An update on Shankhpushpi, a cognition-boosting Ayurvedic medicine

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Abstract: Shankhpushpi is an Ayurvedic drug used for its action on the central nervous system, especially for boosting memory and improving intellect. Quantum of information gained from Ayurvedic and other Sanskrit literature revealed the existence of four different plant species under the name of Shankhpushpi, which is used in various Ayurvedic prescriptions described in ancient texts, singly or in combination with other herbs. The sources comprise of entire herbs with following botanicals viz., Convolvulus pluricaulis Choisy, (Convolvulaceae), Evolulus alsinoides Linn. (Convolvulaceae), Clitoria ternatea Linn. (Papilionaceae) and Canescora decussata Schult. (Gentianaceae). A review on the available scientific information in terms of pharmacognostical characteristics, chemical constituents, pharmacological activities, preclinical and clinical applications of controversial sources of Shankhpushpi is prepared with a view to review scientific work undertaken on Shankhpushpi. It may provide parameters of differentiation and permit appreciation of variability of drug action by use of different botanical sources.

Keywords: Convolvulus pluricaulis; Evolulus alsinoides; Clitoria ternatea; Canescora decussata; medicine, Ayurvedic; cognition disorders

高提高认知能力的印度传统草药土丁桂

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摘要: 土丁桂属草药是作用于中枢神经系统的印度传统药物，特别是对促进记忆和改善智力有较好疗效。从印度传统医学和梵文文献中提取的大量信息提示，冠以土丁桂属草药名称的植物类别共4种：旋花科田旋花、旋花科土丁桂、蝶形花科蝴蝶花豆和龙胆科穿心草。这些草药名称均在古代文献中有所记载，可单独使用或与其他药材组合成各种草药处方。本文就现有的科学信息，如土丁桂属不同植物来源物种的药理学特征、化学成分、药理作用、临床前及临床应用等方面进行综述，以期为科学地应用土丁桂提供依据。此外，还可根据不同植物来源土丁桂草药的不同疗效进行鉴别应用。

关键词：旋花科田旋花；旋花科土丁桂；蝶形花科蝴蝶花豆；龙胆科穿心草；医学；印度传统；认知障碍

Ayurveda is the oldest medical science in the Indian subcontinent and has been practiced since the 12th century BC. Its objective is to accomplish physical, mental, social and spiritual well-being by adopting preventive, health promoting and holistic approach towards life(1). Drugs acting
on the central nervous system (CNS) are among the first to be discovered by the primitive human and are still the most widely used group of pharmacological agents. The CNS acting drugs are invaluable therapeutically, because they can produce specific physiological and psychological effects. From the vast array of materia medica of the indigenous system, many plants have been reported to have activity against CNS disorders and thus act as very useful remedies for the alleviation of human suffering\(^2\). Various attempts have been made to counter the aversive effects of stress, ranging from yoga and meditation to anti-stress drugs. However, despite claims to the contrary, these non-pharmacological and pharmacological methods appear to have limited utility\(^5\).

An answer to this perplexing problem of countering stress-induced perturbations of physiological homeostasis came from the plant kingdom\(^4\). With the advent of newer techniques for chemical characterization and pharmacological investigations, plant-based drugs are receiving much attention. The importance of plants acting on CNS has been reviewed, and the role of adaptogens from plant origin has been emphasized\(^2\).

Memory (cognition) is a recollection of that which has been experienced once or learnt. Memory may be defined as mental information system consisting of encoding, storage and retrieval\(^6\). Memory is the ability of an individual to record sensory stimuli, events, information, etc., retain them over short or long periods of time and recall the same at a later date when needed. Aging and Alzheimer’s disease (AD) leading to memory loss has emerged as a major concern of modern scientists. Amnesia means loss of memory. There are many different types of amnesias according to their cause. Functional amnesia refers to memory disorders that seem to result from psychological trauma, not an injury. Organic amnesia involves memory loss caused by specific malfunctions in the brain. Another variant is infantile amnesia, which refers to the fact that most people lack specific memories of the first few years of their life. AD is a chronic and progressive neurodegenerative disease which is characterized symptomatically by progressive deterioration of the activities of daily living, behavioral disturbances and cognitive loss\(^2\). Involvement of brain cholinergic activity has been recognized in memory loss. Among the possible strategies for enhancing brain cholinergic activity, acetyl cholinesterase inhibitors (AChEIs) have been used most extensively for the symptomatic treatment of AD. Physostigmine and tacrine are the only AChEIs reasonably evaluated in AD patients, even though their use is limited by the short half-life and peripheral cholinergic side-effects of physostigmine, and the dose-dependent hepatotoxicity of tacrine\(^8\). Various mechanisms have been postulated from time to time for memory. Fortunately, basic research during the past 25 years has begun to define a chemistry of brain plasticity, which is suggesting new gene targets for the discovery of memory enhancers\(^6\).

In Ayurvedic literature, medicinal plants from more than one botanical source have been employed for a single entity raising controversy as to correct identity of a drug. The availability of the plant in usage of particular region has forced the practitioners to substitute with nearly similar pharmacological or therapeutic action. Many of the traditional systems have records where one common vernacular name is applied to plants with two or more entirely different plant species\(^4\). Our studies on Ayurvedic plants reveal that although the botanical source of an Ayurvedic medicine may differ, the basic pharmacological category is not inconsistent. It may be that during the process of development of Ayurveda, the Vaidya practicing it in different regions of the subcontinent may have found substitutes which replaced the original plant drug.

1 Shankhpushpi

Shankhpushpi is considered as Medhya Rasayana in Ayurvedic texts. Shankhpushpi of Ayurvedic Pharmacopoeia of India consists of whole plant of *Convolvulus pluricaulis* Choisy (CP, Convolvulaceae) (Syn: *Convolvulus microphyllus* Sieb. ex Spreng.)\(^2\). Plants other than *Convolvulus pluricaulis* are used as sources of drug in different parts of the country, and *Evolvulus alsinoides* Linn. (EA, Convolvulaceae) is also used as Shankhpushpi by some practitioners. Other plants e.g. *Clitoria ternatea* Linn. (CT, Papilionaceae) and *Canscora decussata* Schult. (CD, Gentianaceae) are also used as Shankhpushpi by some practitioners\(^3\). Whatever is the source, the drug finds the use for its therapeutic effects on CNS disorders like insanity, epilepsy, nervous debility and memory enhancement\(^4\). Many formulas containing Shankhpushpi as a single drug or in combination with other drugs are available in Indian market and Shankhpushpi is vigorously advertised for memory enhancement in print and electronic media in India.

1.1 Traditional medicinal uses Shankhpushpi is a reputed drug of Ayurveda and reported as a brain tonic, nerve tonic, alternative and laxa-
tive\textsuperscript{[21, 22]}. It has also been found effective in anxiety and neurosis, due to its clinical anti-anxiety effects and improved mental function highly esteemed by ancient Indian physicians as a wonderful nerve tonic & memory invigorator and used in cerebral abnormalities, epilepsy, insomnia, burning sensation, oedema, urinary disorders, snake-bites and disease caused by evil spirits. It is best tonic for brain and nerves and is also recommended for sexual & seminal debilities\textsuperscript{[23]}. Shankpushpi is found to be one of the ingredients in majority of the formulas available in market like Dimagheen (Dawakhana Tibiya College), Shankpushpi syrup (Unjha), Shankhavali Churna (Narnayan Pharmacy), BR-16A (Himalaya Drug. Co. Ltd.) etc., which were prescribed as brain tonics in Ayurvedic system of medicine.

According to Ayurveda, Medhya can promote intellectual capacity; Swarararini can improve voice; Grahabhootadi dosaghni is useful in diseases of supernatural origin; Rasayani can rejuvenate the body; Kantida can enhance the aura of body and give it a healthy look; Majjadhatu rasayana can rejuvenate the nervous tissue; Unmadagina can alleviate insanity and emotional instability; Vrishya is an aphrodisiac; Pachanbala can increase the strength of the digestive system; Chedana is a laxative; Nidrajnana can promote sleep. Besides this, Shankpushpi can improve digestion, prevent water retention, borborygmus and constipation. It is specifically beneficial where digestion is upset because of nervousness and anxiety (Unpublished). The classification of Shankpushpi\textsuperscript{[24]} was shown in Table 1.

<table>
<thead>
<tr>
<th>Taxonomic hierarchy</th>
<th>E. alsinooides</th>
<th>C. pluriaculis</th>
<th>C. ternatea</th>
<th>C. decussata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingdom</td>
<td>Plantae</td>
<td>Plantae</td>
<td>Plantae</td>
<td>Plantae</td>
</tr>
<tr>
<td>Sub-kingdom</td>
<td>Tracheobionta</td>
<td>Tracheobionta</td>
<td>Tracheobionta</td>
<td>Tracheobionta</td>
</tr>
<tr>
<td>Super-division</td>
<td>Spermatophyta</td>
<td>Spermatophyta</td>
<td>Spermatophyta</td>
<td>Spermatophyta</td>
</tr>
<tr>
<td>Division</td>
<td>Magnoliophyta</td>
<td>Magnoliophyta</td>
<td>Magnoliophyta</td>
<td>Magnoliophyta</td>
</tr>
<tr>
<td>Class</td>
<td>Magnoliopsida</td>
<td>Magnoliopsida</td>
<td>Magnoliopsida</td>
<td>Magnoliopsida</td>
</tr>
<tr>
<td>Sub-class</td>
<td>Asteridae</td>
<td>Asteridae</td>
<td>Rosidae</td>
<td>Asteridae</td>
</tr>
<tr>
<td>Order</td>
<td>Solanales</td>
<td>Solanales</td>
<td>Fabales</td>
<td>Gentianales</td>
</tr>
<tr>
<td>Family</td>
<td>Convolvulacea</td>
<td>Convolvulacea</td>
<td>Fabaceae</td>
<td>Gentianaceae</td>
</tr>
<tr>
<td>Genus</td>
<td>Evolvulus</td>
<td>Evolvulus</td>
<td>Citorea</td>
<td>Canscora</td>
</tr>
<tr>
<td>Species</td>
<td>alsinooides</td>
<td>pluriaculis</td>
<td>ternatea</td>
<td>decussata</td>
</tr>
</tbody>
</table>

Table 1: Taxonomic classification of Shankpushpi

1.2 Geographical distribution Of the four species most commonly associated with the Sanskrit names Shankpushpi and vishnukranti, CD is native to southern India, Sri Lanka, tropical Africa, and Southeastern Asia\textsuperscript{[14, 25]}. CP is known from the margins and within the Sahara and Sind deserts, a distribution that Sáad called “Saharo Sindian”. In India it is widely distributed in and grows on the waste land in the plains of Punjab, Bihar and Chhotanagpur\textsuperscript{[26, 27]}. CT is cultivated throughout India, but is naturalized in the more tropical regions\textsuperscript{[28]}. EA is naturalized widely in India and elsewhere\textsuperscript{[28-34]}.

1.3 Pharmacognostical profile The pharmacognostical profile of Shankpushpi\textsuperscript{[12, 14, 15, 19, 20, 35-42]} is shown in Table 2.

1.4 Phytochemical profile The phytochemical profile of Shankpushpi is shown in Table 3 and Table 4.

1.5 Structures of chief secondary metabolites The chemical structures of chief secondary metabolites are shown in Figure 1\textsuperscript{[177]}, Figure 2\textsuperscript{[39-43, 70]}, Figure 3\textsuperscript{[180]} and Figure 4 to 6.

1.6 Pharmacological activities The pharmacological activities of Shankpushpi are shown in Table 5.

2 Pre-clinical and clinical applications of Shankpushpi

2.1 Evolvulus alsinooides

2.1.1 Toxicology Ayurvedic medicine regards EA highly for its effect on CNS. Moderate doses (200 mg/kg) of the alcoholic extract of EA caused drowsiness, stupor and less mobility in albino mice; higher doses were neither toxic nor lethal. Laboratory studies revealed the herb as anti-catatonic and a CNS depressant with a median lethal dose (LD\textsubscript{50}) of 450 mg/kg\textsuperscript{[184, 185]}.

2.1.2 Learning behavior and memory enhancement activity in rodents The ethanolic extract has been shown to improve learning and memory and it significantly reversed the amnesia induced by scopolamine. EA also exhibited potent memory-enhancing effects in the step-down and shuttle-box avoidance paradigms. Nootropic activity was assessed with passive and active avoidance paradigms using Cook and Weidley’s pole climbing apparatus and elevated plus maze as models\textsuperscript{[182]}.
<table>
<thead>
<tr>
<th>Evaluated characteristics</th>
<th>E. alismoides</th>
<th>C. pluricaulis</th>
<th>C. ternatea</th>
<th>C. decussata</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Habit</strong></td>
<td>Diffuse, perennial herb</td>
<td>Prostrate, perennial herbs</td>
<td>Ornamental perennial climber</td>
<td>Erect, branching, annual herb</td>
</tr>
<tr>
<td><strong>Stem structure</strong></td>
<td>8–10 branches, from central stock (35–40 cm)</td>
<td>Several prostrate stems (10–30 cm)</td>
<td>20–45 cm, splintery, fibrous</td>
<td>20–60 cm, opposite decussate branches</td>
</tr>
<tr>
<td><strong>Surface</strong></td>
<td>Pubescent</td>
<td>Clothed with silky hairs</td>
<td>Smooth</td>
<td>Glabrous</td>
</tr>
<tr>
<td><strong>Internodes</strong></td>
<td>7–10 mm</td>
<td>10–12 mm</td>
<td>6–13 cm</td>
<td>Usually 3.5–4.5 cm, up to 6.2 cm</td>
</tr>
<tr>
<td><strong>Taste</strong></td>
<td>Tasteless</td>
<td>Tasteless</td>
<td>Bitter</td>
<td>Bitter</td>
</tr>
<tr>
<td><strong>Outline in T. S.</strong></td>
<td>Terete, wings absent</td>
<td>Terete, wings absent</td>
<td>Terete, wings absent</td>
<td>Annular with four wings</td>
</tr>
<tr>
<td><strong>Cuticle</strong></td>
<td>Ridged</td>
<td>Striated</td>
<td>Ridged</td>
<td>Ridged</td>
</tr>
<tr>
<td><strong>Trichomes covering</strong></td>
<td>Present, unequally bihormed</td>
<td>Present, conical, unicellular</td>
<td>Present, with two basal cells, multilayered</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Glandular</strong></td>
<td>Present, stalk unicellular, head multilayered (8–10 cells in 2–4 tiers)</td>
<td>Present, stalk unicellular, head multilayered</td>
<td>Present, stalk multilayered, head unicellular</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Chlorenchyma</strong></td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Collenchyma</strong></td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Endodermis</strong></td>
<td>Indistinct</td>
<td>Indistinct</td>
<td>Indistinct</td>
<td>Distinct</td>
</tr>
<tr>
<td><strong>Pericyclic fibers</strong></td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Phloem fibers</strong></td>
<td>Absent</td>
<td>Present in old stem only</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Pith</strong></td>
<td>Core hollow, cells pitted in older stem</td>
<td>Often an angular hollow, pitted with sloping end</td>
<td>Intact, cells pitted when mature</td>
<td></td>
</tr>
<tr>
<td><strong>Leaf structure</strong></td>
<td>Alternate</td>
<td>Alternate</td>
<td>Opposite</td>
<td>Opposite decussate</td>
</tr>
<tr>
<td><strong>Phyllotaxy</strong></td>
<td>Elliptic-oblong</td>
<td>Linear, lower Oblanceolate, upper elliptic</td>
<td>Impari-pinnate, ovate or oblong</td>
<td>Oblong, lanceolate</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>(8–12) mm × (5–7) mm</td>
<td>(12–28) mm × (5–10) mm</td>
<td>(2–5) cm × (1–2) cm</td>
<td>(25–38) mm × (8–15) mm</td>
</tr>
<tr>
<td><strong>Apex</strong></td>
<td>Mucronate</td>
<td>Obtuse-mucronate</td>
<td>Mucronate</td>
<td>Acute</td>
</tr>
<tr>
<td><strong>Surface</strong></td>
<td>Pubescent</td>
<td>Hairy</td>
<td>Hairy</td>
<td>Glabrous</td>
</tr>
<tr>
<td><strong>Midrib</strong></td>
<td>Outline in T. S.</td>
<td>Plano-convex, dorsal bulge prominent</td>
<td>Concavo-convex</td>
<td>Concavo-convex, dorsal bulge irregularly lobed</td>
</tr>
<tr>
<td><strong>Collenchyma</strong></td>
<td>Present on either side</td>
<td>Present beneath upper epidermis</td>
<td>—</td>
<td>Absent on either side</td>
</tr>
<tr>
<td><strong>Calcium oxalate</strong></td>
<td>Present as rosette</td>
<td>Plenty, along veins</td>
<td>Prismatic crystal along veins</td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Lamina</strong></td>
<td>Isobilateral, palisade in 2 layers on either side</td>
<td>Isobilateral, palisade in 3 and 2 layers beneath upper and lower epidermis respectively</td>
<td>Dorsiventral, palisade in either side</td>
<td>Dorsiventral, palisade in 1 layer</td>
</tr>
<tr>
<td><strong>Cuticle</strong></td>
<td>Striated</td>
<td>Striated</td>
<td>Striated, heavy</td>
<td>Ridged</td>
</tr>
<tr>
<td><strong>Trichomes</strong></td>
<td>Present, similar as in stem</td>
<td>Present, similar as in stem</td>
<td>Present, similar as in stem</td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Stomata</strong></td>
<td>Both anisocytic and para-cyclic types on either side</td>
<td>Both anisocytic and paracytic types on either side</td>
<td>Subcoriaceous, rubicaceous stomata with wavy cells present on both side</td>
<td>Anisocytic, upper epidermis has a few stomata</td>
</tr>
<tr>
<td><strong>Quantitative analysis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stomatal number</strong></td>
<td>280–328–405</td>
<td>202–216–238</td>
<td>291–342–411</td>
<td>Very few</td>
</tr>
<tr>
<td><strong>Lower surface</strong></td>
<td>14.5–15.5–16.5</td>
<td>17.0–18.0–19.9</td>
<td>16.9–19.0–19.1</td>
<td>Very few</td>
</tr>
<tr>
<td><strong>Vein-islet number</strong></td>
<td>15.7–17.0–18.7</td>
<td>13.8–15.8–16.9</td>
<td>14.8–16.3–17.2</td>
<td>16.9–21.0–24.6</td>
</tr>
<tr>
<td><strong>Extractive value (w/w, %)</strong></td>
<td>18.80</td>
<td>17.08</td>
<td>18.21</td>
<td>10.00</td>
</tr>
<tr>
<td><strong>Alcohol soluble</strong></td>
<td>18.20</td>
<td>14.04</td>
<td>16.14</td>
<td>13.92</td>
</tr>
</tbody>
</table>
Table 3  Different phytochemical features of controversial sources of Shankhpushpi (Part 1)

<table>
<thead>
<tr>
<th>Phytochemistry</th>
<th>E. alsinosides</th>
<th>C. plarcuicus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td></td>
<td>D-glucose, maltose, rhamnose, sucrose, starch and other carbohydrate(43-45),</td>
</tr>
<tr>
<td>Proteins and amino acids</td>
<td>Ergot alkaloids(46, 52).</td>
<td>Proteins and amino acids</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>Betaine, shankhpushpigne and evolvine(24-27), Tropane</td>
<td>Only convolamine has been identified, but other</td>
</tr>
<tr>
<td></td>
<td>alkaloids(16).</td>
<td>alkaloids (convoline, convolide, convolene, confole, convoxine, etc.) were</td>
</tr>
<tr>
<td></td>
<td></td>
<td>found in other species from this family(19-41). The plant contains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>alkaloid shankhpushpigne (C17H21NO2), melting point from 162 °C to 164</td>
</tr>
<tr>
<td>Fatty acids/Volatile oil/</td>
<td>Fresh plant contains volatile oil. It also contains a yellow neutral fat, an</td>
<td>C. plarcuicus</td>
</tr>
<tr>
<td>Fixed oil</td>
<td>organic acid and saline substances. An unidentified compound has been isolated(42)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stearic, oleic, linoleic acid with magnesium phosphate. Palmitic, 8-hydroxydecanoic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>acids and heptadecanoic acids have been reported(51, 52).</td>
<td></td>
</tr>
<tr>
<td>Phenolics/Glycosides/</td>
<td>Scopeolitin, scopolin, umbelliferone, 2-methyl-1, 2, 3, 4-butaneol, ferulic</td>
<td>Deshpande &amp; Srivastava (1969) carried out a</td>
</tr>
<tr>
<td>Triterpenoid/Steroids</td>
<td>acid esters with alcohols C14-C17, 2, 3, 4-trihydroxy-3-methylbutyl 3-[3-hydroxy-2-</td>
<td>chemical examination of the whole plant of C.</td>
</tr>
<tr>
<td></td>
<td>(2, 3, 4-trihydroxy-2-methylbutoxy) phency-1]-2 propionate and 1, 3-di-O-caffeoyl</td>
<td>plarcuicus and reported the presence of</td>
</tr>
<tr>
<td></td>
<td>quinic acid methyl ester, caffeic acid, 5-ethoxy-7-O-β-glucopyranoside</td>
<td>scopoletin, β-sitosterol and eeryl alcohol(52).</td>
</tr>
<tr>
<td></td>
<td>coumarin, 2-C-methyl erythritol, kaempferol 7-O-β-glucopyranoside, kaempferol</td>
<td>Chloroform fraction of this contains 20-</td>
</tr>
<tr>
<td></td>
<td>3-O-β-glucopyranoside and quercetin-3-O-β-glucopyranoside were reported from</td>
<td>oxodotricotanol, tetratrioxoacetonic acid and 29-</td>
</tr>
<tr>
<td></td>
<td>n-BuOH soluble fraction from the ethanol extract of E. alsinosides(56, 77).</td>
<td>oxodotricotanol, flavonoid-komperol, steroids-phytosterols, β-sitosterol(82),</td>
</tr>
<tr>
<td></td>
<td>Pentriaconta, triaconta and β-sitosterol are found in petroleum ether extract(57),</td>
<td>CP-1, a phytocemical marker has been isolated and</td>
</tr>
<tr>
<td></td>
<td>flavonols, flavonoids, saponins, the alkanes, phenolics, and tanins(24-51, 78-82).</td>
<td>characterized by HPTLC technique(82). Estimation of scopoletin by HPTL in CP</td>
</tr>
<tr>
<td></td>
<td>EA-1, a phytochemical marker has been isolated by preparative</td>
<td>and its formulation(82, 83). Estimation of scopoletin by</td>
</tr>
<tr>
<td></td>
<td>TLC and characterized by IR, FAB-MS, NMR and elemental analysis techniques(42).</td>
<td>spectrofluorimetry(42).</td>
</tr>
<tr>
<td></td>
<td>Estimation of scopoletin by spectrofluorimetry(42).</td>
<td></td>
</tr>
<tr>
<td>Plant growth regulator</td>
<td>Phytorehormones(42)</td>
<td></td>
</tr>
</tbody>
</table>

Table 4  (To be continued) Different phytochemical features of controversial sources of Shankhpushpi (Part 2)

<table>
<thead>
<tr>
<th>Phytochemistry</th>
<th>C. ternate</th>
<th>C. decussata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>Water-soluble mucilage, delphinidin 3, 3, 5-triglucoseidis(46),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oligosaccharides or flutulins(47).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Muclage contains anhydro-agatam, anhydropentosan and methyl-pentosan(48).</td>
<td></td>
</tr>
<tr>
<td>Proteins and amino acids</td>
<td>Amino acids and amides(312), characterization of amino acid(32), Protein</td>
<td></td>
</tr>
<tr>
<td></td>
<td>timon and three unidentified trypsin inhibitors(32).</td>
<td></td>
</tr>
<tr>
<td>Fatty acids/Volatile oil/</td>
<td>Palmitic, stearic, oleic, linoleic, and linolenic</td>
<td></td>
</tr>
<tr>
<td>Fixed oil</td>
<td>acids(79-81), The seeds yield a greenish-yellow fixed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>oil(92).</td>
<td></td>
</tr>
</tbody>
</table>
Table 4 (Continuation) Different phytochemical features of controversial sources of Shankhpushpi (Part 2)

<table>
<thead>
<tr>
<th>Phytochemistry</th>
<th>C. ternatea</th>
<th>C. decussata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenolics/Glycosides/ Triterpenoid/Steroids</td>
<td>P-hydroxyphenylacetic acid, flavonol-3-glycoside, ethyl-α-D-glucopyranoside, adenosine, 3, 5, 7, 4'-tetrahydroyxorflavone, 3-thannomglucoside, a polypeptide, hexacosanol, β-sitosterol, γ-sitosterol and an anthoxanthin glucoside[35-48]. Terpenoids (blue anthocyanins)[49]. The six major anthocyanins ternatins were isolated and the structures were characterized as malonylated delphinidin 3, 5, 7-triglucosides having 5', 6', 7'-side chains with alternative D-glucose and D-coumaric acids unit[49-42]. Flavanol glycosides, kaempferol, quercitin, lactones aparajitin and elcharin[39-102], delphinidin[104], acylated anthocyanins[105], flavonoids, malonylated flavonol glycosides[105, 106]. Yadava &amp; Verma (2003) isolated antimicrobial flavonol glycoside[107]. Banerjee and Chakravarti (1963 – 1964) reported the isolation and identification of pentacyclic triterpenoid, taraxerol and taraxerone from the roots[108, 109]. Content of taraxerol in root of CT was determined through HPTLC[110], Xanthone[35, 68, 111, 112], (-)-loliolide[113], 1, 3, 5-tri and 1, 3, 5, 6, 7-penta oxygenated xanthones[114], 1-hydroxy-3, 7, 8-dimethoxy, 1, 8-dihyroxyl-3,7-dimethoxy, 1, 7-dihyroxyl-3, 8-dimethoxy and 1, 7, 8-trihyroxyl-3-methoxy xanthones[115]. Ghosal (1971) isolated known and new triterpenoids[102], lanostane triterpenoids[116]. Simultaneous estimation of mangiferin and scopoletin by spectrophotometry[117].</td>
<td></td>
</tr>
<tr>
<td>Plant growth regulator</td>
<td>Indole acetic acid, kinetin, ABA and gibberellic acid[118, 119].</td>
<td></td>
</tr>
</tbody>
</table>

Table 5 (To be continued) Different pharmacological features of controversial sources of Shankhpushpi

<table>
<thead>
<tr>
<th>Parts/Extract/Compound used</th>
<th>E. aisanoides</th>
<th>C. pluricaulis</th>
<th>C. ternatea</th>
<th>C. decussata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxicological studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Aqueous extract/Alcoholic extract</td>
<td>[121]</td>
<td>[122, 123]</td>
<td>[124-126]</td>
<td>[127]</td>
</tr>
<tr>
<td>Learning and memory enhancing, enhancement of acetylcholine content</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Aqueous extract/Alcoholic extract</td>
<td>[128-131]</td>
<td>[122, 123, 132]</td>
<td>[120, 124, 133-138]</td>
<td>Not reported</td>
</tr>
<tr>
<td>Nootropic activity/Anxiolytic activity/Tranquilizing property/Antidepressant activity/Antistress activity/Neurodegenerative/Antiinflammatory/CNS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Alcoholic extract/Methanolic extract</td>
<td>[56, 77, 130, 139-142]</td>
<td>[27, 61, 144-152]</td>
<td>[125, 153, 154]</td>
<td>[127]</td>
</tr>
<tr>
<td>Anticonvulsant activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Alcoholic extract/Methanolic extract</td>
<td>Not reported</td>
<td>[150, 155]</td>
<td>[125, 154]</td>
<td>[127, 156, 157]</td>
</tr>
<tr>
<td>Monoamine oxidase-inhibiting activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mangiferin</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Antioxidant activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Aqueous extract/Alcoholic extract</td>
<td>[141, 159]</td>
<td>[160]</td>
<td>[160]</td>
<td>Not reported</td>
</tr>
<tr>
<td>Hypoglycemic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Alcoholic extract</td>
<td>Not reported</td>
<td>[161]</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Immunomodulatory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Aqueous extract/Alcoholic extract</td>
<td>[162]</td>
<td>[163]</td>
<td>[164]</td>
<td>[165]</td>
</tr>
<tr>
<td>Blood platelet aggregation inhibiting and vascular smooth muscle relaxant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flowers/Anthocynins</td>
<td>Not reported</td>
<td>Not reported</td>
<td>[166]</td>
<td>Not reported</td>
</tr>
<tr>
<td>Antipyretic activity/Anti-inflammatory activity/Analgesic activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Alcoholic extract/Methanolic extract</td>
<td>[162, 167]</td>
<td>[150]</td>
<td>[125, 126, 168]</td>
<td>[127, 169, 170]</td>
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<tr>
<td>Antimicrobial activity/Insecticidal activity/Antifungal/Antibacterial/Antihelmintic</td>
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<tr>
<td>Aerial parts/Extract Seeds/Finotin/Flavonol glycoside</td>
<td>[56, 79, 171-176]</td>
<td>[177, 178]</td>
<td>[53, 107, 179]</td>
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<tr>
<td>Antidiabetic activity</td>
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<td></td>
<td></td>
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<tr>
<td>Flowers/Ethanol extract</td>
<td>Not reported</td>
<td>[180]</td>
<td>[181]</td>
<td>Not reported</td>
</tr>
<tr>
<td>Antiallergic and anticotrotic activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcoholic extract</td>
<td>[172]</td>
<td>[182]</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Diuretic activity</td>
<td>Roots/Alcoholic extract</td>
<td>Not reported</td>
<td>Not reported</td>
<td>[183]</td>
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</table>
Table 5 (Continuation)  Different pharmacological features of controversial sources of Shankhpushpi

<table>
<thead>
<tr>
<th>Parts/Extract/Compound used</th>
<th>E. alsinoides</th>
<th>C. pluricaulis</th>
<th>C. ternatea</th>
<th>C. decussata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local anesthetic effect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerial parts/Alcoholic extract</td>
<td>Not reported</td>
<td>Not reported</td>
<td>[125]</td>
<td>Not reported</td>
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<tr>
<td>Spermicidal activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Aqueous extract/Alcoholic extract</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
<td>[184, 185]</td>
</tr>
<tr>
<td>Hepatoprotective and gastroprotective</td>
<td>[186]</td>
<td>Not reported</td>
<td>Not reported</td>
<td>[188, 187]</td>
</tr>
<tr>
<td>Cardiovascular activity</td>
<td>[55, 56]</td>
<td>[188, 189]</td>
<td>Not reported</td>
<td>[127]</td>
</tr>
<tr>
<td>Antituberculosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Aqueous extract/Alcoholic extract</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
<td>[190, 191]</td>
</tr>
<tr>
<td>Skin care</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots and aerial parts/Aqueous extract/Alcoholic extract</td>
<td>[192, 193]</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Drug interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction between phenytoin and Shankhpushpi</td>
<td>Not reported</td>
<td>[194]</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Activity of polyherbal formulation/Clinical studies</td>
<td>[195-209]</td>
<td>[210-212]</td>
<td>[213]</td>
<td>[214]</td>
</tr>
<tr>
<td>Review on various pharmacological aspects</td>
<td>Complete</td>
<td>[16, 56, 215]</td>
<td>[56]</td>
<td>[56, 120]</td>
</tr>
</tbody>
</table>

*Numbers in brackets refer to reference numbers.*

Figure 1  Chemical structures of antistress components isolated from E. alsinoides
Figure 2  Chemical structures of antistress components isolated from *C. pluricaulis*

Figure 3  Chemical structures of antistress components isolated from *C. ternatea*

Figure 4  Structures of different xanthones isolated from *C. decussata*
played most promising antistress effect by normalizing hyperglycemia, plasma corticosterone, creatine kinase and adrenal hypertrophy, while others were also effective in normalizing most of these stress parameters\cite{257}. Effects of methanolic extracts of roots of EA (MEEA) on acute reserpine-induced orofacial dyskinesia showed increased vacuous chewing frequencies (VCMS) andTPs in acute reserpine-treated animals compared with vehicle-treated animals. Chronic treatment significantly reversed the reserpine-induced VCMS and TPs in a dose-dependent manner, decreased the locomotor activity as well as the transfer latency in acute reserpine-treated rats\cite{257}.

2.1.4 Antiulcer and anticitatonic activity

The *in vivo* evaluation of the ethanolic extract of EA revealed its marked antiulcer and anticitatonic activity\cite{372}.

2.1.5 Antioxidant activity

Antioxidant substances were isolated and identified from EA by preparing fractions of phenolic and non-phenolic compounds. Results of antioxidant activities of EA from 2,2-diphenyl-1-picrylhydrazyl (DPPH) assays were not as high as expected. The need of more antioxidant tests with different action mechanisms and also *in-vivo* studies with EA were suggested\cite{392}. Ethanol extracts and water infusions of EA, *Cynodon dactylon* and *Sida cordifolia* were tested for their antioxidant activity in the 2, 2'-azinobis-3-ethyl-benzothiazolene-6-sulfonic acid radical cation (ABTS) decolonization assay. The results showed that the ethanolic extract of *Sida cordifolia* was found to be most potent, followed by EA and *Cynodon dactylon*. The relative antioxidant capacity for the water infusions was observed in the following order: EA > *C. dactylon* > *S. cordifolia*. The results of water infusions on lipid peroxidation were as follows: EA > *S. cordifolia > C. dactylon*\cite{314}.

2.1.6 Immunomodulatory activity

The crude extracts of *Emblica officinalis* and EA were evaluated for immunomodulator activity in adjuvant-induced arthritic rat model. Both the drugs showed a marked reduction in inflammation and edema. At cellular level immunosuppression occurred during the early phase of the disease. The induction of nitric oxide synthase was significantly decreased in treated animals as compared with controls\cite{402}.

2.1.7 Evolvine hydrochloride

The hydrochloride of alkaloid evolvine was reported to exhibit lobeline-like action on the cardiovascular system. In cats, the drug demonstrated sympathomimetic activity. The blood pressure remained elevated for a longer duration as compared with adrena-
line. Increase in peripheral pressure was observed on local injection of the drug.

2.1.8 Activity related to formulas of EA BR-16A (Mentat) is a herbal formula consisting of Brahmi (Bacopa monnieri), Mandukparni (Centella asiatica), Ashwagandha (Withania somnifera), Jatamansi (Nardostachys jatamansi), Shankhpushpi (EA), Tagar (Valeriana wallichii), Vach (Acorus calamus), Guduchi (Tinospora cordifolia), Mallow (Celastrus paniculatus), Kuth (Saussurea lappa), Amla (Emblica officinalis) and the other ingredients of Triphala (Terminalia chebula and Terminalia belerica). The results indicated that Mentat (100 mg/kg) and piracetam (100 mg/kg) induced statistically significant nootropic effect in all the test parameters of learning and memory, and can be categorized as a nootropic agent.

A nine-week cross over study (5-week drug administration and 4-week withdrawal) was performed to see the effect of a composite Indian herbal preparation (CIHP) consisting of EA, viz. Mentat, on avoidance learning during endurance performance of albino rats. Runimex, a circular runway was used for this purpose. Results indicated significant improvement in avoidance learning during endurance performance due to the intake of CIHP.

A study provided a novel herbal composition, which promotes the proven pharmacological activities such as anti-oxidant, antistress and adpatorgenic activities. Composition comprises of plant juices or together with the conventional recipients to form paste/jelly/jam/cake/cream puff/chocolate forms fortified with plants like Mangifera indica, EA, Withania somnifera, Asparagus racemosus and Amaranthus hypochondriacus which are used as functional food.

A clinical trial was undertaken on 31 adult subjects, of which were newly diagnosed cases, while the remaining 25 were old ones taking some anti-epileptic drugs. Mentat, 2 tablets bid, along with the other drugs for a period of six weeks brought about significant reduction in seizure frequency. Thus Mentat served as a valuable adjuvant to commonly used antiepileptic drugs. No side effects were observed with Mentat administration.

Pre-clinical research has established that BR-16A (Mentat) enhances cognition and protects against both anterograde and retrograde amnesia induced by electroconvulsive shock in rats. This relationship holds even when rats are pre- selected for poor learning in an effort to define the floor effect of the formula. Studies on the mechanism of action of BR-16A (Mentat) have indicated that it may have opioid peptidergic activity. BR-16A (Mentat) does not appear to influence α-2 adrenergic receptor functioning but enhances the activity of dopamine postsynaptic receptors in vivo in laboratory rats.

BR-16A (Mentat) also enhances dopamine postsynaptic receptor functioning in the laboratory rats. This suggests a potential application in Parkinson’s disease. A case study describing the clinical use of the formula in Parkinsonism has been reported.

In other experiments of Mentat, on patients with poststroke disability, out of 24 patients in the study, 13 received Mentat and 11 received a placebo for 12 weeks. Electromyography (EMG) recording following neuromuscular stimulation was done at the beginning of the study and after 12 weeks. The final EMG responses in the trial group were found to be better than in the control group during study.

The antistress effects of BR-16A and its interaction with GABAergic modulators against social isolation-induced stress were investigated on various behavioural parameters, pentobarbitone-induced sleep (sleep latency and duration), analgesia (tail-flick test) and locomotor activity. BR-16A (100 mg/kg and 200 mg/kg) treatment for 5 days significantly reversed the social isolation stress-induced prolongation of onset and decrease in pentobarbitone-induced sleep, increased total motor activity and stress-induced antinociception. When diazepam (0.5 mg/kg), a benzodiazepine agonist, was co-administered with BR-16A (100 mg/kg), it significantly potentiated the reversal of pentobarbitone-induced shortening of sleep time effects, increased locomotor activity and stress-induced antinociceptive effects. However, the sleep latency was not decreased significantly. Further, flumazenil (2 mg/kg), a benzodiazepine receptor antagonist and FG 7142 (10 mg/kg), an inverse agonist, when co-administered with BR-16A (100 mg/kg), showed no significant reversal on pentobarbitone-induced hypnosis, locomotor activity and social isolation-induced antinociception compared with their effects perse. The study demonstrated the antistress effects of BR-16A preparation against social isolation-induced stress. The study also suggested that the GABAergic system may be involved in its antistress effect.

2.2 Convolvulus pluricaulis

2.2.1 Toxicological assessment The LD₅₀ of the whole extract of CP was found to be 1 250 (1 000–1 400) mg/kg p.o. Mice treated with the
extract showed a sedative effect at doses greater than 200 mg/kg and reflected a moderate to marked decrease in locomotor activity which lasted nearly for 12 h.  

2.2.2 Learning, memory and behavior The ethanolic extract of CP and its ethyl acetate and aqueous fractions were evaluated for their memory-enhancing properties. Significant improvement in learning and memory in rats was noted in passive avoidance paradigms and active avoidance tests using various laboratory models for learning and memory assessment.  

2.2.3 Anxiolytic and antiamentic activity Alcoholic extract of CP was found to cause an antagonist effect against amphetamines and tremors, a potentiation of acetylcholine effect, of pentobarbitone-induced hypnosis and morphine analgesia, without having own sedative properties. A protective action on muscle against electrical shocks has been shown. The chloroform fraction of the total ethanolic extract of CP elicited a significant antidepressant-like effect in mice by interaction with the adrenergic, dopaminergic, and serotonergic systems. Methanolic extract of the whole plant produced alterations in the general behaviour pattern, reduction in spontaneous motor activity, hypothermia, potentiation of pentobarbitone-sleeping time, reduction in exploratory behavioural pattern, and suppression of aggressive behaviour. Ethyl acetate and aqueous fractions of ethanolic extract showed an anxiolytic effect in the elevated plus maze. The ethyl acetate fraction at dose of 200 mg/kg p.o. significantly reduced the neuromuscular coordination indicative of the muscle relaxant activity. Nitrogen containing active principle of drug produced marked reduction in J3-131 uptake, PBI, acetylcholine, suggesting its effect on various glands through neurohumors particularly acetylcholine. Upadhyay studied the therapeutic role of Ayurvedic herbs in mental disorders and classified CP as a brain tonic. CP in a dose of 100 mg/100 g body weight exhibited a barbiturate potentiation effect in albino rats; this effect was weaker than that of diazepam, but stronger than that of Centella asiatica Linn. (Syn. Hydrocotyle asiatica Linn.).  

2.2.4 Anticonvulsant activity The water soluble portion of ethanolic extract abolished spontaneous motor activity and the fighting response, but did not affect the escape response; electrically induced convulsive seizures and tremorine-induced tremors were antagonized by the extract. It was observed that the animals treated with the methanolic extracts of stem callus, leaf callus and whole plant of CP, showed significant protection against tonic convulsion induced by transcorneal electroshock, which was also comparable with that of standard drug phenytoin.  

2.2.5 Antioxidant activity Ethanolic extract of CP possesses significant antioxidant activity when tested in vitro.  

2.2.6 Hypolipidemic activity Ethanolic extract of whole plant when administered to cholesterol fed gerbils, reduced serum cholesterol, low density lipoprotein cholesterol, triglycerides and phospholipids significantly after 90 days.  

2.2.7 Effect on thyroid gland The root extract of CP [0.4 mg/(kg • d) for 30 days] administered to L-thyroxine-induced hyperthyroid mice decreased serum concentration of T3 and hepatic 5-D activity. These results indicate that the plant extract-induced inhibition in thyroid function is primarily mediated through T3 to T3 conversion. Potential effect was shown by CP for the management of thyrotoxicosis.  

2.2.8 Analgesic activity The extract caused a reduction in the fighting behavior in mice but was devoid of analgesic activity although it potentiated morphine analgesia.  

2.2.9 Antiulcer and anticitatonic activity The antiulcerogenic effect of CP was found to be due to augmentation of mucosal defensive factors like mucin secretion, lifespan of mucosal cells and glycoprotein rather than the offensive factors like acid-pepsin.  

2.2.10 Cardiovascular activity Total water soluble fraction of the plant caused a marked and prolonged hypotension in dogs and inhibited the frog myocardium. Ethanolic extract of the entire plant exerted a negative inotropic action on amphibian and mammalian myocardium. It also exerted spasmodic activity on smooth muscles.  

2.2.11 Drug interactions There was unexpected loss of seizure control and reduction in plasma phenytoin levels in two patients who were also taking Shankhapushpi, an Ayurvedic preparation containing CP as an ingredient. In an attempt to know the cause, it was found that single dose SRC and phenytoin (oral/i. p.) co-administration did not have any effect on plasma phenytoin level but decreased the antiepileptic activity of phenytoin significantly, but in multiple-dose co-administration, Shankhapushpi not only reduced the antiepileptic activity of phenytoin but also lowered plasma phenytoin levels.  

2.2.12 Activity of convolve — an alkaloid isolated from CP The specific pharmacological action of convolve has been found to block M2 and M4
cholinergic muscarinic receptors. It was also found that convolvule potentiates the effects of arecoline, a muscarinic memory enhancer that ameliorates cognitive deficits in Alzheimer’s disease\textsuperscript{[230, 231]}.

2.2.13 Clinical studies of activity of polyherbal formula Maharishi Amrit kalash (MAK) is a herbal formula composed of two herbal mixtures, MAK-4 and MAK-5. These preparations are part of a natural health care system from India, known as Maharishi Ayurveda. A combination of MAK-4 and MAK-5 was found to have cancer inhibiting effects \textit{in vitro} and \textit{in vivo} when both used in combination\textsuperscript{[212]}.

Thyrocap is a herbal preparation containing solid extracts of \textit{Bauhinia variegata}, \textit{Commiphora mukul}, \textit{Glycyrrhiza glabra} and CP (100 mg of each extract/capsule). This preparation was tried in 50 patients of simple diffuse goiter at a dose of one capsule three times a day for 3 months. A significant increase in serum T\textsubscript{3} and T\textsubscript{4} concentrations and a decrease in serum cholesterol concentration confirmed its thyroid stimulating property\textsuperscript{[213]}.

2.3 \textit{Clitoraea ternatea}

2.3.1 Toxicological assessment Gross behavioral and acute toxicity studies after administration of graded doses of alcoholic extract of aerial parts of CT were carried out. LD\textsubscript{50} of the extract in mice was 2 290 mg/kg, i.p. An ethanolic extract of aerial parts and root of CT when administered orally to mice, in doses of 1 500 mg/kg and above was found to be lethargic instead of CT root extracts which up to 3 000 mg/kg administered orally failed to produce any lethality in mice\textsuperscript{[215, 216]}.

2.3.2 Learning, memory and behavior Effects of CT aqueous root extract on learning and memory in rat pups observed by using open field behaviour test, spontaneous alternation test, rewarded alternation test and passive avoidance test showed that the oral treatment of CT roots extract at different doses significantly enhanced memory in rats\textsuperscript{[213]}. The alcoholic extracts of aerial parts and roots of CT attenuated electroshock-induced amnesia\textsuperscript{[194]}. The authors also studied the possible mechanism through which CT elicits the anti-amnesic effects on central cholinergic activity by evaluating the acetylcholine content of the whole brain and acetylcholinesterase activity at different regions of the rat brain, viz., cerebral cortex, midbrain, medulla oblongata and cerebellum. It was suggested that an increase in ACh content in rat hippocampus may be the neurochemical basis for improved learning and memory\textsuperscript{[216, 195]}. In another study, the effect of CT aqueous root extract on the dendritic cytoarchitecture of neurons of the amygdala was studied. The study showed a significant increase in dendritic intersections, branching points and dendritic processes arising from the soma of amygdaloïd neurons in aqueous root extract-treated rats compared with age-matched saline controls\textsuperscript{[197]}.

2.3.3 Anxiolytic and antistress activity The ethanolic extract of CT caused reduction in spontaneous activity, decrease in exploratory behavioural pattern by the head dip and Y-maze test, reduction in the muscle relaxant activity by rotarod, 30° inclined screen and traction tests, and potentiated the pentobarbitone-induced sleeping time\textsuperscript{[155]}. In another study, the effect of alcoholic extract of aerial part of CT on spatial discrimination in rats followed by oral treatment with alcoholic extract at a dose of 460 mg/kg significantly prolonged the time taken to traverse the maze, which was equivalent to that produced by chlorpromazine. The lower dose 230 mg/kg was ineffective\textsuperscript{[185]}.

2.3.4 Anticonvulsant activity Methanolic extract from the aerial parts of CT was screened by using pentylentetrazol (PTZ) and maximum electroshock (MES)-induced seizures in mice at the dose of 100 mg/kg p.o. CT significantly delayed the onset of convulsions in PTZ-induced convulsions and also delayed the duration of tonic hind limb extension in MES-induced convulsions\textsuperscript{[114]}. At the dose of 230 and 460 mg/kg, no significant effects were observed in both tests\textsuperscript{[122]}.

2.3.5 Antidiabetic activity Ethanolic extracts of flowers significantly lowered serum sugar level in experimentally induced diabetes\textsuperscript{[118]}.

2.3.6 Antimicrobial activity A flavonol glycoside isolated from the ethyl acetate soluble fraction of the roots of CT showed antimicrobial activity against various bacteria and fungi\textsuperscript{[107]}.

2.3.7 Anti-inflammatory, analgesic and antipyretic activity Methanolic extract of CT roots was reported to have significant anti-inflammatory activity in the experiment using carrageenin-induced rat paw edema and acetic acid-induced vascular permeability models in rats\textsuperscript{[148]}.

2.3.8 Activity of formulation \textit{Clitoraea}, \textit{Glyricidia} and \textit{Mucuna} was found to be active as nitrogen supplements to Napier grass basal diet in relation to the performance of lactating Jersey cows\textsuperscript{[211, 232]}.

2.4 \textit{Canscora decussata}

2.4.1 Anticonvulsant activity The results of administration of crude fine powder and alcoholic extract of CD against MES, MST and hypnosis potentiation tests were found to be encouraging.
The drugs were also tested for toxicity studies prior to clinical trial. In another set of experiments crude dried powder and its alcoholic extract with reference to phenytoin sodium (serve as positive control) were found to provide cent percent protection against supramaximal electroshock. Mangiferin and total xanthones did not elicit any anticonvulsant activity against maximal electroshock and pentylene tetrazol-induced convulsion in a dose up to 100 mg/kg.

2.4.2 Antitubercular activity Chloroform soluble fraction of ethanolic extract of CD gave a mixture of about dozens of polyoxygenated xanthones, which were used for the assessment of the antmycobacterium tuberculosis H 37 RV using Youmanin medium by tube dilution methods on these xanthones. A potent antitubercobacterium tuberculosis component of CD was reported to possess xanthone nucleus, which should contain oxygen functions at 1-, 3- and 5-, 6- or 8-position.

2.4.3 Immunomodulatory activity Aqueous extract of CD was found to promote the adhesion of neutrophils by inducing the expression of cell intercellular adhesion molecule-1 and E-selectin on endothelial cells.

2.4.4 Anti-inflammatory activity Significant anti-inflammatory activity was observed in rats by carrageenin hind paw oedema, cotton pellet granuloma, and granuloma pouch techniques. Magostin-3, 6-di-O-glucoside and mangiferin, a C-glucoside from CD roots provides a definite protection against experimentally induced carbon tetrachloride liver injury in albino rats.

2.4.5 Hepatoprotective activity Magostin-3, 6-di-O-glucoside and mangiferin, a C-glucoside from CD roots provides a definite protection against experimentally induced carbon tetrachloride liver injury in albino rats.

2.4.6 Spermicidal activity Aqueous extract of this herb in a dose of 25 mg/100 mg body weight arrested spermagogenesis in albino rats.

2.4.7 Effect of its formula on postmenopausal One of the leading pharmaceutical house in India has formulated a safe and effective herbomineral preparation viz. Menotab to relieve the distressing symptoms of postmenopausal syndrome. Menotab comprises of Withania somnifera, Eleltaria cardamomum, Bombax malbaricum, Centella asiatica, Embelia ribes, Canesra decussata, Asparagus racemosus, Oyster shell extract, Glycyrhiza glabra, Adhatoda vasica, Tinospora cordifolia and Boerhaavia diffusa.

2.4.8 Simultaneous pharmacological screening Methanolic extracts of five of these plants, e.g. Clitorea ternatea, Canesra decussata, C. diffusa, Evolulus alsinoides, E. nummularius were analyzed for their anti-oxidant and acetylcholinesterase inhibitory properties by using mice brain homogenates as the enzyme source. All the plants (except CT) inhibited acetylcholinesterase in a dose-dependant manner, significantly scavenged DPPH radical and superoxide radical and chelated metal ions. Total anti-oxidant capacity (equivalent to ascorbic acid) of the plant extracts was also good. It was found that CD has the highest acetylcholinesterase inhibitory activity. Anti-oxidant activity in all systems (except metal chelation property) was highest in CD.

2.4.9 Some important facts related to Shankpushpi Upadhya and Kambojkar carried out studies on Shankpushpi from Western Maharashtra, India and identified four major species viz. C. decussata, C. ternatea, E. alsinoides and Tephrosera purpurea as Shankpushpi out of the nine species he studied. Rajagopalan reported the effect of Ayushman-8 (containing Shankpushpi, Brahmi and Vacha) on Manasa-mandata (mental retardation). Singh and Vishwanathan suggested that there was a need for the authentication of samples of the crude drug purchased from the local market under the trade name Shankpushpi before their utilization. They also suggested the need for authentication of C. microphyllus and E. alsinoides.

3 Summary and conclusion

An estimate of the World Health Organization (WHO) states that around 85% – 90% of the world’s population consumes traditional herbal medicines. Use of herbal remedies is on the rise in developing and developed countries. Many traditional systems have records where one common vernacular name is used for two or more entirely different plant species. Controversial herbs in other words are accidental herbal medicine which comes in existence due to wrong identification of a prescribed medicinal plant. Sandidgha drayavas, a term used for medicinal plants having controversial sources, appear in the ancient Indian literature. India is a country having variety of languages and population dependent on different tribal and folklore medicine. The variation in the language sometimes is responsible for confusion in the nomenclature of different plants having similar name. Moreover the description of a plant in the ancient literature is found in verses having ample use of synonym. These synonyms have caused controversy in the identification of plants and hence the correct source sometime is mistaken with a fictious plant. In Ayurveda, the plant Shankpushpi is regarded as controversial in origin. Existence of four different plants is seen in different places of India as Shankpushpi. Even the official publication of Government of India
has shown more than one plant as source for the drug. Although there is lot of work for all plants which has been done for the presence of different chemicals and for various activities. A survey on different Ayurvedic formulas revealed its use as a brain tonic. Sometimes instead of using botanical name doctors only prescribed common name. Since herbal products are prepared by using the extracts of plant known for particular activity, the controversial source sometimes leads to variable preparation. Hence generation of parameters based on characterization and identification of chemical and biomarker, using modern method may provide a solution for solving out the controversy. The available herbal products may be evaluated and analyzed by using sophisticated modern techniques such as UV, TLC, HPLC, HPTLC, GC, Spectrofluorimetric, micro-array and other methods. Their biological efficacy also needs to be evaluated to justify the indications of the polyherbal formulas. In present work parameters of identification as well as differentiation among different plant sources having similar name Shankhpushpi in Ayurvedic literature have been reviewed, which may serve the purpose for solving controversy of Shankhpushpi.

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