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Nutraceutical properties of jack bean, *Canavalia ensiformis* (L.) DC. proteins

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Abstract

Canavalia comprises 48 species of underutilized legumes with good yield potential. The nutritional characteristics of jack bean, *Canavalia ensiformis* (L.) DC. reveals that bean is a potential source of protein, 23% to 34%, in addition to Ca, Zn, P, Mg, Cu and Ni. Except two amino acids, methionine and cystine, the jack bean protein is adequate in most essential amino acids. Antinutritional factors and toxic factors such as trypsin inhibitors, hemagglutinins, cyanogen glucosides, and oligosaccharides are present in *canavalia*. The nutritional value of raw *C. ensiformis* as a partial substitute for soybeans meal as well. Current research is needed to focus on development of varieties with high protein and nutritional quality.

1. Introduction

Legumes are the reservoirs of quality nutrients. Proteins are the concentrated nutrients in legumes, and are components in innovative human foods. Proteins of plant origin, which are consumed as an alternative to meat proteins. They have higher protein content than cereals: hence, regarded as primary source of amino acids for humans. Legumes, *i.e.*, *Glycine max* and *Phaseolus* species are grown in the tropical and subtropical regions. They represent main sources of proteins and minerals, low amounts of saturated fats, rich in carbohydrates (up to 60%), in many vitamins (thiamine, niacin, biotin, riboflavin, folic acid), low-glycaemic food. Hence, as per the epidemiological studies, the intake of legume seeds and maintenance of a good health status in humans are correlated.

2. *Canavalia*, an under exploited leguminous crop

The genus *Canavalia* comprises 48 species of underutilized legumes. Its total yield potential is 2.5 tons-ha⁻¹ under good agronomic practices (Okonkwo and Udedibie, 1991). Fresh *C. ensiformis* seeds contain about 300 g·kg⁻¹ protein and 600 g·kg⁻¹ carbohydrates (Rajaram and Janardhanan, 1992), hence, they have great potential as a replacement for conventional feed stuffs. Jack bean, *Canavalia ensiformis* (L.) DC. is under exploited dry beans. Asia, Africa and West Indies, Latin America is having larger area of acreage. Its widely distributed underexploited legume in India. Beans (Figure 1)

contained proteins at 20-30% (dry basis) (Doss *et al.*, 2011), the beans have a amenability to be processed into a plant-based milk product, its flavonoids attributes the health benefits, including antioxidants and antidiabetes (Ade-Omowaye *et al.*, 2015). Over to other common legumes, jack bean seeds have a higher protein nutritional profile. Its protein hydrolysate is a potential substitute for soyprotein and animal protein in feeds. Various roles of legume proteins are presented in Table 1.



Figure 1: Fresh beans of jack bean.

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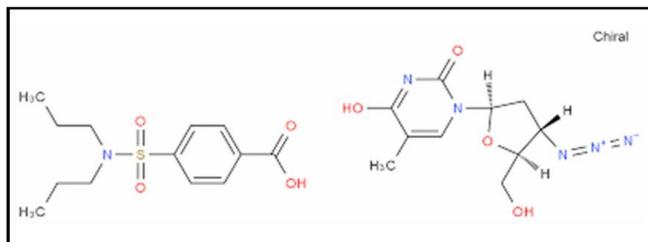
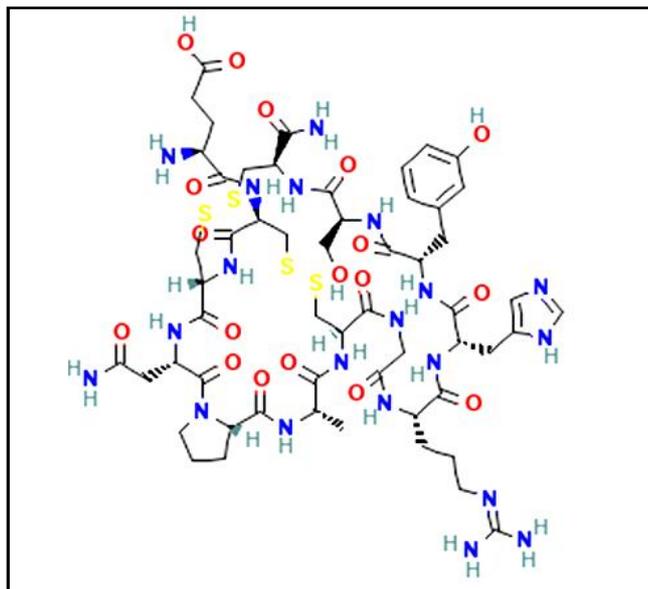
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Table 1: Various roles of legume proteins

The health benefits of of legume seeds	Cancer, diabetes, weight control, cardiovascular disease, immune response, the ageing process, osteoporosis, mental health digestive tract diseases
Small peptides of soybean, lupin, lentil, chickpea, pea, common bean	Cardiovascular protection, anticancer activity, control of inflammation, immune cell action, type 2 diabetes mellitus bone protection, control of weight, insulin sensitivity
Enzyme inhibitors of legume seeds	Control of amylases, proteases, and glycosidases; defense against exogenous attack of insects and microbes

The proteins of jack bean contributed as milestones in modern biochemistry. One of such is urease, which was the first protein to be crystallized by Sumner (1926) and the first nickel-containing enzyme established as well. The lectin concanavalin A (Figure 2) was also isolated from *Canavalia* by Sumner and Howell (1936). Another toxic protein from jack beans named canatoxin, which accounts for 0.5% of seed dry weight was also reported. Canatoxin (Figure 3) is lethal to rats and mice by intraperitoneal injection, but it is inactive given orally. In the recent time, the insecticidal properties of canatoxin were reported with its defensive role in the plant. There is a need to explore the potential local legumes, such as jack beans, which have great potential to be developed in food products. *Canavalia* is easy to cultivate due to its tolerance to acid dry land and can grow in all kinds of soils. The *in vitro* protein digestibility (63.39 to 76.92%), of JB is low because of its anti-nutritional compounds such as trypsin inhibitor. Jack bean also got the low concentrations of leucine, lysine, and tryptophan.

**Figure 2: The structure of concanavalin A.****Figure 3: The structure of canatoxin.**

On inactivation, proteins known as antinutritional factors, that are protease inhibitors and lectins, reported with health effects. The legumes reduce the risk of colon, prostate, gastric, and pancreatic cancers. Soybean, lentil, and pea proteins are active in the prevention and suppression of prostate colon, lung, liver, and mammalian, *etc.*, induced cancers. Lectins are blood grouping substances; immunomodulators and tissue markers which have ability to combine with sugars and glycoconjugates and are having role in in the activation of immune system, in the prevention of cancers, and in antimicrobial and insecticidal mechanisms. The protein extracts of local varieties of *Phaseolus vulgaris* L., like antiradical, anti α -amylase, and angiotensin converting enzyme-inhibitory activity and helps in intestinal permeability.

The toxic amino acid, canavanine, was low (27-42%) in *C. gladiata* and *C. ensiformis*. *C. ensiformis* seeds reported with high level (69.0%) of *in vitro* protein digestibility compared to the red and brown varieties of species, *C. gladiata* and *C. virosa*. The seed lipids of all the *Canavalia* variants had a large proportion of UFAs-unsaturated fatty acids (71-78%) with oleic acid as the major one (38.6-47.4%), while, other samples were richer in dietary fibre (17.5-23.6%).

When two species of *Canavalia* studied, *C. ensiformis* has more crude protein, crude fat and ash contents than *C. gladiata*. The crude protein content of *C. ensiformis* and *C. gladiata* is comparable to that of ground nut, *Mucuna utilis*. The crude lipid contents are closer to the values reported for the seeds of *Pisum sativum*, while contents of minerals, K and Ca, are found to be higher and the other minerals like P, Ca, Mg, Fe, Cu, Mn and Zn are lower in both the species of *Canavalia*. Hence, *Canavalia* species can be considered as good sources of minerals because any diet which meets 70% of recommended dietary allowances values. Both albumins and globulins formed the major seed proteins as found in the other common pulses. Glutamic acid, aspartic acid, isoleucine plus leucine, tyrosine plus phenylalanine and lysine were the major amino acids as in the wild populations of *Vigna minima* (Siddhuraju and Becker, 2001).

The nutritional value of raw *C. ensiformis* as a partial substitute for soybeans meal was investigated by Solomon *et al.* (2018). The lysine, histidine, and phenylalanine were significantly higher, while crude protein and other essential amino acids were significantly lower in *C. ensiformis* seed meal compared to soybean meal. Feeding trial revealed that replacing about 40% soybeans meal with *C. ensiformis* in the diet of *Clarias gariepinus* is possible without significant effect on growth and nutrient utilization.

3. Conclusion

From the above, it is concluded that jack bean, *C. ensiformis* is a leguminous crop with future potential. Jack bean beans are potential

sources of protein in addition to minerals. The nutritional value of raw *C. ensiformis* as a partial substitute for soybeans meal as well as per the recent investigations. Current research is needed to focus on development of varieties with high protein and nutritional quality in jack bean for more use of jack beans in food industry.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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