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## *Cynoglossum* L.: A review on phytochemistry and chemotherapeutic potential

**Kalpana Joshi**

#### Abstract

The genus *Cynoglossum* L. contains about 75 species found in hot and temperate regions of Asia, Africa and Europe especially in Taiwan, Turkey, India, Kenya and China etc. The plants are mainly perennial with wide uniformity in external morphology which makes it most difficult taxonomical genus to study. The plants contains mainly pyrrolizidine alkaloids of many types and used as traditional medicines by tribals and v aids for cough, burns, wounds, ear infection, antibacterial and sometimes as veterinary medicines. Some plants of this genus are scientifically validated for antioxidant, antihyperlipidaemic, antidiabetic, antifertility, antitumor, anti-inflammatory, diuretic, analgesic and hepatoprotective activity.

**Keywords:** *Cynoglossum*, pyrrolizidine, heliosupine, viridiflorine, heliotridine, echinatine

#### 1. Introduction

The genus *Cynoglossum* L. represents about 75 known species distributed in Asia, Africa and Europe, 12 species in China <sup>[1]</sup> about 50 to 60 species in distributed widely in warmer and temperate regions of both hemispheres, 3 species in Taiwan <sup>[2]</sup>, 8 species in Turkey <sup>[3]</sup> but recently revision in the plant list have increased the number of accepted species in this genus to over 86 species. All species grow along the open woodlands, roadside and sand dunes. *Cynoglossum* L. is a species rich genus and due to its similarities in external morphology it is described as a taxonomically difficult genus <sup>[3]</sup>. According to "The Plant List" of Royal Botanical Garden, Kew and Missouri Botanical garden, Global Compositae Checklist, includes 266 plant names of species ranked for this genus in which only 83 are accepted species names and further 306 species including infra specific name for genus *Cynoglossum*. 'The Plant List' shows that only 29.4% are accepted species, and 43.8% are synonym, while 26.8% are still unassessed. *Cynoglossum* species are used as remedies in folk medicine and grown as ornamental plant in gardens and parks.

#### Distribution

*Cynoglossum* L. includes numerous species distributed in Asia, Mediterranean regions and Europe mainly in Turkey, China, Pakistan, India, Bhutan, Kenya and Malaysia. *Cynoglossum baeticum* has been described as an endemic species in SE Spain occurring at an altitude of 1000-1800 m <sup>[4]</sup> while *Cynoglossum germanicum* has been described as an endemic species in Bulgarian flora and is legally protected by the Biological Diversity Act. Annex 3 (2007) <sup>[5]</sup>. In the western parts of Mediterranean area *Cynoglossum montanum* is distributed widely and ranges from central Spain to eastern part of Black sea region and also reported in the localities of Italy, France <sup>[6]</sup>.

In the checklist of flowering plant of Afganistan *C. glochidiatum* was found in province of Badakhshan, Badakhshan (Wakhan) Baghlan Kabul Maidan (Wardak) Parwan Takhar, *C. lanceolatum*, *C. zeylanicum* and *C. nervosum* were found in province of Kabul, *C. stylosum* was found in Badakhshan (Wakhan) and Takhar, *C. anchusoides* from Badakhshan, Takhar *C. intermedium* from Bamian, Ghazni, Kunar, Logar, Paktia while *C. stamineum* in Badghis, Orozgan Herat, Parwan <sup>[7]</sup>. Akcin (2012) <sup>[3]</sup> studied the foliar anatomy of *Cynoglossum* L. from North Anatolia, Turkey viz. of *C. creticum* Miller, *C. officinale* L., *C. montanum* L. and *C. glochidiatum* <sup>[3]</sup>. Akcin (2008) <sup>[8]</sup> studied the seed coat and fruit surface micromorphology of some *Cynoglossum* L. (Boraginaceae) species <sup>[8]</sup> for TLC.

**Table 1:** Distribution of plants of genus *Cynoglossum* L.

Botanical name	Altitude (m)	Habitat/origin	Type	Life	Plant height (cm)	Blooming time
<i>C. aequinoctle</i>	1760-2300	Zambia, Kenya	H*	P#	20	Spring
<i>C. alpestre</i>	1200-1500	Taiwan	H	P	50	-
<i>C. alpinum</i>	1400-2200	Ethiopia	H	P	20-50	-
<i>C. castaneum</i>	Plains	Malaysia	H	B#/P	75	-
<i>C. amabile</i>	3325	China, Central America	H	A	45-60	May-Sep
<i>C. amplifolium</i>	1980-2440	Africa	H	P	100	-
<i>C. austral</i>	below 800	Australia, Tasmania	H	P	30-75	Oct-March
<i>C. baeticum</i>	1000-1800	Africa	H	B	40-50	-
<i>C. birkinshawii</i>	2050	Asia, Africa, Europe	H	P	12-30	-
<i>C. bottae</i>	2500	Arabia	H	B	50	-
<i>C. coeruleum</i>	3150	East tropical Africa	H	P	120	-
<i>C. columnae</i>	Up to 1800	Turkey	H	A	50	-
<i>C. cheranganise</i>	2850-3270	Kenya	H	P	180	-
<i>C. creticum</i>	1000	Mediterranean	H	B	30-60	Feb – Jun
<i>C. dioscorides</i>	500-2300	Europe	H	B	75	-
<i>C. divaricatum</i>	500-2500	China	H	P	25-100	-
<i>C. germanicum</i>	1300-1400	Asia	H	B	30-60	May-Aug
<i>C. grande</i>	-	California, Washington	H	P	60-90	Early spring
<i>C. hispidum</i>	2200	S. Africa, Switzerland	H	B/P	30-60	Oct
<i>C. lanceolatum</i>	300-2800	China, Africa, Asia, Pakistan, India,	H	P	20-90	Nov-Jan
<i>C. macrocalycinm</i>	1500-1800	China	H	B	50-60	-
<i>C. microglochii</i>	3000	Pakistan, Nepal, Bhutan	H	P	12	May-Jun
<i>C. monophlebium</i>	100-2500	Africa	H	P	-	-
<i>C. celebicum</i>	1800	England	H	B/P	-	-
<i>C. glabellum</i>	1750	Malaysia	H	P	-	-
<i>C. hellwigii</i>	1200-1300	Malaysia	H	A	100	-
<i>C. gansusense</i>	1600-2900	China	H	P	30-60	July
<i>C. javanicum</i>	7620	Malaysia	H	B	30-100	-
<i>C. macrolimbe</i>	2050	Malaysia	H	B	30	-
<i>C. nebrodise</i>	4000-6000	India, France	H	B	30-70	-
<i>C. novaguineense</i>	2014	Malaysia	H	B/P	50-75	-
<i>C. obtusicalyx</i>	975-1676	South Africa	H	B/P	30-40	-
<i>C. officinale</i>	2100	Europe	H	B	30-120	May-Sep
<i>C. papuanum</i>	Plains	Malaysia	H	A	15	spring
<i>C. suaveolens</i>	DampPlace	Australia	H	P	10-60	Summer
<i>C. triste</i>	2500-3100	China	H	P	15-50	May-July
<i>C. virginianum</i>	Forest gaps	North America	H	P	75	June-July
<i>C. viridiflorum</i>	700-1700	China	H	P	50-100	May-Aug
<i>C. wallichii</i>	1300-3600	China, India (Kashmir), Nepal, Pakistan	H	B	20-60	May-Aug
<i>C. zeylanicum</i>	1200-4100	India (Tamilnadu)	H	B	2	June-Nov

H\*=herb, P#= perennial, B#= Biennial.

### Morphology

The genus *Cynoglossum* L. contains biennial, perennial or rarely annual herb, leaves are usually basal and long petiolate leaves are present in lower stem. Cymes are axillary or terminal, bracteates or ebracteate, often branched dichotomously with spreading panicles and crowded. Pedicellate flowers are present, while 5 Calyx is parted to base, enlarging in fruit with reflexed or spreading lobes. Corolla is blue, dark purplish red, rarely white, yellow green or blackish purple, tubular or funnel form, campanulated, five

parted. Tubes are more or less shorter than calyx with 5 throat appendages, square, lunate or trapeziform and it is depressed at apex while orbicular to ovate lobes are present ovoid glochids with subapical scar attachment<sup>[1]</sup>.

However because of uniformity in external morphology it is taxonomically difficult genus and detailed observations of the micromorphology of most of the *Cynoglossum* species are lacking and cannot be resolved without proper investigation. Some morphological features are summarized in table no 2.

**Table 2:** Morphological characteristics of plants of genus *Cynoglossum* L.

Botanical name	Leaves		Flower Colour	Fruits	
	Type	Length(cm)		Nutlets Type	Nutlets Size(mm)
<i>C. aequinoctle</i>	Basal Cauline	19.5×2.5 4.0×0.8	Pale blue	Compressed-ovoid	5×5
<i>C. alpestre</i>	Lanceolate-elliptic	2-18×0.5-2.5	Blue	Ovoidsubglob	4-5
<i>C. alpinum</i>	Lanceolate-narrowly elliptic	2-18×0.5-2.5	Blue	Ovoboid-subglobose	4-5
<i>C. castaneum</i>	Stem leaves linear lanceolate	2.5-10×0.5-1.5	Bluish white	Ovate	2.5
<i>C. amabile</i>	Basal-petiolate Stem-obl. lanceolate	5-20 2-7	blue rarely white	Ovoid	3-4
<i>C. australe</i>	Basal cluster	6-12	Blue, white	Ovoid	5-6

<i>C. baeticum</i>	Rosette leaves Cauline leaves	20×2.2 8×0.7	Blue-violet	Ovoid suborbicular	7.5-8.1×6.5
<i>C. birkinshawii</i>	Cauline	1.5-4×0.8	Blue	Ovoid	4-5
<i>C. bottae</i>	Lanceolate –elliptic	8	White blue throat	-	3-5
<i>C. coeruleum</i>	Linear lanceolate	25×3	Blue	Ovate	2.5×2.0
<i>C. cheranganise</i>	Radical-oblancoel. Cauline-oblancoel.	30×3.5 4-20×0.7-2	White and blue tip	Grayish ovate	2-2.2×1.8-2
<i>C. creticum</i>	Oblong-lanceolate	20×2.5-3.5	Bluish to pinkish	Ovate	7-8 × 6-7
<i>C. dioscorides</i>	Rosette	7-15×0.5-1.5	Deep blue	Ovate	5-7×3.7-5
<i>C. divaricatum</i>	Oblong-lanceolate to lanceolate	7-15×2-4	Blue purple	Ovoid	4.5- 6
<i>C. grande</i>	Petiolate	8-18×3-11	Blue or violet	Obovoid-globose	-
<i>C. germanicum</i>	Elliptic	3-10×2-3-5	Pale pink	Rounded	7-10
<i>C. javanicum</i>	Oblong-lanceolate	2-4×0.25-2	Blue/pink	Broadly ovate	3×3
<i>C. lanceolatum</i>	Petiolate,oblancoelate	8-14×3	Light blue	Ovoidglobose	2 - 2.5
<i>C. macrocalycinum</i>	Oblong lanceolate	13-14×3-3.5	Darkpurple	Unknown	Unknown
<i>C. microglochii</i>	Elliptic,ovate,oblance	6-20×15-10	Blue/puple	Ovate	4-5
<i>C. glabellum</i>	Lanceolate-lanceolate oblong	1.8-3×0.7-1.4	Deep blue	Ovate	4-4.5×2.5
<i>C. hellwigii</i>	Elliptical oblong, lanceolate	-	White-pale blue	Ovate	2-3×1.5-2
<i>C. gansusense</i>	Linear lanceolate	9-16×1-1.5	Blue	Ovoid-long	5-6.5
<i>C. macrolimbe</i>	Lanceolate	10-11×2.8-3	-	Ovate	3-3.5×2.5
<i>C. novaguineense</i>	Lanceolate	6-7.5×1.5-2.1	blue	Ovate	4.5-3.5-4
<i>C. officinale</i>	Obovate	40×8	Purple	Ovate	5-8.4×2-6
<i>C. papanuam</i>	Obovate-oblong	4.6×1.2	-	Marginate	6
<i>C. sabirensis</i>	Lanceolate	20	Sky-blue		4-5
<i>C. suaveolens</i>	Long petiolate	90	Blue-white	Ovoid	90
<i>C. sphacioticum</i>	Linear lanceolate		Deep blue	Ovate	5-6
<i>C. schlagintweitii</i>	oblanceolate to obovate	2-4×5-10	Blue, blue-purple	Ovoid	3-4
<i>C. triste</i>	Long petiolate, cordate to ovate	5-12×3.5-8	Black-purple	depressed	1.5 cm
<i>C. viridiflorum</i>	Oblong elliptic	15-25×7-9	Greenish yellow	Ovoid-rhombic ovoid	5-7×4.5-5.5
<i>C. wallichii</i>	Lanceolate-obovate	2-5cm×5- 12mm	Blue-blue purple	ovoid	3-4×2.5-3
<i>C. zeylanicum</i>	Elliptic lanceolate	-	Pale liliac-light blue	Not margined prominently	-

### Phytochemistry

The literature survey revealed that very little phytochemical studies has been carried out in genus *Cynoglossum* and they are known to accumulate pyrrolizidine alkaloids as a major means of chemical defense. Nuclear magnetic resonance technology was used to determine the level of total pyrrolizidine alkaloids, free bases and N-oxides form of alkaloids in leaves, stems, buds, flowers and pods of *Cynoglossum officinale* and four individual alkaloids were obtained i.e. 7-angelylheliotridine, echinatine, acetylheliosupine and Heliosupine, a predominant alkaloid in the plant<sup>9</sup>. The flowering and fruiting plants of *Cynoglossum officinale* and *Cynoglossum amabile* were used for determination of alkaloids. On the basis of mass spectroscopy [<sup>1</sup>H, <sup>13</sup>C] NMR such acetylheliosupine, heliosupine N-oxide, 3'-acetyl heliosupine, viridiflorine were isolated and identified while 5 pyrrolizidine were recorded i.e. supinine, amabiline, rinderine, echinatine, 3'-O acetylechinate<sup>[10]</sup>. The aerial parts and roots of *Cynoglossum furcatum* were analysed for pyrrolizidine alkaloids and some constituents are identified as Neo coramandaline, echinatine, virifloryl ester of laburnine<sup>[11]</sup>.

The study of aerial parts of *Cynoglossum creticum* by GC-MS revealed the presence of 13 alkaloids together as 3'-Acetyl

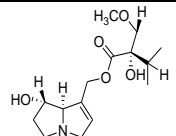
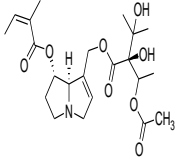
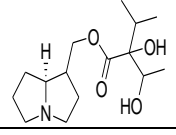
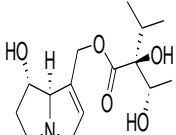
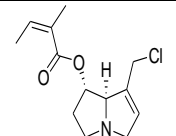
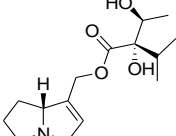
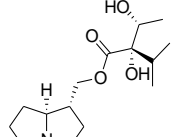
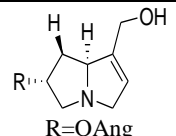
rinderine, 3'-Acetylechinate, heliosupine, 3'-acetyl heliosupine, 7-Angeloylheliotridine, Rinderine, Supinine, 7-seneciolyheliotridine, Echinatine of which four are based on tentative identification as Trachelanthamine, isomer of trachelanthamine, 7 $\alpha$ -Angeloyl-1-chloromethyl-1,2-dehydropyrrolizidine, 7-angeloyl-9-methyl butyryl heliotridine<sup>[12]</sup>.

From the alcoholic extract of *Cynoglossum gansusense* two new alkaloids were isolated (2,3-dihydro-1-oxo-1H-pyrrolo[1,2-a]pyrrol-7-yl)methyl(2S\*,3S\*)-3-[( $\beta$ -D-glucopyranosyl)oxy]-2-hydroxy-2-(1-ethylethyl)butanoate(1) and 1, 2-dihydro-8-methoxy-2-oxoquinoline-4-carboxylic acid(2) and their structures were characterized by means of spectroscopic by <sup>1</sup>H, <sup>13</sup>C, <sup>2</sup>D-NMR and by HR-MS methods<sup>[13]</sup>.

The chemical constituents in the essential oil of *Cynoglossum lanceolatum* Forsk. were analyzed by means of GC-MS<sup>[14]</sup>.

The GC-MS analysis of ethanol extract of *Cynoglossum zeylanicum* was revealed the presence of 9, 12-oetadeca octadecadienoyl chloride, Ethanamine, N-ethyl-N-nitro, 2-furan carboxaldehyde, phyto 1, 5-(hydroxyl methyl)<sup>[15]</sup>. Some chemical constituents of genus *Cynoglossum L.* are summarized in table no 3.

**Table 3:** Phytochemical constituents in various species of genus *Cynoglossum* L.

Chemical Structure	Chemical constituent	Occurrence	Reference
	Heliotrine	<i>C. nervosum</i>	16
	Heliosupine	<i>C. officinale</i> <i>C. montatum</i> <i>C. macrostylum</i> <i>C. creticum</i> <i>C. pictum</i> <i>C. viridiflorum</i> <i>Paracynoglossum imeretium</i> <i>C. anabile</i>	13, 17
	Rinderine	<i>C. columnae</i> <i>C. creticum</i> <i>C. officinale</i>	13,17
	Echinatine	<i>C. anabile</i> <i>C. columnae</i> <i>C. creticum</i> <i>C. furcatum</i> <i>C. zeylanicum</i> <i>C. germanicum</i> <i>C. macrostylum</i> <i>C. montanum</i> <i>C. nervosum</i> <i>C. officinale</i> <i>C. pictum</i>	13,17
	3'-Acetyl heliosupine, 7α-Angeloyl-1-chloromethyl-1,2-dehydropyrrolizidine	<i>C. creticum</i>	13
	Cyanustine	<i>C. lanceolatum</i> , <i>C. montanum</i> , <i>C. australe</i>	13
	Cynaustraline	<i>C. australe</i> <i>C. furcatum</i> <i>C. lanceolatum</i> <i>C. montanum</i>	13,18
	7-angeloyl heliotridine	<i>C. officinale</i>	17,18

**Ethno-pharmacology**

The plants of genus *Cynoglossum* L. contains mainly pyrrolizidine alkaloids, echinatine and is used traditionally

for the treatment of various diseases globally summarized in table no. 4.

**Table 4:** Traditional uses of plants of genus *Cynoglossum* L.

S. No	Plant Name	Local Name	Region	Traditional Use	Ref
1	<i>C. amabile</i>	Dao Ti Hu Nadma Byar- Ma	China Tibet	Cough, scrofula, Stop bleeding of wounds, Internal of digestion restorative, external in case of fracture, Chronic wound and swelling of extremities	19, 20
2	<i>C. amplifolium</i>	Ay-Charo, Pitsi-Charo	Ethiopia	Ear infection, Arthritis	21
3	<i>C. coeruleum</i>	Shimgigit Awi –Tasiyo Ingolongonzi, Mashonanguo	Shinasha Tanzania	Amoeba (leaf), oral toothache, violent illness (oral, skin, hold between teeth) Fresh leaf powder-burns, wounds Roots- antispasmodic, Antibacterial, vermifuge,	19

				Stomachic, crushed dried roots-decoction for impotence, Veterinary medicine, Astringent, for diarrhea, Dysentery	
4	<i>C. lanceolatum</i>	Nariin Navcit, Conyn Khel, Nad Ma Jar Ma, Nad Ma Byar Ma, Lahaul-Spiti, Small petaled Hounds tongue Ya Yong Cao, Xiao Hua Liu Li Cao Urwiba Diadilonda, Kolokoso Igishokoro Baleriaan Knoppiesklits Bohome Bhavarband, Kamraaj, Laksmana, Lichkura Shima Ruri-So, Shima-Suna-BikiSo	Mongolia Tibet England China Burundi Congo Rwanda Southern Africa South Sotho India Japan	Infantile diarrhea, Heals sores, wounds, joins cracked and fractured bones and relieves swollen limbs and treats accumulation of serous fluids in the joints. Lowers fever, coughs, difficulty in passing urine due to water retention and regulates proper flow of menstruation cycle. Also as a aphrodisiac, sedative, mental problems	19,20
5.	<i>C. zeylanicum</i>	Bhere Kuro, Kanike Phul, Bhende Kuro, Koda Kuro, Thina, Tam, Tinet-T, Kanike Kuro Tapa, Nema Jarma. Hound is Tongue, Forget-Me-Not Ti Gu San Lichkuru Jathakkai, Andhahuli Pissintorai Rajpatti AmudraSoppu, Kadaanthrinta, Vattachedy	Nepal Tibet England. China India (Himachal Pradesh) India (Tamilnadu) India (Mandi, Malaya district India (Western Ghats) India(Garhwal) India	Roots and leaves peel as antiseptic healing agent for cuts and wounds; powder in ringworm. Dilute leaf juice is applied in corneal conjunctivitis, Also used in fractured bone. Dissolve uterine tumors, and draws out lymph fluids. Root paste is applied in boils and to heal wounds as antiseptic. The pasted flowers are applied around boils. It helps to draw out pus and quickens the healing process. Leaf juice as eye drops to treat. Conjunctivitis. Sores, swellings, cough and fractured bone. It dissolves uterus tumours and draws out lymph fluids. Whole plant poultice-heal cuts and wounds. Whole plant decoction or leaf paste -Vomiting, Inflammation Dyspepsia, digestive disorder Roots-jaundice. Juice, leaf paste-Earache, Ulcer Used in Siddha –eye infections, stomachache, ring worm, Scabies	20 22 23,24 25 26 27 19
6.	<i>C. denticulatum</i>	Dao Gou Xi Nan Liu Li Cao Andhahuli, Lichkura, Lutakai, Tejraj Book Tinai	China India Nepal	Plant juice-wound healing, controlling vomiting in infants. Roots-to enhance potency Root juice-stop vomiting	19
7.	<i>C. grande</i>	Pacific Hounds Tongue	-	Roots for stomachache, gastrointestinal disorder, veneral diseases, burns and scalds.	19
8.	<i>C. javanicum</i>	Dekemp, Semongokina	Papua new guinea	Fresh leaves for topical ulcers.	19
9.	<i>C. meeboldii</i>	Khuriattai	India	Root juice-ripe boils	19
10.	<i>C. monophlebium</i>	Darakinambo, Lelosy, Maindraitsiresina	Madagascar	Antirheumatic	19
11	<i>C. officinale</i>	Gipsy Flower, Hound's Tongue Langue De Chien Lisan-El-Kalb Ouden-Esh-Shah Saboun-El-Arais Yao Young Dao Ti Hu	French Arabic China Tibetan	Antihemorrhagic, Antiseptic, Diuretic. Poultice to running sores, dropsy, veneral diseases	19

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12	<i>C. virginianum</i>	Wild Comfrey blue houndstongue	Canada	Roots- sores, itching, cancer, respiratory infections.	19
13	<i>C. wallichii</i>	Dhlabravisabata	India	Plant juice-wounds, controlling vomiting in infants, Root juice-to stop vomiting, Powdered roots-ant allergic, applied on swellings.	19

## Pharmacological Effects

### *In vitro* Antioxidant Activity

The antioxidant activity of extracts of whole plant of *C. zeylanicum* was evaluated in solvents such as petroleum ether, benzene, ethyl acetate, methanol and ethanol extracts using different methods such as DPPH-radical scavenging activity, hydroxyl radical scavenging activity, superoxide radical scavenging activity, ABTS radical cation scavenging activity, reducing power and for IC<sub>50</sub> values. The ethanolic extract of plant at a dose of 800 µg/ml exhibited 118.51% scavenging activity by the DPPH- radical scavenging method while the ethyl acetate extract possessed 83.14% scavenging activity by hydroxyl radical scavenging activity. Using Superoxide radical scavenging method 93.61% scavenging activity was exhibited in benzene extract. The ABTS radical cation scavenging activity showed that methanol extract possessed 84.63% scavenging activity when compared to standard Trolox (74.39%) also the methanolic extract exhibited highest reducing activity when compared to standard drug ascorbic acid [28].

### Antihyperlipidaemic and antidiabetic activity

The investigation of ethanolic extract of whole plant of *C. zeylanicum* was performed for its antihyperlipidemic and antidiabetic effect in wistar albino rats in alloxan (150mg/kg i.p.) induced diabetes. Further the ethanolic extract at single dose per day of 150 and 300 mg /kg of body weight were administered for a period of 14 days to diabetic rats and blood glucose, creatinine, plasma insulin, glycosylated haemoglobin, serum enzymes serum glutamate pyruvate transaminases (SGPT), and serum glutamate oxaloacetate transaminases (SGOT), and alkaline phosphatase (ALP)], lipoprotein peroxidation (LPO), antioxidant enzymes catalase (CAT), superoxide dismutase (SOD), reduced glutathione (GSH) and glutathione peroxidase (GPx), urea serum lipid profile like total cholesterol (TR), low density lipoprotein – cholesterol (LDL-C), triglycerides (TG), very low density lipoprotein – cholesterol (VLDL-C), high density lipoprotein – cholesterol (HDL-C) and phospholipid (PL) serum protein, globulin, albumin were measured. Significant reductions in blood glucose ( $p < 0.05$ ), lipid parameters except HDL-C, serum enzymes and significantly increased HDL-C were elicited. Also it showed significant increase in plasma insulin ( $p < 0.05$ ) in diabetic rats [29].

### Antifertility activity

According to Anitha M. *et al.* (2013) [32] the ethanolic extract of whole plant extract of *C. zeylanicum* was evaluated for antifertility activity in male albino rats. Decrease in the relative weight of the testes and epididymis were observed. In treated rats the epididymal sperm count, motility and sperm abnormality were reduced significantly. In the plant extract treated rats an increase in serum urea, creatinine and the activity of liver marker enzymes (SGOT, SGPT and ALP) level occurred. The activities of serum antioxidants (CAT, SOD, GPX, GST and GRD) were also decreased. An increased serum levels of FSH and estrogen but decreased in the serum levels of LH and testosterone compared to control

was observed in hormonal assay. The number of females impregnation was reduced by extract treated male rats and also the number of viable fetus and the number of implantations were reduced. The extract also reduces sperm concentration, motility and testosterone which might result in a male sterility and useful as an antifertility drug [30].

### Hepatoprotective activity

Anitha M *et al.* (2012) [31] evaluated the hepato-protective effect of ethanolic extract of whole plant of *C. zeylanicum* in CCl<sub>4</sub> induced hepato-toxicity. At an oral dose (50, 100 and 150mg/kg) of extract of this plant showed significant decrease in liver conjugated and unconjugated bilirubins which confirms its hepato-protective effect [31].

### Anti-inflammatory activity

The anti-inflammatory activity of ethanolic extract of *C. zeylanicum* plant was evaluated using the Carrageenan induced Paw edema method. After 3 hrs of administration of plant extract at a dose of 150 mg/kg significant decrease in paw edema was observed when it was compared to standard drug indomethacin [32].

### Antitumour activity

Anitha M. *et al.* (2012) evaluated that anti-tumour activity against DAL tumour bearing mice by assessment of parameters such as solid tumour volume, viable and non-viable cell count, relative organ weight, mean survival time and % increase in life span. At the doses of 100 and 150 mg/kg animals treated with ethanolic extract of *C. zeylanicum* significantly inhibited the tumor volume, packed cell volume, tumor (viable) cell count and hematological parameters came back to more or less normal levels [33].

### Diuretic, analgesic and anti-inflammatory activity

Chang *et al.* (2011) studied the diuretic effect of *C. lanceolatum* in rats and rabbits. The evaluation of anti-inflammatory activity was performed using fresh egg white-induced paw edema in rats, carrageenan-elicited paw edema in adrenalectomized rats, and dimethyl benzene-induced inflammation in mice. Also the estimation of analgesic action in mice by using acetic acid-induced writhing test and the hot-plate test was done and it was concluded that *C. lanceolatum* has evident diuretic, anti-inflammatory, and non-central analgesic activities [34].

### Toxicological evaluation of *Cynoglossum glochidiatum*

The roots of *Cynoglossum glochidiatum* used as aphrodisiac in Orissa by tribal people were studied to evaluate the toxic effects in two phases in albino rats and found to be nontoxic without mortality [35].

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