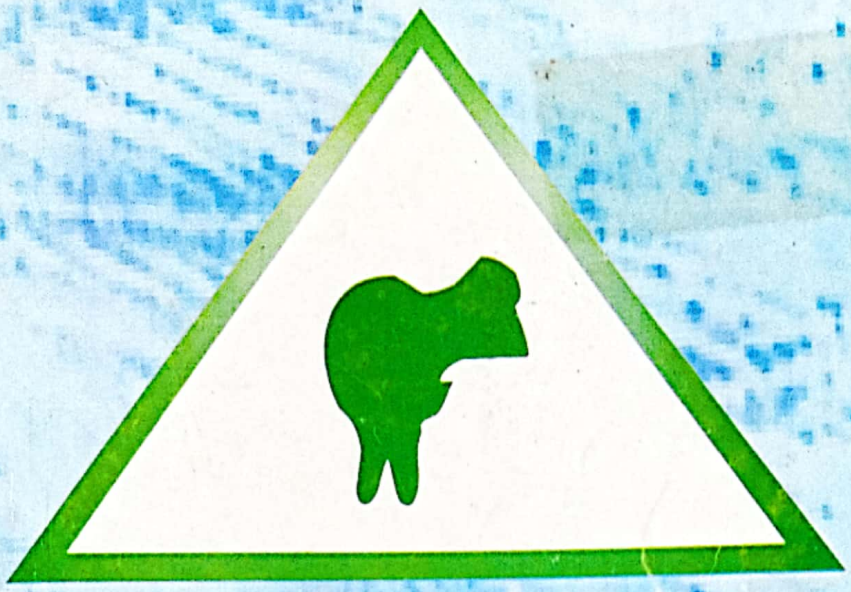
ISSN NO: 978-[illegible]

NEW CHALLENGE IN ANIMAL PRODUCTION: THE WAY FORWARD



ASAN

Proceedings of 11th Annual Conference of ANIMAL SCIENCE ASSOCIATION OF NIGERIA 18TH - 21ST SEPTEMBER, 2006 INSTITUTE OF AGRICULTURAL RESEARCH & TRAINING, IBADAN.

EDITED BY:

A. M. RAJI
J. A. OLUOKUN
S. O. ODUKOYA

ANIMAL SCIENCE ASSOCIATION OF NIGERIA

Proceedings of the 11th Annual Conference

MRS. K. E. AKANDE

Theme

New Challenged In Animal Production:
The way Forward

Editors

A. M. RAJI
J. A. OLUOKUN
S. O. ODUKOYA

18TH - 21ST SEPTEMBER, 2006
Institute of Agricultural Research & Training, Ibadan

ISSN 978-34777-2-2

Re-typesetting and formatting by:

Dr. A. Raji: College of Animal Health and Production Technology
IAR&T, Moor Plantation, Ibadan.

Published by:
The Animal Science Association of Nigeria

Printed by:
IAR&T, Moor Plantation, Ibadan

Copies of the Proceedings can be purchased from: **Dr. K. Adesehinwa** - Secretary, Animal Science Association of Nigeria IAR&T, Ibadan.

TRUSTEES AND NATIONAL EXECUTIVE COUNCIL OF THE ANIMAL SCIENCE ASSOCIATION OF NIGERIA

MEMBERS BOARD OF TRUSTEES

1. ALHAJI AZEEZ O. BELLO
2. PROF. G. M. BABATUNDE
3. PROF. O. A. OSINOWO
4. PROF. I. I. DAFWANG
5. PROF. C. O. UBOSI

NATIONAL EXECUTIVE COUNCIL

1.	Dr. G. O. Oyediji	-	President
2.	Prof. S. O. Alaku	-	1st Vice President
3.	Alhaji Habib Abba	-	2nd Vice President
4.	Dr. A. O. K. Adesehinwa-		General Secretary
5.	Dr. F. A. S. Dairo	-	Asst. General Secretary
6.	Mr. A. R. Asafa	-	Treasurer
7.	Mr. S. O. Taiwo	-	Financial Secretary
8.	Dr. Tolu Ososanya	-	Publicity Secretary
9.	Dr. Akin Hassan	-	Editor - in- Chief.
10.	Dr. R. A. Hamzat	-	Deputy Editor - in - Chief.
11.	Prof. A. M. Bamgbose	-	Ex-Officio
12.	Mrs. M. O. Omotoso	-	Ex-Officio
13.	Dr. Bazil Nw	-	Ex-Officio

Physiological and nutritional implications of the antinutritive constituents of jackbean (*Canavalia ensiformis*) seeds : a review.

K.E. Akande

Animal production programme,
Abubakar Tafawa Balewa University,
P.M.B. 0248, Bauchi State,
Nigeria.

Introduction:
The use of untreated (raw) seeds of jackbeans (*Canavalia ensiformis*) in diets of livestock nimals is restricted by the presence of various factors which are toxic. However, properly processed jackbean seeds have great potential for inclusion in animal diets when other sources of vegetable protein (soybeans, groundnut cake, and cotton seed meal) are either not available or are too expensive (Perez, 1984; Fabiyi, 1999).
When considering toxic and antnutritional factors in the seeds jackbean or other seeds which may serve as potential feedstuff for livestock, it is worth noting that it is only the toxicity associated with oral ingestion of the factor that has any nutritional significance. This is because a factor which may be toxic if injected into the body may not be toxic if orally ingested due to possible modification by the gastro-intestinal tract (Carlini and Udedibie 1997).

Discussion: Anti-nutritive constituents of jackbean plant
The use of legumes for livestock nutrition is impeded by the anti-nutritional substances in their raw seeds and foliage. Anti-nutritional factors are substances that are found in feedstuff which reduce their nutritional value and also affect the animals adversely in various ways. The deleterious effects of ingested raw legumes have been attributed to the presence of anti-nutritional factors. Thus, feeding chickens on diets containing raw legumes depressed growth (Ologhobo, *et al.*, 1993), inhibited amino acid absorption (Santidrian *et al.*, 1988), induced pancreatic hypertrophy (Roebuck, 1986) and caused marked alterations in the normal activities of some hepatic and extrahepatic enzymes (Aletor and Fetuga, 1984). In common with a number of other tropical legumes, both the foliage and seeds of the jackbean plant contain anti-nutritional factors which affect its nutritional quality for monogastric animals.

Concanavalin A : Concanavalin A, a lectin found in jackbean was first described by Sumner and Howell (1936). Concanavalin A constitutes about 20% of the total protein of the seed (Dalkin and Bowles, 1983). Concanavalin A is a potent haemagglutinin and it is capable of agglutinating the erythrocytes of many animal species and can also react with the sugar components of intestinal cells causing a disruption in cell structure which leads to abnormalities in nutrient absorption. Jayne-Williams (1973) postulated that lectin-induced disruption of the intestinal cell structure permits invasion of lymph, blood and liver by bacteria normally confined within the lumen of the gut. Consequently the animal succumbs to otherwise innocuous organisms. Concanavalin A adversely affects nutrient absorption and utilization by various mechanisms. It binds to the glycoprotein and glycolipids of the disgestive tract mucosa (Jaffe, 1980), interferes with the adherence of enterobacteria of the intestinal wall (Jayne-Williams, 1973) and inhibits the activity of the enzymes of the brush border of the enterocytes (Rosenthal, 1972). Concanavalin A has been implicated in the pathogenesis of coeliac disease (Kolberg and Sollid, 1985) and likely has several negative effects on protein metabolism, hormonal function, enzyme activities and immune functions (Pusztai, 1989). It induces severe reduction in feed intake of monogastrics (Liener, 1953; Larue – Achagiotis *et al.*, 1992).

Trypsin inhibitors: Trypsin inhibitors have been implicated in reducing protein digestibility and in pancreatic hypertrophy (Liener, 1976). They are polypeptides that form well-characterized stable complexes with trypsin on a one-to-one molar ratio, obstructing the binding sites and disrupting the enzymatic action (Carlini and Udedibie, 1997). Borchers and Ackerson (1950) reported that trypsin inhibitors in the seeds of jackbean were heat-labile. Babar *et al.* (1988) confirmed this by complete inactivation of trypsin inhibitors in jackbean seed and meal following 24 hours of soaking in water prior to cooking for just 20 minutes.
Toxic non- protein amino acids jackbean seeds : Toxic non-protein amino acids appear to play a major role in determining the nutritional value of a number of tropical legumes (D'Mello, 1982). It has been proposed that these amino acids act antagonistically towards certain nutritionally important amino acids (Liener, 1980). Fowden

(1971) suggested that the metabolic pathways culminating in the synthesis of certain non-protein amino acids might reflect subtle alteration in the genome responsible for directing the formation of crucial amino acids. Bell (1971) reported that while non-protein amino acids function primarily as storage metabolites, they may also provide an adaptive advantage to the plants, for example, to render the plant less susceptible to attack by various animals and lower plants. The seeds of jackbean contain two non-protein amino acids, canavanine and its degradation product, canaline (Duke, 1981).

Canavanine : The toxic, non-protein amino acid, canavanine, occurs widely in unbound form in various legumes plants of the family papillionoideae (Bell *et al.*, 1978) and abundantly in *Canavalia ensiformis (L.) DC.)* by Kitagawa and Tomiyama (1929) Canavanine toxicity in higher animals is not completely understood (Belmar *et al.*, 1999). Canavanine is believed to exert its toxic influence by virtue of its structural similarity with the nutritionally indispensable amino acid, arginine. The toxicity of canavanine to insects (Rosenthal, 1977) and other organisms (Walker, 1955) is well established and the role of this amino acid in plant defence mechanisms was reported by Bell *et al.*, (1978). The deleterious effects of *Canavalia ensiformis* for vertebrate animals have, in part, been attributed to the presence of canavanine (D'Mello *et al.*, (1985). Canavanine may antagonize arginine and interfere with ribonucleic acid (RNA) metabolism (Rosenthal, 1982). Canavanine has been demonstrated to reduce feed intake of non-ruminants but this was observed only at the equivalent of about 300/kg dietary level of raw jackbean (Tschiersch, 1962).

Enneking *et al.* (1993) and Michelangeli and Vargas (1994) reported reduction in feed intake of monogastrics when the feeding of pure canavanine was done. However, the effect of feeding pure canavanine may be different from its effect as a component of a feedstuff because of differences in release in the gut. The heat stability of canavanine poses a formidable problem with regard to detoxification. However, it has been reported that canavanine is hydrosoluble (Obizoba and Obiano, 1988; D'Mello and Walker, 1991).

Canaline: Hydrolytic cleavage of canavanine by arginase results in the production of urea and canaline, a structural analogue of ornithine which is a derivative of arginine. This non-protein amino acid is also found in jackbean seeds. It is also heat-stable, but solubilizes in water. The derivative of canavanine, canaline, inhibits the activity of transaminases (Rosenthal, 1982).

The structural similarity of canaline to ornithine allows canaline to react with the pyridoxal phosphate moiety of BG-containing enzymes to form a covalently bonded stable schiff base. Therefore, canaline has been shown to be a potent inhibitor of pyridoxal phosphate-dependent enzymes (Rahiala, 1973; Rosenthal 1981). However, canaline toxicity in animals has been suggested to occur in the following ways: by inhibition of enzymes, by competition with ornithine in the arginine urea cycle; or by forming a complex with pyridoxal phosphate cofactor in a manner similar to mimosine (Acamovic, 1987).

Saponins: Saponins have been reported to be detectable in jackbeans (Acamovic, 1987; Udedibie *et al.* 1988). Udedibie *et al.* (1988) found that saponins were not detected after boiling jackbeans for the hour. It has been reported that saponins can affect animal performance and metabolism in a number of ways as follows:- erythrocyte haemolysis, reduction of blood and liver cholesterol, depression of growth rate, bloat (ruminants), inhibition of smooth muscle activity, enzyme inhibition and reduction in nutrient absorption. (Cheeke, 1971). Saponins have been reported to alter cell wall permeability and therefore to produce some toxic effect when ingested (Belmar *et al.*, 1999).

Others : About 1.3% of polyphenols have been reported in *Canavalia* and, like trypsin inhibitors, they are destroyed by moist heat (30 minutes) rather than dry heat (Babar *et al.*, 1988). It has been reported that there is 108mg/kg hydrogen cyanide in raw jackbean seeds (SECAB, 1990), although the cyanogenic glycosides and terpenoids in *Canavalia* are eliminated within 30-60 minutes by boiling (Udedibie *et al.*, 1988).

Conclusion :

Jackbean has a high potential as a protein replacer, but the toxicity conferred by the heat labile and non - heat labile toxins severely restricts its use in monogastric nutrition. Detoxification of the antinutritional factors is necessary for the improvement in the nutritional quality of the legume and to effectively utilize their full potential as livestock feed ingredient. Several authors have reported that soaking, cooking, toasting, autoclaving, extrusion cooking, sprouting, cracking and chemical treatment improve the quality of the legume, because of the removal or inactivation of the antinutritional factors. In many instances, for effective detoxification process, a combination of two or more methods may be required.

References

Acamovic T. (1987) analysis and nutritional evaluation for young chicks of some toxic factors in three novel legumes.PhD Thesis, University of Edinburgh.

Aletor, V.A. and Fetuga, B. L (1984). Influence of raw and cooked limabeans on some liver enzyme activity in the rat. *Nutrition Reports International.*

Babar, V.S., Chava, J.K and Kadam, S.S. (1988). Effects of heat treatments and germination on trysin inhibitor activity and polyhenols in jackbean (*Canavalia ensiformis*). Plant food for Human Nutrition 38:319-324.

Bell, E.A. (1971). Comparative biochemistry of non-protein amino acids. In:Chemotaxonomy of the Leguminosae. (eds. Harborne, J.B., Boulter, B. and Turner, B.L.). Academic Press, New York. Pp 179-206.

Bell, E.A., Lackey J.A. and Polhill, R.M. (1978). Systematic significance of canavanine in the papilionoideae (Faboideae). *Biochemistry of Systems Ecology* 6: 201-212.

Belmar, R., Nava- Montero, R., Sandoval – castro C., Mcnab, J. M.(1999).Jackbean (*Canavalia ensiformis L.DC*) in poultry diets: antinutritional factors and detoxification studies – a review. *World Poultry Science Journal* 55 (1) 37-59

Borchers, R. and Ackerson, C.W. (1950). The nutritive value of legume seeds. X. Effects of autoclaving and trypsin inhibitor test for 17 species. *Journal of Nutrition.* 41: 339-345.

Carlini, C.R. and Udedibie A.B.I (1997). Comparative effects of processing methods on haemagglutinating and antitryptic activities of *Canavalia ensiformis* and *Canavalia braziliensis seeds. Journal of Agricultural and Food Chemistry.* 45 (11): 4372-4377.

Cheeke, P.R. (1971). Nutritional and Physiological implication Saponins: a review. *Canadian Journal of Animal Science* 51: 621-623.

Dalkin, K. and D.J. Bowles (1983). Analysis of inter-relationship of jackbean seed components by two-dimensional mapping of iodinated tryptic peptides. Planta, 157: 536-539.

D'Mello, J.P.F. (1989). Toxic amino acids. In: Anti-nutritional factors, Potentially Toxic Substances in Plants. (eds. J.P.F. D'Mello and C.M. Duffus). Pp. 29-50 (Warwick, Association of Applied Biologists.)

D'Mello, J.P.F., (1982). Toxic factors in some tropical legumes. *World Review of Animal Production.* 18: 41-46.

D'Mello, J.P.F., Acamovic, T., and Walker, A.G. (1985). Nutritive value of jackbean (*Canavalia ensiformis*) for young chicks. *Tropical Agriculture* (Trinidad), 62: 145-150.

D'Mello, J.P.F., and Walker, A.G. (1991). Detoxification of jackbeans (*canavalia ensiformis*): studies with young chicks. *Animal Feed Science and Technology,* 33: 117-127.

Duke, J.A. (1981). Handbook of Legumes of World Economic Importance; Plenum Press; New York and London, pp. 39-42.

Enneking, D., Giles, L.C. Tate, M.E. and Davies R. L (1993). L – canavanine: A natural feed-intake inhibitor for pigs (Isolation, identification and significance). *Journal of the Science of Food and Agriculture,* 61: 315-325.

Fabiyi, K.E. (1999).Utilization of Jackbean (*Canavalia ensiformis* (L).DC) meal as Replacement for Soybean meal in Broiler Diets. M. Sc Thesis, Abubakar Tafawa Balewa University, Bauchi State, Nigeria, 85pp

Fowden, L. (1971), Amino acid biosynthesis. In: Biosynthetic Pathways in Higher Plants. (ed. Pridham, J.B and Swain, T.) Academic Press, New York. pp. 73-99.

Ho., H. K. and Shen, C. (1966). Studies on the distribution of canavanine in Taiwan plants and its metabolic change during germination, *Chinese Agricultural and Chemical Society* (special issue) 23-31.

Jaffe, W.G. (1980) Haemagglutinins (lectins). In: Toxic constituents of Plant Foodstuffs. (ed. Liener I.E) New York; Academic Press. Pp. 525-552.

Jayne-Williams, D. J. (1973). The influence of dietary jackbean (*Canavalia ensiformis)*and concanavalin A. on the growth of conventional and gnotobiotic Japanese quail. (*Coturnix coturnix japonica*), *Nature, New Biology.* 243: 150-151.

Kitagawa, M. and Tomiyama, T. (1929). A new amino acid compound in the jackbean and a corresponding new ferment. *Journal of Biochemistry* (Tokyo), 11:265-271.

Kolberg, J. and Sollid, L. (1985) Lectins activity of gluten identified as wheat germ agglutinin. *Biochemistry and Biophysics Research Communication* 130:867-872.

Larue-Achagiotis, C., Pichard, M. and Louis – Sylvestre, J. (1992). Feeding behaviour in rats on a complete diet containing concanavalin A. *Reproduction and Nutrition Development* 32: 34-350.

Liener, I.E. (1953). Soyin, a toxic protein from the soybean. I. Inhibition of rat growth. *Journal of Nutrition.* 49: 527-539.

Liener, I.E. (1976). Legume toxins in relation to protein digestibility – a review. *Journal of Food Science*, 41: 1076-1081.

Liener, I.E. (1980). Heat Labile antinutritional factors. In: Advances in Legume Science, (eds. Summerfield, R.J and Bunting, A.H.), Kew, London, Royal Botanic Gardens, pp. 157-170.

Michelangeli, C. and Vargas, R.E. (1994). L-canavanine influences feed intake, plasma basic amino acid concentrations and kidney arginase activity in chicks. *Journal of Nutrition*, 124: 1081-1087.

Obizoba, I.C. and Obiano, N. (1988). The nutritive value of jackbean (*Canavalia ensiformis*). *Ecology of Food and Nutrition*., 21: 265-270.

Ologhobo, A.D., Apata, D.F., and Oyejide, A. (1993). Utilization of raw jackbean (*Canavalia ensiformis*) and jackbean fractions in diets for broiler chicks. *British Poultry Science*, 34: 323-337.

Perez, M.M (1984) *Canavalia ensiformis* en la alimentacion de pollos de engorda.EQ Thesis, F.M.V.Z – U.A.D.Y.

Pusztai, A. (1989). Biological effects of dietary lectins. In: Recent Advances of Research in Antinutritional Factors in Legume Seeds; (ed. Huismay) Wageningen, The Netherlands, pp. 17-29.

Rahiala, E. (1973) Canaline. Characterization of enzyme pyridoxal phosphate complex. *Acta Chemica Scandinavica* 27: 3861-3867.

Roebuck, B.D. (1986). Enhancement of pancreatic carcinogenesis of raw soy protein isolate. In: Nutritional and Toxicological Significance of Enzyme Inhibitors in Foods, pp. 91 (ed. Friedman, M.). New York, Plenum Press.

Rosenthal, G.A. (1972). Investigations of canavanine biochemeistry in the jackbean plant. II: Canavanine biochemistry in the developing plant. *Plant physiology*, 50: 328-331.

Rosenthal, G.A. (1977). The biological effects and mode of action of L – canavanine, a structural analogue of L-arginine, *Quarterly Review of Biology* 52: 155-178.

Rosenthal, G.A. (1981) A mechanism of L – Canaline toxicity. European Journal of Biochemistry 114: 301-304.

Rosenthal, G.A. (1982). Plant Non –Protein Amino and Imino Acids: Biological, Biochemical and toxicological properties NewYork and London, Academic Press, pp. 95-113.

Santidrians, S.Reig, G. and Miralles, M. (1988). Growth rate, muscle protein composition, intestinal absorption of D-galactose and L-leucine and nitrogen balance in rats fed the raw legume *Chamaecytisus proliferus*. *Plants Foods for Human Nutrition*, 38: 135-143.

SECAB (1990) *Haba Criolla Canavalia ensiformis* (L.) DC, (*Fabaceae – Fabiodeae*). Monografia No. 2. Programma de Recursos vegetates del Convenio Andres Bello (PREVECAB). Secretaria Ejecutiva del Convenio Andres Bello, SECAB, B ogota; Colombia, pp. 177-192.

Sumner, J.B. and Howell, S.T. (1936). Identification of the haemagglutinin of jackbean with concanavalin A. *Journal of Bacteriology*, 32: 227-237.

Tschiersch, B. (1962). Uber das vorkommen von Canavanin. *Flora*, 150: 87-94.

Udedibie, A.B.I, Nwaiwu, J., Madubuike F. Nkwocha, C.O and Imo, I.O. (1988) Jackbean (*Canavalia ensiformis*): Poison turned to good protein feed. Federal University of Technology Owerri, Nigeria.

Walker, J.B. (1955). Canavanine and homoarginine as antimetabolites of arginine and lysine in yeast and algae. *Journal of Biological Chemistry* 212: 207-215.