The Role of AGRICULTURE in POVERTY ALLEVIATION

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THE ROLE OF AGRICULTURE IN POVERTY ALLEVIATION

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HAEMAGGLUTININS AND TRYPSIN INHIBITORS IN SOME TROPICAL LEGUME SEEDS: THEIR SIGNIFICANCE IN ANIMAL NUTRITION - A REVIEW.

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ABSTRACT

Legumes are important source of protein and energy in the diet of farm animals. The use of legumes for livestock nutrition is however, impeded by the presence of antinutritional substance in their seeds. The most important ones include haemagglutinins and trypsin inhibitors. Haemagglutinins adversely affect the absorption of nutrients from the intestinal tract, agglutinates the erythrocytes, induces severe reduction in feed intake and depresses growth. Trypsin inhibitors negatively affect proteolytic activity of the digestive enzyme trypsin which can lead to reduction in the availability of amino acids, induced pancreatic hypertrophy and depressed growth. Inactivation of these undesirable substances in legume seeds is essential in order to improve their nutritional quality in livestock feeds. This paper high-lights the contents, nutritional significance and effects of processing (roasting, cooking and autoclaving) on haemagglutinins and trypsin inhibitors in some tropical legume seeds such as African yam bean (*Sphenostylis stenocarpa),* bambaranut *(Voandzeia subterranea),* kidney bean (*Phaseolus vulgaris L.*), Lima bean (*Phaseolus linatus L*), pigeon peas (*Cajanaus cajan L. Millsp*), and jack bean (*Canavalia ensiformis).* The application of moist heat has been found to be the most efficient method of inactivating haemagglutinins and trypsin inhibitors in these legume seeds.

INTRODUCTION

Legumes are vital sources of protein and energy in diet of farm animals. The deleterious effect of ingested raw legumes have been attributed to the presence of antinutritional factors in their seeds. Antinutritional factors are substances in the seed that reduce the nutritional value of feedstuff and affect the animal adversely. Several antinutritional factors abound in plant seeds, among the most important ones are haemagglutinins and trypsin inhibitors. When considering antinutritional or toxic factors in 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 nutrition 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 gastro-intestinal tract (Carlini and Udedibie, 1997). The inclusion of raw legumes in the diet of livestock animals lead to a significant impariment in growth and other undesirable physiological and biochemical alterations. Inactivating or removing of undesirable components is essential in order to improve the nutritional quality of legumes and effectively utilize their full potential as livestock feed. It is widely accepted that simple and inexpensive processing techniques are effective methods of achieving desirable changes in the composition of legume seeds.

This paper highlights the nutritional significance and the effects of processing (roasting, cooking and autoclaving) on haemagglutinins and trypsin inhibitors in some tropical legume seeds such as African yam bean, bambaranut, kidney bean, lima bean, pigeon pea and jackbean.

Haemagglutinins

Haemagglutinins also called lectins are Carbohydrate-binding proteins that are resistant to disgestion (Pusztai, 1989). These proteins posses a specific affinity for certain sugar molecules present in the membranes of many animal cells, including those of the intestinal mucosa. Haemagglutinins are 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; Jaffe, 1980) 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 the otherwise innocuous orgainsms.

Haemagglutinins adversely affects nutrient absorption and utilization by various mechanisms. It binds to the glycoprotein and glycolipids of the digestive tract mucosa (Hague, 1975; Jaffe, 1980), inhibits the activity of the enzymes of brush border of the enterocytes (Rosenthal, 1972) and likely has several negative effects on protein and carbohydrate metabolism, hormonal function, enzyme activities and immune functions (Pusztai, 1989). It induces severe reduction in feed intake of monogastrics and thus leading to growth depression (Larue -Achagiotis *et al.*, 1992) (Table 1).

Table 1:Nutritional Significance Of Haemagglutinins And Trypsin Inhibitor

Antinutritional factor	Implications	References
1. Haemagglutinins	(a) Agglutinates the erythrocytes.	Liener, 1979
	(b) Induces severe reduction feed intake.	Leon *et al.*, 1991.
	(c) Adversely effects nutrient absorption and utilization in various ways.	
	(1) Causes disruption of the cell structure of intestinal mucosa.	Hague, 1975; Jaffe, 1980.
	(2) Permits invasion of lymph, blood and liver by bacteria.	Jayne-Williams, 1973.
	(3) Inhibits the activity of the enzymes of enterocytes.	Rosenthal, 1972.
	(d) Negatively affects protein and carbohydrate metabolism.	Putsztai, 1989
	(e) Causes growth depression.	Larue-Achagiotis *et al.*,1992
2. Trypsin inhibitors	(a) Inhibit the proteolytic activity of the digestive enzyme trypsin.	
	(b) Lead to reduced availability of amino acids.	Liener, 1976 Liener and Kakade, 1980
	(c) Induce pancreatic hyper-trophy.	Roebuck, 1986
	(d) Cause growth depression.	Liener and Kakade, 1980

Trypsin Inhibitors

Trypsin inhibitors have been implicated in reducing protien 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). Trypsin inhibitors inhibit the proteolytic activity of the digestive enzyme trypsin which can lead to reduction in the availability of amino acids (Liener, 1976; Liener and Kakade, 1980). Trypsin inhibitors induce pancreatic hypertrophy (Roebuck, 1986) and depress growth (Table 1).

Heat Treatments

Heat processing is widely accepted as an effective means of inactivating the thermo-labile antinutritional factors of legume grains. The nutritive quality of most tropical legume grains, particularly cowpea, soybean, pigeon pea, lima bean and winged beans is notably improve by heat treatment. Heat treatment improves protein quality by inactivating antinutritional factors, particularly trypsin inhibitor and haemagglutinin and by unfolding the protein structure, thus making them more susceptible to attack by digestive enzymes (Sathe *et al.* 1984).

Complete inactivation of haemagglutinins in the raw tropical legume seeds were achieved by cooking and autoclaving (moist heat treatment), while roasting (dry heat treatment) was less effective in the elimination of the haemagglutinating activity of the raw seeds, with the exception of bambaranut (Apata and Ologhobo1997). It was also observed that cooking was the most effective method in inactivating the trypsin inhibitors present in the raw legume seeds followed by autoclaving which was also more effective than roasting (Apata and Ologhobo) (Table 3). Carlini and Udedibie (1997) reported that it took 2 hours of boiling to completely eliminate trypsin inhibitor activity in jackbean and 3 hours of boiling to completely inactivate haemagglutinins in the legume.

Moist heating is often more effective than dry heating, and the degree of inactivation is also governed by temperature, duration of heating and particle size (D' Mello, 1982). Other authors (Babar *et al.*, 1988; Bressani and Sosa, 1990; Carlini and Udedibie, 1997) have also reported the superiority of moist heat over dry heat as methods for processing the jackbean seeds.

Table 2: Haemagglutinating activity in raw and processed tropical legumes (Hu/mg Protein)

Legume type	Raw Seeds	Cooked seed	Autoclaved Seeds	Roasted seeds
African yam bean	38	0	0	3.7
Bambaranut	5	0	0	0
Kidney bean	102	0	0	12.3
Lima bean	59	0	0	5.3
Pigeon pea	18	0	0	0.9
Jack bean	73	0	0	9.5

HU = Heamagglutinating Unit

Source: (Apata and Ologhobo, 1997)

Table 3: Trypsin inhibitor activity in raw and processed tropical legumes (TIU/ mg Protein)*

Legume type	Raw seeds	Cooked seeds	Autoclaved Seeds	Roasted seeds
African yam bean	43.1	0	3.0	13.2
Bambaranut	9.4	0	0.4	2.7
Kidney bean	87.6	0	10.4	27.4
Lima bean	88.6	0	7.4	29.3
Pigeon pea	23.8	0	1.2	6.2
Jack bean	41.6	0	5.2	14.7

* Trypsin inhibitor units (TIU) per mg protein.
Source: Apata and Ologhobo, 1997.

CONCLUSION

The application of moist heat (particularly cooking) has been found to be the most efficient method of inactivating haemagglutinins and trypsin inhibitors in legume seeds. The fact that some sources of plant protein are capable of producing harmful effects in animals is in itself of importance with respect to man's food supply. Thus the role of naturally occurring antinutritional substances as they relate to their effects on animals cannot be dismissed as being irrelevant to the problem of feeding.

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