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CANAVALIA VIROSA ROXB.: A REVIEW

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ABSTRACT: Man has been dependent on plants for the treatment and cure of different diseases since time immemorial. Plants have served not only as a source of food and shelter but also as a very important source of different "portions" used for the treatment and cure of diseases. These portions are herbal or plant based mixtures made by traditional healers; who are individuals having a knowledge of medicinal plants of that particular area. In India, there are several thousands of medicinal plants, known to be used for specific diseases. *Canavalia virosa* is one such plant, known to be used for different curative purposes. However, it is more popular as a food plant as it is a tribal pulse. *Canavalia virosa* is a flowering plant belonging to the family Fabaceae. It is one of the lesser know vines from the genus *Canavalia.* It is not only important as an alternative protein source but also a promising medicinal plant as indicated by traditional medicine systems. This paper brings together some of the work carried out on this wonder plant by different researches.

INTRODUCTION: All civilizations have always had traditions of using herbs to promote healing. From the ancient times to date, people healed themselves with traditional herbal medicines. In the recent years, a global trend of interest has been noticed in the traditional system of medicines. Plants still remain the basis for development of modern drugs and medical plants have been used for years in daily life to treat diseases all over the world [1]. Traditional remedies are part of the cultural and religious life of the tribal [2]. The herbal medicines do not have any side effects but have benefits due to the combinations of medicinal ingredients coupled with vitamins and minerals [3].

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The presence of diverse secondary metabolites in plants is what makes them possess curative properties [4].

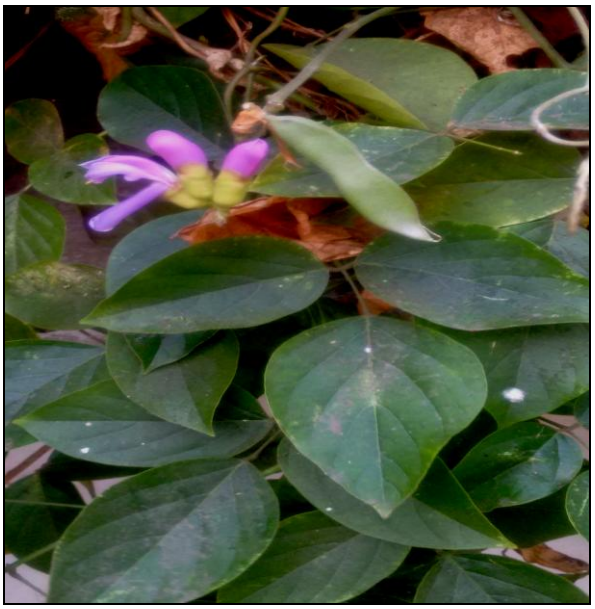

FIG. 1: ***CANAVALIA VIROSA***

The genus *Canavalia* is well known owing to the extensive carried out on *Canavalia gladiata, Canavalia ensiformis, Canavalia maritime, Canavalia rosea* etc. This genus comprises of 51 species and is widely distributed in the tropical and subtropical regions of the world. Among other members of the genus *Canavalia, Canavalia virosa* is morphologically very similar to *Canavalia gladiata* and *Canavalia ensiformis* [5].

FIG. 2: *C. VIROSA* INFLORESCENCE AND FRUIT

1.1 Taxonomic Classification:

Kingdom: Plantae

Sub-kingdom: Tracheobionta

Super division: Spermatophyta

Division: Magnoliophyta

Class: Magnolipsida

Sub-class: Rosidae

Order: Fabales

Family: Fabaceae/ Leguminosae/ Papilionaceae

Genus: *Canavalia*

Species: *C. virosa*

1.2. Synonyms:

Canavalia virosa (Roxb.) Wight & Arn. is a synonym of *Canavalia cathartica* Thouars [6].

1.3. Vernacular Names:

The vernacular names of *Canavalia virosa* are given in **Table 1**.

TABLE 1: VERNACULAR NAMES OF *CANAVALIA VIROSA* [7, 8]

Language	Vernacular Name
Hindi	*Sem*
Bengali	*Kathshim*
Oriya	*Kolasimo*
Tamil	*Kattuttambattan*
Telugu	*Adavi chemma*

1.4 Geographical Distribution:

Canavalia virosa extends southward as from Arabia, Socotra and India, through tropical Africa into north-east South Africa [9]. *C. virosa* is widely distributed all over India, and is commonly found in the Western and Eastern Ghat regions.

1.5 Botanical Description:

Perennial climber or trailer. Stem oppressed pubescent when young. Leaf trifoliolate, petiole 4-16 cm long; Leaflets 6-18 cm long, 3.5-15 cm broad, ovate, obtuse to acuminate, pubescent on both surfaces; petiolule 7-10 mm long; stipules 2 mm long. Inflorescence a peduncled raceme, peduncle 12-28 cm long; pedicel 2 mm long; bracteoles 1 mm long. Calyx pubescent, tube 6-9 mm long; upper lip 4-5 mm long, rounded or emarginate. Vexillum mauve with white veins, 2.7-3.0 cm long. Fruit 10-17 cm long, 2.5-3 cm wide, linear-oblong, each valve with a sutural rib and an extra rib below this, densely brown pubescent. Its pods measure about 10 to I5 cm, and when ripe, commonly in March, open up in a curled fashion releasing 4 to 8 ovoid seeds which are mottled brown in color [10].

1.6 Economic Importance:

More than 30 wild legumes are commonly consumed by different tribal sects in India [11-13]. One among them is *Canavalia virosa.* It is consumed as a staple food by Malayali tribals in the Kolli hills of Namakkal District, Tamil Nadu in Eastern Ghats of Peninsular India. They then soak them in water and consume the seed meal with their regular diet after boiling and decanting several

times. These legumes can be utilized to overcome the difficulties of feeding the ever-expanding world's population and protein-calories-malnutrition, particularly in tropical countries [14]. The young pods however, are reported to be poisonous in animals [15].

1.7 Ethnobotanical Uses:

C. virosa has been known for its medicinal properties for many years. In fact, it is used widely in the Siddha system of traditional medicine (originating from the state of Tamil Nadu, in India) for various ailments. The roots of *C. virosa* are made into a paste and mixed with the latex of *Ficus arnottiana*. This paste is applied on the swelling of thigh, which brings quick relief and complete curing from swelling and pain [16]. The leaves of *C. virosa* are used known to be used in the Siddha system of medicine for the treatment of peptic ulcers. They are also employed for making 'Kozhi Avarai Ilai Chooranam', a herbal medicinal powder that is made from the leaves of *C. virosa*, milk and water. This powder can effectively be used for the treatment of gastric problems such as acidity and ulceration [17]. In another system, the leaf paste is combined with the leaf paste of Takkali (Clerodendron phlomides), fowl extract and tamarind. This composite paste may be applied over swellings during body pain of affected animals to give relief. The seed of *C. virosa* is made into a paste and this paste is applied to the injured area in case of scorpion bites. It is known to give a soothing effect and reduce pain and itching. *Canavalia virosa* seed is applied on a wound after removing the seed coat. This sticks to the skin till the poison is completely removed and falls off which takes five to seven hours. There is complete relief of the poisoning in the case of Scorpion, Centipede [18].

2. Studies on *Canavalia virosa:*

2.1 Chemical composition and nutritional evaluation of *Canavalia virosa:*

Canavalia virosa seeds were collected from Tamil Nadu in Eastern Ghats of Peninsular India, and were analyzed for proximate composition, total (true) seed proteins, amino acids, minerals, and some antinutritional factors. Crude protein, crude fat, ash, and nitrogen free extractives constitute 31.3%, 4.9%, 3.8%, and 48.2% respectively. The calorific value of seed material was 1512.4 kJ/100 g Dm. The essential amino acids, isoleucine, histidine, cystine+methionine, and threonine, were present in relatively large quantities. The seeds are rich in calcium, zinc, manganese, and iron. Antinutritional factors such as tannins (5.8%), L-DOPA (4.3%), hydrogen cyanide (0.013%), and phytic acid (1.1%) are present in variable quantities [19].

2.2 Physico-Chemical Characteristics of Tribal Bean (*Canavalia virosa*) and its Alternative Tofu and Tempeh Food Products:

Increasing price of soybean becomes a serious problem for producers of traditional foods such as tempeh and tofu. These traditional foods are important protein sources for many people. Tribal bean (*Canavalia virosa*) could be used as a substitution of soybean for tempeh and tofu processing. Tribal bean old pods were peeled manually.

The peeled seeds were dried and their epidermis were removed mechanically by using an abrasive peeler to produce yellowish clean peeled beans. The beans were analyzed physically and chemically using the standard procedures. Since the tribal bean seeds contained high HCN, to minimize HCN content the beans were presoaked for 48 hours in water. The beans were then mixed with soybean at a ratio of 50:50 or 25:75 and processed for making tempeh and tofu using traditional methods.

Physico-chemical and organoleptic characteristics of the tribal bean tempe and tofu were analysed, involving organoleptic test with hedonic method, texture, as well as water, ash, protein and crude fiber contents. The results showed that tribal bean contained protein (37.30%), essential amino acids, minerals and fiber (3.1%), and a toxic substance HCN. Presoaking the beans in water for 48hours significantly reduced HCN content by 98.51%, from 1334ppm. Tofu made of a mixture of tribal bean and soybean at a ratio of 25:75 plus 2% rice vinegar as a coagulant has a white color and normal flavor appearances, and was accepted by panelists. This study suggests that tribal bean is more suitable for tempeh than for tofu based on its HCN content [20].

2.3 Anti-ulcer Activity:

Canavalia virosa leaves have been widely used in Siddha system of medicine for various diseases. The powder of Kozhi Avarai Ilai Chooranam, which is a herbal drug preparation of the leaves of *C. virosa* was assessed for its efficacy in the treatment of peptic ulcers. The powder showed a significant inhibitory effect when screened at 200 mg/kg, for the *in vivo* antiulcer activity on chemical induced ulcer in rats. Ranitidine (60mg/kg) used as reference standard. Single dose (200 mg/kg) treatment with the siddha drug Kozhi Avarai Ilai Chooranam produced 30% antiulcer effect [21].

2.4 Pharmacological Studies:

Canavalia virosa was found to have a depressant effect on the CNS of albino mice as shown by sedation potentiation of pentobarbitone hypnosis and decrease in locomotor activity. *C. virosa* per se did not have any cataleptogenic effect but it significantly potentiated morphinecatalepsy. Morphine catalepsy in albino rats is known to be central neurogenic in nature [22]. Interaction of *C. virosa* with morphine indicates central effect of *C. virosa*. Similarly, the hypothermic effect of *C. virosa* in albino rats indicated central action. The lack of any effect on electroshock convulsions and on rota rod test might indicate that *C. virosa* has no muscle relaxant property. Thus, it seems that *C. virosa* has a depressant effect on CNS, the exact mechanism of which cannot be explained with the present findings.

C. virosa was found to markedly degranulate mesenteric mast cells of albino rats in very low concentration (10pg/ml). Degranulation of mast cells leading to liberation of histamine may be responsible for the hypotension seen in clinical poisoning cases. Liberation of histamine does not explain the CNS activity of *C. virosa*.

The active constituent of *C. virosa* appeared to be very labile. None of the hot, acidic or organic solvent extractives was active. Only the cold aqueous buffered extractive was potent. The legumes are known sources of phospholipids which are also known to strongly potentiate the histamine-releasing activity of lectins on mast cells [23]. During the usual process of organic solvent extraction the in-built phospholipases present in the plant, destroy the phospholipids, so no activity was discerned in of the solvent extraction. In the cold extract, however, the activity of phospholipases is not mainfest, hence the phospholipid-lectin actions are maintained [24].

2.5 Anti-poisonous Property:

Canavalia virosa seed is directly applied over the wound after removing a portion of the seed coat by rubbing on a rough surface or by other means. The inner portion of the seed gets attached to the wound and sticks to the skin to it for several hours till the symptoms of poisoning disappear. The poison is completely removed and the dried portion of the seed falls off. It takes five to seven hours for removal of poison. There is complete relief of the poisoning in the case of Scorpions and Centipedes. Further studies led to the extraction of a lectin from the seeds by using normal saline. It is probable that this lectin found in the seeds of *C. virosa* reacts with the glycoproteins found in the venom and renders them ineffective biologically, hence alleviating the symptoms of the bite [25].

2.5 Purification, Partial Characterization and CNBr – Sepharose Immobilization of a Vaso relaxant Glucose/Mannose Lectin from *Canavalia virosa* Seeds:

A novel mannose/glucose-binding lectin from *Canavalia virosa* (designated as ConV) has been purified from seeds of *C. virosa* by affinity chromatography on mannose-Sepharose 4B column. ConV strongly agglutinates rabbit erythrocytes and was inhibited by monosaccharides (D-mannose, D-glucose, and α-methyl-D-mannoside) and glycoproteins (ovalbumin and fetuin). SDS-PAGE revealed three bands corresponding to three subunits (α β and γ) confirmed by ESI mass spectrometry with exact mass of 25,480±2 Da, 12,864±1 Da, and 12,633±1 Da, respectively. The purified lectin was more stable in pH ranging from 7.0 to 9.0, supported up to 80ºC without any loss in activity and unaffected by EDTA. ConV showed no toxicity against *Artemia sp*. nauplii and relaxed endothelized rat aorta, with the participation of the lectin domain [26].

2.6 Primary structures of concanavalin A-like lectins from seeds of two species of Canavalia: The amino acid sequences of two lectins from the

seeds of *Canavalia lineata* and *C. virosa* have been determined by the manual Edman degradation method. Both proteins were found to be highly homologous to concanavalin A, a lectin from *C. ensiformis*. All the residues suggested to participate in binding to carbohydrates and metal ions are completely conserved in the proteins [27]. The lectin was found to consist of 237 amino acids. The sequence is as follows:

1 adtivaveld typntdigdp syphigidik svrskktakw nmqngkvgta hiiynsvgkr

61 lsavvsypng dsatvsydvd ldnvlpewvr vglsastgly ketntilsws ftsklksnst

121 hetnalhfmf nqfskdqkdl ilqgdattgt dgnleltrvs sngspqgnsv gralfyapvh

181 iwessavvas fdatftflik spdshpacgi affisnidss ipsgstgrll glfpdan

(Sequence obtained from NCBI; Accession No. AAB28242)

2.7 On the routine use of soft X-rays in macromolecular crystallography. Part IV. Efficient determination of anomalous substructures in biomacromolecules using longer X-ray wavelengths:

The crystal form of concanavalin A like lectin from *Canavalia cathartica* was examined with respect to their anomalously scattering substructures using diffraction data collected at a wavelength of 2.0 Å (6.2 keV). It was observed that the substructure was found to contain more than just the protein S atoms. The data presented suggest that chloride, sulfate, phosphate or metal ions from the buffer or even from the purification protocol are frequently bound to the protein molecule and that these ions are often overlooked, especially if they are not bound at full occupancy. Thus, in conclusion, it can be made mandatory while studying any macromolecule that the structural determination is complemented with a long-wavelength data set, in addition to the soft X-ray molecular crystallography. The lectin contained two protein S atoms, one manganese ion, one calcium ion, one sodium ion and three partially occupied chloride ions (q = 0.85–0.65) [28].

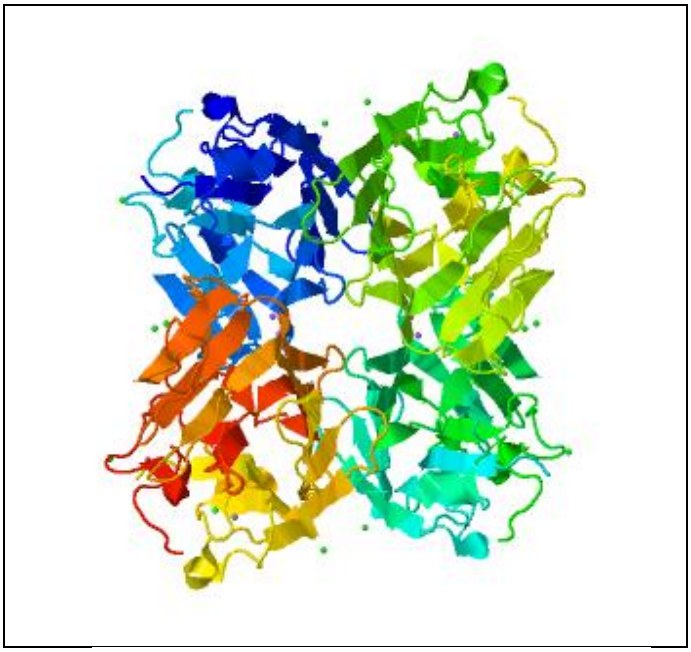

FIG. 3: ANOMALOUS SUBSTRUCTURE OF CONCANAVALIN A

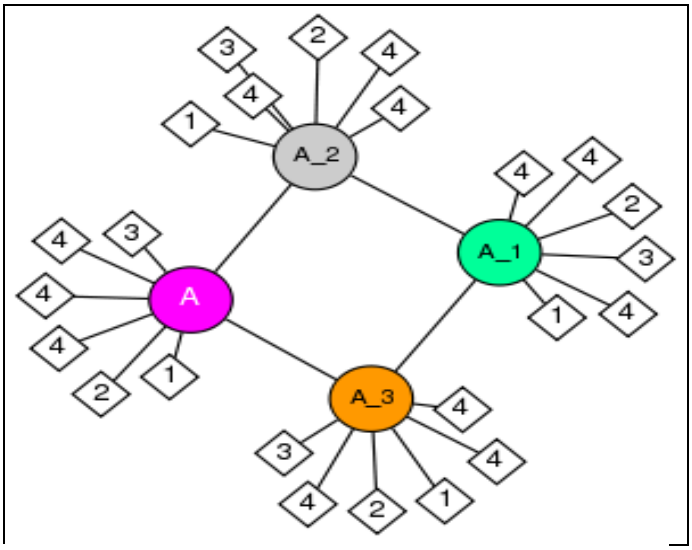

FIG. 4: ANOMALOUS SUBSTRUCTURE OF CONCANAVALIN A- LIGANDS

TABLE 2: ANOMALOUS SUBSTRUCTURE OF CONCANAVALIN A- LIGANDS

Chemicals and interactions (24 molecules)			
Label	**Count**	**Molecules**	**Interactions**
1	4	Mn (Manganese (Ii) Ion)	Concanavalin A
2	4	Ca^{++} (Calcium Ion)	Concanavalin A
3	4	Na^{+} (Sodium Ion)	Concanavalin A
4	12	Cl^{-} (Chloride Ion)	Concanavalin A

2.8 Crystal Structure of Concanavalin a Bound to an Octa-alpha-mannosyl- Octasilsesquioxane Cluster:

Concanavalin A-like lectin isolated from the seeds of *Canavalia virosa* is a tetramer, consisting of four subunits. These four subunits are identical. Being a

lectin; i.e., a protein that binds specifically to carbohydrate moieties, it is known to bind to mannose and glucose. It has four binding sites, one corresponding to each of the four subunits. The binding of Con A-like lecithin from *Canavalia cathartica* to mannose is given in **Fig. 5** [29].

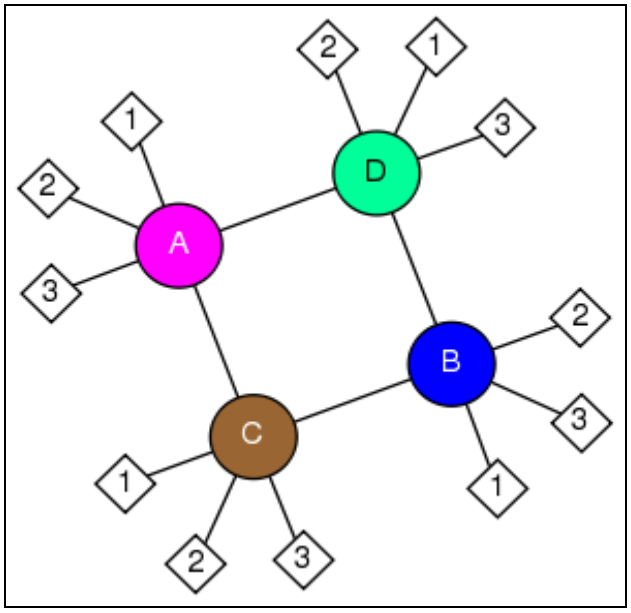

FIG. 5: BINDING OF CON A-LIKE LECTIN TO MANNOSE

TABLE 3: INTERACTIONS OF CON A-LIKE LECTIN

Chemicals and interactions (12 molecules)			
Label	**Count**	**Molecule**	**Interactions**
1	4	Ca^{++} (Calcium Ion)	Concanavalin-a
2	4	Mn (Manganese (Ii) Ion)	Concanavalin-a
3	4	Alpha-D-Mannose	Concanavalin-a

CONCLUSION: This review discusses about the importance of the perennial vine *Canavalia virosa.* It is found abundantly in India. It is commonly used as a vegetable in tribal areas. So, it can be considered as an alternative protein source as the nutritional studies show that it has high amounts of protein and a high calorific value. Another advantage of *C. virosa* as a food source is that it has good amounts of essential amino acids (histidine, threonine, isoleucine, cysteine+methionine) in addition to high amounts of minerals (calcium, manganese, zinc, iron). However, the presence of certain antinutritive elements (tannins, L-DOPA, hydrogen cyanide and phytic acid) make it necessary and a prerequisite to treat the pulse appropriately prior to cooking. It can also be used for making tofu and tempeh, after proper treatment.

C. virosa is also used in the traditional medicine system for treatment of peptic ulcers and for the cure after a scorpion or centipede bite. These activities were tested scientifically and were found to hold true.

A lectin (carbohydrate binding protein), was isolated from *C. virosa.* This was similar to Con A (a lectin) isolated from its related genus, *Canavalia lineata*. This lectin was responsible for the anti-poisoning activity of *C. virosa.* This lectin was studied extensively and its structure and amino acid sequence was determined. This gave way to studying its interactions with various ligands.

In conclusion, it may be stated the *Canavalia virosa* will also prove to be a very important plant for further study like other plants from the genus *Canavalia.* Its properties observed so far prove that it will make an interesting study, which is highly recommended for further understanding its full potential, both as an alternative source for protein and as a medicinal plant.

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CONFLICT OF INTEREST: The authors declare that there is no conflict of interest.

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