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RESEARCH ARTICLE

CROTALARIA JUNCEA LINN.: A COMPREHENSIVE REVIEW

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ABSTRACT

Plants are playing a vital role in the treatment of various diseases in all important system of medicine. There are many plants on the earth which lies unexplored in the field of medicine. One such plant is *Crotaleria juncea* L. which is known as sunhemp, pundi or san etc. valuable fibre is obtained from the bark which has greater tensile strength and more durable than jute. Plant is a rich source of alkaloids, particularly pyrrolizidone alkaloids and toxic aminoacids in seeds. *C. juncea* having a promising place in the Ayurveda for its abortificient, emetic, laxative, leprosy and blood diseases. In the present review the complete update on the plant has been enlightened to bring out the hidden medicinal values of the plant.

INTRODUCTION

A complete understanding of medicinal plants involves a varoius factors like botany, chemistry, quality control, pharmacognosy and pharmacology. In addition there is a large wealth of knowledge in the medicinal and other properties of plants inherited by recitation (by words of mouth) from one generation to another generation by the tribal societies (Trease and Evans, 2002). *C. juncea* is a well known plant, the bark (fibre) is used in the pulp industry. It is an herbaceous plant belongs to family Fabaceae. It is commonly called as san, sun hemp, pundi etc. it is used as fodder in limited extent. A plant contains series of chemical constituents like phenols, flavonoids, steroids alkaloids. Alkaloids makes the plants pharmacologically and therapeutically active. It has a prominent place in Ayurveda due to its various pharmacological activities like (Seeds) psoriasis, skin diseases and as an emmenogogue. The leaves antemetic, laxative, abortifacient, and bleedin g disorders. The flowers in treating gonorrhea and blood diseases (Kirtikar and Basu, 1935; Wealth of India, 1952; Chopra *et al*., 1956).

Taxonomy

Plant Profile

Botanical Name: *Crotalaria juncea L.*
Kingdom: *Plantae*
Subkingdom: Tracheobionta
Super division: Spermatophyta
Division: *Magnoliophyta*
Class: *Magnoliopsida*
Subclass: Rosidae
Order: Fabales
Family: Fabaceae
Genus: **Crotalaria** L.
Species: **Crotalaria juncea** L.

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Habitat

C. juncea is grown in tropical, subtropical, and temperate locations from sea level to approximately 5,000 ft elevation (FAO, 2007), but is not found in the wild.

Vernacular names

Kannada: Pundi; Hindi: San; Chinese: Yin du ma, Tai yang ma, Zixiaorong; French: Chanvre Du Bengale, Crotolaire Jonciforme; German: Bengalischer Hanf, Bombay Hanf, Sanhanf; Hawaiian: Sannai, Sunn; Japanese: Kurotararia Junsea; Khmer: Kâk´tung; Malay: Orok-Orok Lembut (Indonesia); Portuguese: Cânhamo Da India, Cânhamo-Da-índia, Cánhamo Da India, Canhamo-Da-India, Cânhamo-De-Bengala, Crotalária, Crotalária Júncea, Crotalária; Russian: Krotalyariya Sitnikovaya; Spanish: Cáñamo De La India, Cáñamo San; Thai: Po Thueang

Vietnamese: CâyMung.

Botanical description

C. juncea is an erect, herbaceous, laxly branched annual, 1-3.5 m tall (Fig. 1). The stems are cylindrical and ribbed, pubescent, up to 2 cm in diameter; vegetative parts covered with short, downy hairs.

Figure 1. Legends:
Fig.A-D *Crotaleria juncea*.Linn.
A. Habitat of *Crotaleria juncea*
B. Flowering plants of *Crotaleria juncea*
C. Root nodules of *Crotaleria juncea*
D. Seeds of *Crotaleria juncea*

Long, strong taproot, well-developed lateral roots, and multi-branched and lobed nodules, up to 2.5 cm in length. Leaves are simple, linear-oblong to oblong, 4 to 10 centimeters in length. Flowers are scattered, on terminal racemes, 8 to 20 centimeters long. Calyx has long lobes and densely covered with brown hairs. Corolla is yellow and about 2.5 centimeters long. Hairy pods are oblong, and about 3 centimeters long. Pods cylindrical, 3-6 x 1-2 cm, tomentose, light brown, containing about 6 seeds. Seed heart-shaped, with narrow end strongly incurved, up to 6 mm long, dark brown to black.

Distribution

Crotalaria juncea is generally considered to have originated in India, where it has been cultivated since prehistoric times (Montgomery, 1954). The genus name Crotalaria means rattle and is indicative of the noise made by the seeds shaken in the mature pods (White and Haun, 1965). The species name *juncea* was given to this plant by Linnaeus because of its resemblance to the Spanish broom of the Mediterranean region with its green rush like, scantily leaved branches (Kundu, 1964). It is also found in Bangladesh, Botswana, Bhutan, Brazil, Pakistan, Indonesia, Cambodia, Ethiopia, Japan, Kenya, Laos, Namibia, Russian Federation, Sri Lanka, Rhodesia, Malaysia, Taiwan, Thailand, China, South America and Africa (Fig. 2- Plant distribution map) (Rotar and Joy, 1983; Orwa *et al*., 2009).

Plants Uses

General Uses

Fodder: *C. juncea* is widely used as forage in Sri Lanka and southern Africa. The presence of compounds that cause unpalatability, which are poisonous under some conditions, is typical of the genus Crotalaria. Seeds may contain about 35-40% protein; stems are about 40% fibre. Leaves and stems are dried, as animals do not eat *C. juncea* when it is green. Sheep will not suffer any adverse effects if forced to eat dried forage, but they will suffer from toxicity if fed large quantities of seed. *C. juncea* should not be fed to horses, and intake of hay by cattle should be restricted to about 10% of their diet.

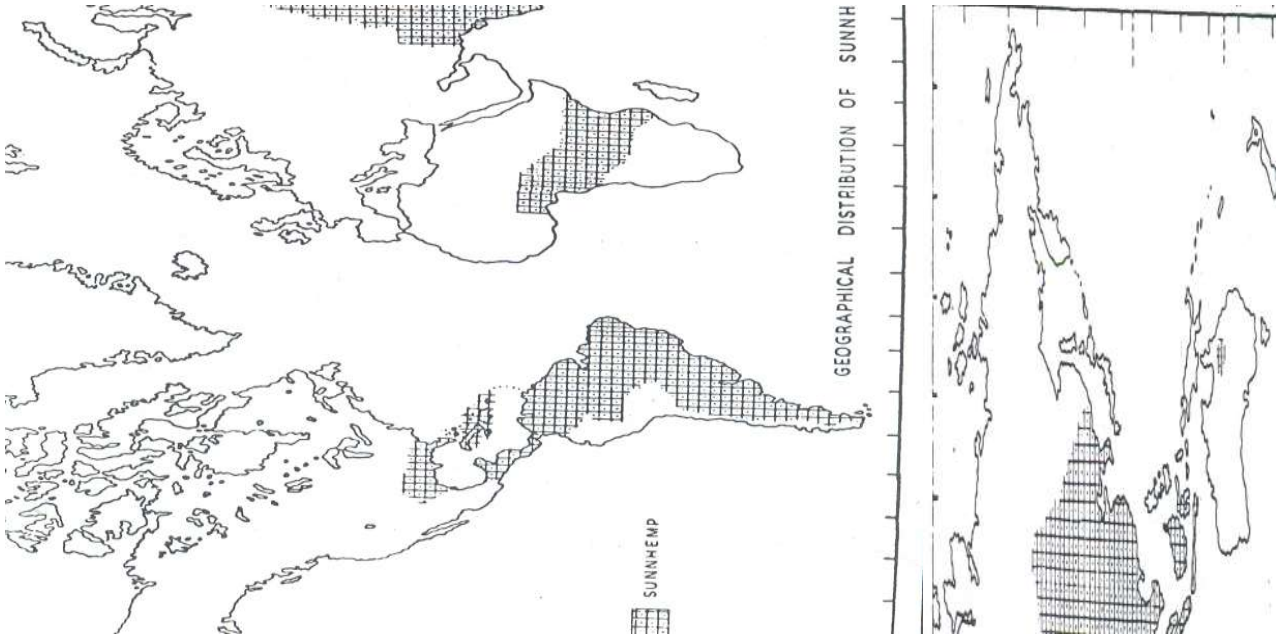

Figure 2. Geographical distribution of *Crotalaria juncea* Linn

Fibre: The major significance of sunn hemp lies in its valuable fibre, which is extracted from the bark and used to make twine and cord, canvas and fishing nets, and paper and pulp. Sunn hemp fibre has greater tensile strength and is more durable under exposure than jute. It is not as strong as hemp (Cannabis sativa). The 3 main properties that make sunn hemp an excellent candidate for paper-making are 1) good yields of bleachable sulphate pulps, 2) pulp strength properties that are equal to or greater than those of mixed southern hardwood pulp, and 3) length-to-width ratio of bastfibre that is greater than that of wood fibres. Stems are composed of 2 fibres-the bast and the woody core. Bastfibres, located in the outer bark, are much longer than the core fibres, but the 2 fibre widths are similar. The proportion of bark in the total stalk by dry weight ranges from 15% to 20%. Sunn hemp fibre is used in twine, rug yarn, cigarette and tissue papers, fishnets, sacking, canvas and cordage. Fibre is stronger when wet; it is fairly resistant to mildew, moisture and microorganisms in salt water.

Poison: The seeds of many Crotalaria species contain toxic pyrrolizidine alkaloids. Trichodesmine is the principal toxic alkaloid in *C. juncea*. The seeds are reported to contain trypsin inhibitors; they are said to be poisonous to cattle, and they can poison both horses and pigs.

Medicinal Uses

The seeds are used to purify blood and in treatment of impetigo and psoriasis, other skin diseases and as an emmenogogue. In ayurveda, the leaves are used as an emetic, laxative, abortifacient and analgesic, and for treating diarrhea and bleeding disorders. The flowers are useful in treating gonorrhea and blood diseases. The leaves are used for external application to relieve swelling, leprosy and other skin diseases. The juice of the leaves is used in Southern India, both internally and externally for treating scabies and impetigo (Kirtikar and Basu, 1935; Wealth of India, 1952; Chopra *et al*., 1956).

Personnel observation: The seeds are used by Ayurvedic Physicians of north Karnataka to regulate the fertility in woman (personal communication with women of rural natives).

Phytochemicals

The seeds contain various Csuch as junceine, riddelliine, senecionine, seneciphylline and trichodesmine (Smith and Culvenor 1981) (Figure 3). This was confirmed again by Nurhayati and Ober (2005) who did not detect alkaloids in cotyledons, leaves, flowers or roots of *C. juncea*, which suggests that alkaloid production is limited to the seeds. A study of free amino acids in Crotalaria seeds indicated a high correspondence between free amino acid distribution and taxonomic relationships in the genus (Pilbeam and Bell 1979b). Some Crotalaria species have the toxic amino acids a-amino-b-oxylaminopropionic acid, a-amino-goxylaminobutyric acid and/or a,g-diaminobutyric acid in the seeds (Pilbeam and Bell 1979b). Another compound reported to be in sunn hemp seeds is cardenolidecardiogenin 3-O-beta-D-xylopyranoside (Yadav and Thakur 1994).

Toxicity of Crotalaria spp.

About 20 species of *Crotalaria* in tropical Africa alone are known to cause poisoning to cattle (Polhill, 1982).

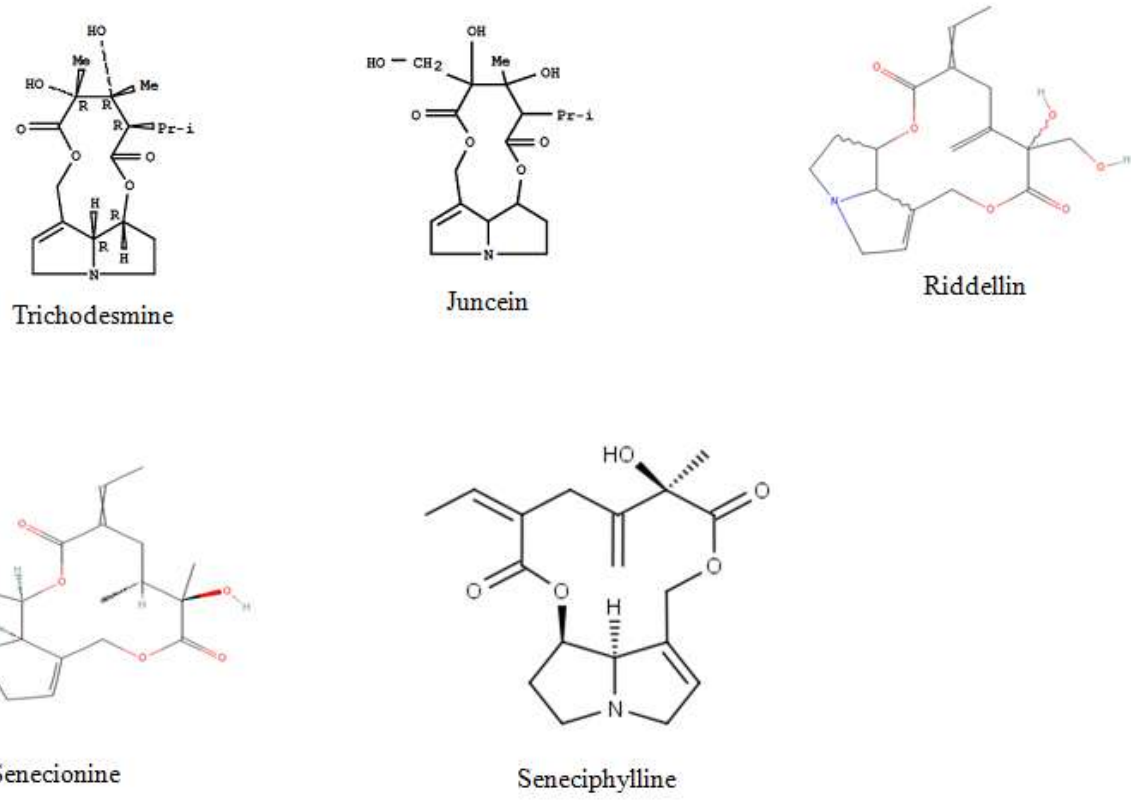

Figure 3. Pyrrolizidine alkaloids junceine, riddelliine, senecionine, seneciphylline and trichodesmine

The symptoms seem to vary but common syndromes include inflammation of the horn, lameness and occasional starvation due to refusal by the animals to eat. The more lethal forms of poisoning affects the nervous systems; lungs and liver (Polhill, 1982). Poisoning seems to be serious at flowering and seed stages. Probably this is due to accumulation of the toxic alkaloid substance called *Crotaline* in these parts of the plant at maturity. Steyn and van de Walt (1945) reported loss of wool when sheep were fed *C. juncea* hay that was cut at flowering stage. They suggested that supplementation level in livestock feeds should not exceed 10% of the daily ration. Rupper (1984) observed that when *C. ochroleuca* seeds are sprinkled between the bags containing cereal grains, storage pests were killed instantly. They reappear six to nine months later. The fact that *Crotalaria* spp. have been observed to be toxic in one location but non-toxic in another, may explain the contradicting reports. The reasons why one species can be toxic in one location and non-toxic in another is still not yet understood. *Crotalaria ochroleuca* may be poisonous at flowering stage and the seeds may contain some poison, however, the legume seems to be non-toxic before flowering (Rupper, 1984). Further research on this area is needed to establish the effect of feeding the legume on livestock performance and health.

Established scientific uses

Antibacterial activity

The study of ethnolic extractof seeds and flower were evaluated for the antibacterial activity by the agar disc diffusion method. The seed possess significant antibacterial activity against *E. coli, K. pneumonia, P. aeruginosa, S. aureus and V. chlorae* than flower. The zone of inhibition ranged between 14.00 to 18.00mm (Hemendra and Sushil 2010). The antibacterial activity of *Crotaleria juncea* seed pet. ether extract (CJSPE) was evaluated against two strains of gram positive and six strains of negative bacteria by the paper disc agar diffusion method. Results showed that CJSPE have good antibacterial activity against the *Staphylococcus aureus, Escherichia coli Klebsiella Pneumonia* and *Shigellaflexneri*. However, the zone of inhibition showed by CJSPE was found less than that of ciprofloxacin (5 _g/disc) used as a standard in the experiment. (Chouhan *et al*., 2011).

Antifertility Effects

Study evaluated the antifertility activity of various extracts of *Crotalaria juncea* seeds in male mice. Results showed decrease in testis and accessory organ weights, with spermatogonia, spermatocytes, spermatids and sperm counts were reduced at 25 mg/kg/day. There was a significant reduction in the protein and glycogen contents and an increase in the cholesterol content in the testis, epididymis and vas deferens. The ethanol extract showed the most potent antispermatogenic activity. Study concludes that various extracts arrest spermatogenesis and are likely to have antiandrogenic activity (Vijaykumar *et al*., 2004). In female rats, the ethanol extract of Crotalaria juncea seeds which showed promising antiovulatory activity in female albino rats was examined for the isolation of its active fractions. After preliminary trials, the fraction I (200mg/kg body weights) showed maximum antiovulatory activity when administered orally to the rats for 30 days. Decreased number of healthy follicles (Class I – ClassVI) and corpora lutea and increased number of regressing follicles (Stage IA, Stage IB, Stage IIA, Stage IIB) were observed in the ovary after 30 days treatment. The treatment had increased the cholesterol level and acid and alkaline phosphatase activity and decreased protein and glycogen contents of the ovary. Estrous cycle was affected as a significant increase in estrus and metaestrus phases and decrease in diestrus and proestrus phases in the treated groups during experimental period of 30 days were observed. These results suggest that a fraction of ethanolic extract of crotalaria juncea might be used as a contraceptive in the females (Vijaykumar and Saraswati 2007). In females rats, the ethanol extract at 400 mg/kg inhibited pregnancy and mean number of implants. It also found to be effective in interruption of pregnancy which received the treatment from day 8-14 of pregnancy (Vijaykumar *et al*., 2004).

Antifungal Activity

In vitro assay indicated that *cj*-AFP was able to inhibit the development of the filamentous fungi *Fusarium oxysporium.* This protein was also subjected to amino acid *de novo* sequence, showing no homology to existing proteins in the databank. Author believe that *cj*-AFP protein discovery could contribute, in near future, to the development of biotechnological products as transgenic plants with resistance to pathogenic fungi (Pelegrini *et al*., unpublished data).

Antiarthritic/ Antiinflemmatory activity

Arthritis was induced in male albino Wistar rats by injection ofComplete Freund's Adjuvant (0.1 ml) into the left foot pad ofthe animals. Treatment with ethanolic extract of the leaves of *Crotalaria juncea* at 200 and 400 mg/kg and standard indomethacin (0.3 mg/kg) was started on the same day and continued up to day 12. The paw volume was measured on day1, 5, 12 and 21 for both the paws and antiarthritic activity was evaluated. The drug ethanolic extract of the leaves of *Crotalaria juncea* produced a reduction in the inflammation of the paw produced due to Complete Freund's Adjuvant. The anti-arthritic action started on the day 5 and continued till day 12 and the activity was comparable to that of the standard onboth days. Significantly inhibited adjuvant induced arthritis and has significant anti-inflammatory effect (p<0.001) (Purnima *et al*., 2006). The anti-inflammatory activit of *Crotaleria juncea* seed Petrolium extract (CJSPE) was determined by carrageenan induced rat paw edema model. Study demonstrated a dose dependant reduction of carragennan induced rat paw edema by the CJSPE. 100 and 200 mg/kg oral dose of CJSPE moreover, significant anti-inflammatory activity (Chouhan *et al*., 2011).

Antioxident

The antioxidant activity of *Crotalaria juncea* seed oil (CJSPE) was evaluated by in vitro assay methods which revealed the 2,2- Diphenyl-1-picrylhydrazy l (DPPH), hydroxyl and superoxide radical scavenging activity of CJSPE; its

antioxidant activity was found to be concentration dependent and IC50 values were 132.31, 286.409 and 31.254 g/ml respectively. Moreover, CJSPE has displayed dose dependant, significant inhibition of NO production in the isolated rat peritoneal macrophages (Chouhan *et al*., 2011). *Crotalaria juncea* shows high antioxidant enzyme activity in response to cadmium (Cd) *Crotalaria juncea* the reactive oxygen species (ROS) induced by Cd, are metabolized by CAT in the peroxisomes. In the case of GR activity, the increase observed in the leaves suggest that GR (glutathione reductase) is also playing a role in the detoxification of Cd induced ROS possibly via the glutathione-ascorbate cycle (Pereira *et al*., 2002).

The response of *Crotalaria juncea*seedlings to nickel (Ni) was investigated. The results suggest that in *Crotalaria juncea* GR participates in the detoxification of Ni-induced reactive oxygen species via the glutathione-ascorbate cycle (Cardoso *et al*., 2005). Ultraviolet-B supplemental radiation (UV-B) radiation increases the production of reactive oxygen species (H2O2, O2–, OH−). These oxygen species are extremely reactive and have a cytotoxic nature (Bowler *et al*., 1992). The role of antioxidant enzyme activities in *Crotalaria juncea* under control without UV-B treatment and UV-B was investigated. UVB treatment for 6 h for 4 days resulted in severe inhibition in catalase activity. On the other hand, the activities of peroxidase, polyphenol oxidase, superoxide dismutase and phenylalanine ammonialyase increased after the UV-B treatment when compared to control seedlings (Veluchanmy *et al*., 2009). In this study, catalase activity was decreased by UV-B treatment. Catalase is the most efficient antioxidant enzyme, which protects plants by scavenging H2O2. However, it is susceptible to photo-inactivation and degradation. *Crotalaria juncea* increases could be an adaptive mechanism to minimize the effects of UV-B radiation (Veluchanmy *et al*., 2009).

Acute Toxicity Studies

Acute toxicity studies were carried out following OECD guidelines and was found to be safe up to 2000 mg/kg body weight in albino Wistar rats (Purnima *et al*., 2006).

Toxicological Studies on Seeds

Study showed the administration of a dose of 200 mg/kg of extracts of seeds on liver, kidney, spleen and adrenals of adult rats caused significant alterations. Organ net weight decreased, histology showed disintegration necrosis and degeneration in the liver, renal tubular cell degeneration and exfoliation, zonaglomerulosa hypertrophy in the adrenals, and splenic increase in megakaryotic cells and lymphocytes (Prakash *et al*., 1995).

Hepatoprotective activity

The petroleum ether extract of *C. juncea* seeds at low and high dose (100mg/kg and 500mg/kg) were tested for its efficacy against thioacetamide induced acute hepatic damage in rats. The different groups of rats were administered with thioacetamide (100mg/kg, s.c.). Drug Silymarin (100 mg/kg,) was used as reference standard. Histopathological changes were observed. From the experimental results it was proved that the *crotalaria junceas*eed extract (CJSE) possesses hepatoprotective potency in a dose dependent manner by reducing the elevated levels of marker enzymes and by increasing the decreased antioxidant enzyme activity (Rahila *et al*., 2013).

Hyperlipidemia and Hyperglycemic activity

The anti-hyperlipidemias activity of methanolic and alcoholic leaf extracts of *Crotolaria juncea* may be due to the presence of tannins, anthra quinones, chebulinic acids, chebulic acid, ellagic acid and gallic acid. *C. juncea* was selected and this study focus on the antihyperlipidemic activity of alcoholic and methanol extract of leaves of *Crotalaria juncea* against Triton induced hyperlipidemia in mice. *C. juncea* was administered at a dose of 100 and 200mg/kg (p.o) to Triton induced hyperlipidemic mice. Atorvastatin was usedas reference standard. The statistical analyses were carried outusing one way ANOVA followed by bonferroni test using acomputer based fitting program (Prism, Graph pad.). *C. juncea* shows a significant decrease in the levels of serum total cholesterol, triglyceride, LDL, VLDL and significant increase in the level of serum HDL at the dose of 100 and 200mg/kg (p.o) against Triton induced hyperlipidemiain mice. Methanol and alcoholic extracts of *C. juncea* showed significant anti-hyperlipidemic effect and this study provides the scientific proof for their traditional claims. Therefore it effectively suppressed the Triton induced hyperlipidemia in mice, suggesting the potential protectiverole in Coronary heart disease (Harikumar *et al*., 2012). Treatment with ethanolic extract showed a significant decrease in the cholesterol, triglycerides, LDL, VLDL, blood glucose and body weight levels when compared to control group. On the other hand HDL levels were increased significantly when compared to control group. Histopathological evaluation of liver tissue showed less fatty cytoplasmic vacuoles in ethanolic extract treated group when compared to control group. It was observed that the ethanolic extract of *C. juncea* possess antihyperlipidemic and antihyperglycemic activity in a dose dependent manner (Oruganti *et al*., 2014).

Antiulcerogenic activity

Anti-ulcerogenic potential of *C. juncea* was also evaluated. For possible mechanism of anti-ulcerogenic potential, appetite suppressant activity was recorded. In indomethacin treated animals ulcer was observed, whereas *C. juncea* was found to protect the animals from ulcer formation which may be due to appetite suppressant activity. It has anti-ulcerogenic property compared to indomethacin, which may be due to appetite suppressant activity (Purnima *et al*., 2006).

Antidiarrheal activity

The anti-diarrhoeal activity of methanolic extract of leaves of *C. juncea.* (MECJ) was investigated in this study using castor oil induced diarrhea. Standard drug Atropine (3 mg/kg, p.o) was shown significant reductions in fecal output. After 30 min administration of castor oil the diarrhea was clinically apparent

in all the animals of the control group, for the next 4 h. This was markedly reduced by atropine (3 mg/kg p.o) (75%). A similar marked reduction in the number of defecations after four hours was achieved with *C. juncea*at the doses of 200 or 400 mg/kg p.o. MECJ 200 and 400 significantly inhibited the defecation (25% and 50%) MECJ 200 and 400 mg/kg, p.o. dose of extract delayed the onset of diarrhea. Small intestinal transit models in rats. The distance traveled by charcoal in the intestine was measured. Thepercent intestinal transit was increased with control (74%), but it was reduced at both doses of extract, and much more markedly by atropine (37%). MECJ 200 mg/kg, p.o dose of extract produced 20% intestinal transit induced by castor oil respectively. Whereas, MECJ 400 mg/kg, p.o dose produced 24% of castor oil induced charcoal meal transit. The MECJ showed marked reduction in intestinal transit (Ramya *et al*., 2011).

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