). The floss may also substitute cotton wool for surgical purposes (Akhtar et al., 2014).

The seed oil can be used for soap, paint and making varnish and oil cake is used as manure (Ranade and Acharya, 2014). In Thailand, the flowers are used in wedding ceremonies, various floral arrangements in temples and in rosaries (Gaur et al., 201). Ruminant (sheep, goats, and camels) are fed with other feeds which are mixed with chopped leaves of *Calotropis* (Payal and Sharma, 2015). *Calotropis* is a good source of green manure which can help to improve soil water conditions and also acts as a soil binder and mulching (Gaur et al., 2013; Payal and Sharma, 2015; dos Santos et al., 2017; Fanish, 2017). Wood is used in making charcoal and cooking fuel (Gaur et al., 2013; Nasser et al, 2012; Hindi, 2013).

Plants often escape from cultivation, especially when growing on sandy soils (near to sea beaches and coastal areas). This precious plant is able to propagate and thrive in harsh conditions of heat, drought and poor soils, high salinity and water logging wastes, fallow lands, rubbish heaps, roadsides, sand dunes and arable lands in different environments (Meena et al., 2010; Hindi, 2013). Moreover, this plant has a high level of regeneration potential and could be harvested up to 4 times a year. *Calotropis* often self-sows freely on overgrazed land and has been used as an indicator of exhausted soil. Due to its ability to accumulate heavy metals, natural elements (Uranium) from different soils and an abandoned mining site, *Calotropis* has several ecological roles: serves as natural phytoremediation, improves the quality of soil, rehabilitates abandoned and exhausted lands and brings back life once again (Moustafa and Sarah, 2017).

The liquid latex, a rubber-like product can be used as a renewable source of valuable hydrocarbons and intermediate energy resources which may be utilized to convert into diesel substitutes (Erdman and Erdman 1981; Shilpkar, 2007: Moustafa and Sarah, 2017). Due to free from NOx gases, SO_2 and Suspended Particulate Matter (SPM) and high cetane value, the bio-diesel derived from *Calotropis* may be a good source of renewable energy (Payal and Sharma, 2015). Therefore, *Calotropis* may be a potential plant for bioenergy and biofuel production in these areas where *Calotropis* grow. (Payal and Sharma, 2015; Moustafa and Sarah, 2017).

Future areas of the research

As a conclusion, scientists, relevant authorities and other stakeholders have not paid attention on this wonderful and amazing plant present in Sri Lanka. Therefore, further researches are necessary to elucidate the phytochemical and pharmacological aspects of this plant to look forward the therapeutic aspects, development of new drugs from *Calotropis* for the control and combat the various diseases. Because of its high adaptability to severe environments, invading abilities, researchers consider this valuable plant as a weed or an invasive plant and are looking for controlling strategies. Instead of destroying, considering the numerous benefits and

products of the plant in different facets (eco-friendly solutions to pollution, to fulfil the demand of fibre for textile industry, energy limitation and habitat degradation problems, etc.), this valuable and fast-growing tree species can be utilized to overcome these problems.

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