

## ALTERNATIVE FEED RESOURCES FOR FORMULATING CONCENTRATE DIETS OF RABBITS.

### 2. JACK BEAN (*Canavalia ensiformis*) SEEDS.

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**ABSTRACT :** In an eight-week long feeding and digestibility trial, the acceptable amount of heat-processed (1h boiling) jack bean seed that can be used to substitute partially for oil cakes (palm kernel and groundnut cakes) in concentrate diets of rabbits was examined (8 rabbits 7-9 week old of local population per treatment). Four diets were formulated to contain 0, 10, 20 and 30 % jack bean seed, respectively. The proximate composition of heat-processed jack bean (27.4 % crude protein, 14.2 % crude fibre and 51.1 % nitrogen free extract) showed that it has potential for use in rabbit feeding. Dry matter intake significantly declined with increasing levels of inclusion of jack bean, being 44.0, 46.5, 33.3 and 30.5 g/day at 0, 10, 20 and 30 % levels respectively. Weight gains declined by a non-significant 33.4 % with 20 % jack bean and by a significant 69.9 % with 30 % jack bean inclusion level relative to the average weight gain of the control (10.6 g/day) and 10 % jack bean diets (11.1 g/day). Feed conversion efficiency value was similar for the control and 10 and 20 % jack bean diets (average 0.23),

but declined by 57 % with 30 % jack bean. The digestibility of DM and nutrients was generally high in all the diets, varying between 61 and 87 % ; digestibility significantly declines with increasing levels of jack bean, being about 15 to 20 % lower with 30 % jack bean diet. There were minor changes in the haematological and some serum enzyme parameters of the rabbits, except for the significantly higher levels of white blood cells and lymphocytes in the rabbits on 30 % jack bean diet. Serum proteins (total protein, albumin and globulin) were significantly depressed beyond 10 % inclusion of jack bean. The study demonstrated that good feed intake, digestibility, weight gain and haematological and biochemical responses can be achieved in rabbit with heat-processed jack bean seed replacing expensive oil cakes up to levels of 10 % in their diets and may be up to 20 %. Serum protein levels were depressed at 20 % level and beyond that level weight gains were also appreciably depressed.

**RÉSUMÉ :** Matières premières alternatives pour la formulation des aliments concentrés pour lapins. 2 – Graines de *Canavalia ensiformis*.

La valeur alimentaire pour le lapin des graines de *Canavalia* (un type de pois tropical), a été étudiée dans un essai de croissance et de digestibilité. Les graines ont été bouillies pendant une heure, puis après séchage, introduites dans des aliments concentrés aux taux de 0% (témoin) - 10% - 20% et 30% en remplacement partiel de tourteaux de palmiste et d'arachide. Ces aliments ont été distribués pendant 8 semaines à 8 lapins de 7-8 semaines par lot. Par rapport à la matière sèche, la composition des graines de *Canavalia* traitées était de 27,4% de protéines, 14,2% de cellulose brute et 51,1% d'extractif non azoté. L'ingestion de matière sèche a été réduite avec l'élévation du taux d'incorporation : 44,0 - 46,5 - 33,3 et 30,5 g/j pour les aliments contenant 0 - 10 - 20 et 30% de graines respectivement. Par rapport à l'aliment témoin (10,6 g/j) la vitesse de croissance a été similaire avec 10% de graines (11,1 g/j) mais réduite non significativement de 33,4% avec 20% de graines et significativement de 69,9% avec 30% de

graines. L'efficacité alimentaire a été similaire pour les 3 premiers taux d'incorporation (0,23 g de gain de poids vif par g d'aliment consommé), mais elle a été réduite de 57% avec le taux de graines le plus élevé. La digestibilité de la matière sèche et des nutriments est généralement haute, variant entre 61 et 87% pour l'ensemble des éléments. Elle décroît avec l'élévation du taux d'incorporation et est finalement réduite de 15 à 20% pour l'aliment contenant 30% de graines de *Canavalia*. Les modifications hématologiques et des enzymes du sérum sanguin sont restées mineures en dehors d'une forte élévation du taux de globules blancs et de lymphocytes avec l'aliment contenant 30% de graines. Les protéines du sérum (protéines totales, albumine, globulines) ont été réduites avec les aliments contenant plus de 10% de graines de *Canavalia*. En conclusion les auteurs soulignent les bons résultats obtenus lorsque 10% de graines de *Canavalia*, voire avec 20% sont introduits dans la ration en remplacement des tourteaux. Les protéines sanguines sont réduites avec 20% de graines et au-delà de ce taux la vitesse de croissance est gravement altérée.

## INTRODUCTION

Having established that concentrates are essential for optimal performance of rabbits (BAMIKOLE and EZENWA, 1999), we set out to evaluate the use of commonly available alternative feed resources with the aim of reducing the cost of concentrate diets. This is a

sequel to the evaluation of grain amaranth seedheads (BAMIKOLE *et al.*, 2000). In the present study, we considered jack bean (*Canavalia ensiformis*) seeds. Jack bean is a legume the seeds of which have good potential for use in livestock feeding due to the high contents of protein and carbohydrates (UDEDIBIE and CARLINI, 1998). Its utilization in feed is limited by the

**Table 1 : Ingredient composition (g/kg) of the experimental diets containing different levels of heat-treated jack bean seeds.**

Ingredient	Inclusion level of jack bean (g/kg)			
	0	100	200	300
Maize	200.0	200.0	200.0	200.0
Jack bean	0	100.0	200.0	300.0
Dried brewer's grain	227.5	227.5	227.5	227.5
Palm kernel cake	440.0	390.0	340.0	240.0
Groundnut cake	100.0	50.0	0	0
Oyster shell	10.0	10.0	10.0	10.0
Bone meal	15.0	15.0	15.0	15.0
Mineral and Vitamin mix <sup>1</sup>	2.5	2.5	2.5	2.5
Salt	5.0	5.0	5.0	5.0

<sup>1</sup>Supplied per kg of diet: Vitamin A, 7,000 IU; Vitamin D3, 1,400 IU; Vitamin E, 5 IU; Vitamin K, 2.0 mg; Vitamin B1, 1.5 mg; Vitamin B2, 4.0 mg; Vitamin B6, 1.5 mg; Vitamin B12, 0.1 mg; Niacin, 15 mg; Pantothenic acid, 5.0 mg; Folic acid, 0.5 mg; Mn, 75 mg; Zn, 45 mg; Fe, 20 mg; Cu, 5 mg; I, 1 mg; Se, 0.1 mg; Co, 0.2 mg; Choline Chloride, 100 mg.

presence of antinutritional factors such as lectins, canavanine, Concanavanine A (Con A) and other non-protein amino acids (ARORA, 1995 ; D'MELLO, 1995a,b). The deleterious effects of these antinutritional factors range from a reduction in intake and nutrient absorption to interference of some biochemical processes and depressed growth (D'MELLO, 1995a ; D'MELLO *et al.*, 1989 ; BELMAR and MORRIS, 1994a,b ; KESSLER, 1990 ; UDEDIBIE and CARLINI, 1998). The growth limiting factors in jack bean seed have to be detoxified before it can be used. Various processing methods with varying levels of efficiency have been developed (D'MELLO, 1995a,b). Among these methods, soaking plus boiling is the method that can easily be adopted by most of the rabbit keepers under the prevailing small-scale operation in most parts of the tropics.

There is some information on the use of jack bean seed in animal feeding, but mostly with avian species, pigs and rats. Information on the use of jack bean seed in rabbit feeding is thus rarely available. With rabbit keeping gaining popularity in the developing countries due to the recognition of the suitability and unique biological and behavioral attributes of the animal, an evaluation of the use of jack bean seed in rabbit diets is imperative. This is the thrust of this research. The objectives of the study were to determine the nutritional value of jack bean seed for rabbits, its

replacement value for oil cakes in concentrate diets and the performance of rabbits fed diets containing different levels of inclusion of the seed.

## MATERIAL AND METHODS

The experiment was carried out in the Rabbit Unit of the Teaching and Research Farm of the University of Ibadan (7° 20' N, 3° 50' E; 200 m above sea level; average daytime temperature = 28 – 34° C).

Jack bean seeds were obtained from the Agronomy Department of the University. Following air-drying, the seeds were removed from the pods and subjected to the aqueous heating method suggested by OLOGHOBO *et al.* (1993), with some modifications. The seeds were soaked in water for 72 hours, boiled for one hour and thereafter sun-dried and milled. The seeds were then incorporated into the experimental diets with the other ingredients. Four diets were formulated using the heat-processed jack bean to replace palm kernel and groundnut cake in the diets. Increasing levels of 0, 10, 20 and 30 % were achieved while maintaining the nutrients at levels that were adequate to provide the animals' requirements as recommended by NRC (1977).

Thirty-two rabbits (20 females and 12 males) of mixed breeds purchased from different locations around the Ibadan metropolis were used. The rabbits were seven to nine weeks old and had an average initial weight of 640 g (range = 450-890 g). The initial prophylactic treatments and housing of the animals were the same as given in the previous trial (BAMIKOLE *et al.*, 2000). During the 8 week experiment, each rabbit was given feed amounting to 50 g DM/kg of liveweight (LW)/day. Water was provided *ad libitum*. Daily feed intake was monitored daily. Digestibility was determined in the last seven days of the trial. During this period, the faeces and urine voided by four randomly selected rabbits were collected. Feed intake and the quantity of faeces and urine voided were

**Table 2 : Proximate composition (g/kg DM) of jack bean seed and the experimental diets containing different levels of the heat-treated seeds.**

Nutrient	Jack bean	Inclusion level of jack bean (g/kg)			
		0	100	200	300
Dry matter	615.2	911.0	911.5	921.9	929.0
Crude protein	274.4	195.2	187.8	181.5	194.5
Crude fibre	142.0	106.8	110.9	114.7	114.9
Ether extract	45.7	61.0	56.7	59.0	61.5
Ash	22.6	54.3	52.2	51.0	48.1
Nitrogen Free Extract	511.3	582.7	596.0	593.8	581.0

determined daily and 10 % aliquots were taken and later bulked over the whole period per rabbit for DM and chemical analysis. Haematological and serum biochemical parameters were measured in the blood of the animals taken on the last day of the trial. Details of the experimental procedure, chemical analysis and statistical analysis are the same as those in the previous trial (BAMIKOLE *et al.*, 2000)

## RESULTS

The ingredient proportion in the experimental diets is presented in Table 1 while the proximate compositions of jack bean seed and the diets are shown in Table 2. It was possible to formulate the diets and ensure adequate supply of the basic nutrients to the rabbit because of the high proteic content of jack bean.

The feed intake and growth performance of the rabbits fed diets containing different levels of jack bean are shown in Table 3. Intake of DM declined with increasing levels of jack bean in the diets. The highest DM intake was obtained with 10 % inclusion of jack bean, which was not significantly higher than those obtained with the control and 20 % jack bean diets. Intake of DM was lowest at 30 % jack bean level.

The weight gain of rabbits on 20 % jack bean diet was about 68 % of the average of those of the control

**Table 3. Feed intake, growth performance and nutrient digestibility in rabbits fed diets containing different levels of heat-treated jack bean seeds.**

Variable	Inclusion level of jack bean (g/kg)				SEm <sup>1</sup>
	0	100	200	300	
Daily intake (g/day)					
Dry matter	44.0a <sup>2</sup>	46.5a	33.3ab	30.5b	5.51
Weight gain (g/day)	10.0a	11.1a	7.1ab	3.2b	2.34
Feed efficiency	0.23a	0.24a	0.21a	0.10b	0.05
Digestibility coefficients					
Dry matter	0.89a	0.76b	0.74b	0.74b	0.22
Crude protein	0.87a	0.79b	0.75c	0.79b	0.10
Crude fibre	0.84a	0.67c	0.72b	0.63c	0.17
Ether extract	0.77b	0.87a	0.86a	0.87a	0.10
Ash	0.79a	0.71b	0.61c	0.65c	0.15

<sup>1</sup>Standard error of the mean

<sup>2</sup>Means in a row followed by the same letters are not significantly different at P < 0.05.

and the 10 % jack bean diets. Increasing the level of inclusion of jack bean to 30 % led to a significantly depressed weight gain in the rabbits, the weight being about 30 % of the average of the control and 10 jack bean diets. The feed conversion efficiency (g weight gained per g of feed consumed) values for the control, and 10 and 20 % jack bean diets were not significantly different from one another but were significantly higher than the feed conversion efficiency value for the 30 % jack bean diet.

The digestibility values for DM and the other nutrients were generally high in all the diets (Table 3).

The digestibility coefficients of DM, CP, CF and ash were generally the highest in the control diet and declined significantly with inclusion and increasing levels of jack bean. The digestibility coefficient of ether extract was significantly higher in the jack bean diets than in the control. In general, the digestibility coefficients of DM and nutrients in the 30% jack bean diet declined by about 6 to 20 % of the values of the control diet but increased by about 13 % in the case of the ether extract.

Haematological indices of the rabbits showed minor but, in some cases significant, variations among the diets (Table 4). Packed cell volume (PCV) and red blood cell (RBC) count declined, but non-significantly, with increasing levels of jack bean in the diets. The haemoglobin (Hb) value was highest in 10 % jack bean diet but this

**Table 4 : Haematological and serum biochemical and enzyme parameters of rabbits fed diets containing different levels of heat-treated jack bean seeds.**

Parameter	Inclusion level of jack bean (g/kg)				SEM
	0	100	200	300	
Packed cell volume (%)	32.0a <sup>1</sup>	34.5a	32.0a	28.5a	2.25
Haemoglobin (g/dl)	8.5b	10.3a	9.3ab	8.8b	0.42
Red blood cell (x10 <sup>12</sup> /l)	8.5a	6.5a	6.8a	6.0a	0.96
White blood cell (x10 <sup>9</sup> /l)	6.4b	4.6b	4.1b	11.8a	1.85
Lymphocyte (%)	70.5ab	68.0ab	56.0b	73.5a	5.62
Neutrophil (%)	26.5ab	30.5ab	43.5a	26.0b	5.53
Eosinophil	0.5a	0.5a	0.5a	0.0b	0.25
Monocyte (%)	1.7a	1.0b	0.0ab	2.0a	0.84
Total protein (g/dl)	9.7ab	11.6a	7.4bc	5.5c	0.98
Albumin (g/dl)	3.5ab	4.4a	2.7bc	2.0c	0.34
Globulin (g/dl)	6.1ab	7.2a	4.6bc	3.4c	0.64
GPT <sup>2</sup> (IU/l)	61.5a	60.0a	61.0a	84.0ab	10.30
GOT <sup>3</sup> (IU/l)	25.0a	40.0a	15.0b	10.0b	7.50

<sup>1</sup>Means in a row followed by the same letters are not significantly different at P < 0.05.

<sup>2</sup>GPT = Glutamic-pyruvic transaminase

<sup>3</sup>GOP = Glutamic-oxaloacetic transaminase

was not significantly higher than that of the 20 % jack bean diet. The control and the 30 % jack bean diets had the lowest values of Hb. The white blood cell (WBC) count of the rabbits on 30 % jack bean diet was highest and more than twice the average of the values of the control, 10 % and 20 % jack bean diets, the values of which did not differ significantly from one another. Higher values of lymphocyte and lower values of neutrophil were recorded in the control and 30 % jack bean diets. There were minor changes in the values of the eosinophil and monocyte.

The concentrations of the serum metabolites were significantly influenced by the dietary treatments (Table 4). Total protein, albumin and globulin were highest with the 10 % jack bean diet though not significantly higher than the values of those of the control diet. The values were significantly lower at higher levels of inclusion of jack bean. The values of glutamic-oxaloacetic transaminase (GOT) followed a trend similar to that of the serum protein while those of the glutamic-pyruvic transaminase (GPT) did not vary significantly.

## DISCUSSION

The proximate composition of jack bean in this study is similar to the values reported by other workers (APATA, 1989; DUKE, 1983; BELMAR and MORRIS, 1994b), except that ether extract and CF were higher in the current study than previously reported. The nutrient composition of the diets could ensure adequate availability of nutrients for growing rabbits according to the standard of NRC (1977). The protein content value of jack bean and the higher intakes, weight gain and FCE values obtained when jack bean was included at 10 % level in the diet in this study are indications of the role that jack bean can play in rabbit nutrition when fed at a safe level. WYSS and BICKEL (1988) also reported from their study with rats that intake and liveweight gain were not reduced when jack bean was 5 or 10 % of the rations but both parameters declined at 20 % level of inclusion of jack bean.

Although inclusion of jack bean up to 20 % level in the feed of chicks is possible (UDEDIBIE *et al.*, 1996), appreciable reductions in intakes of DM and nutrients and weight gain were recorded in our study at that level of inclusion. The reduction in the weight gain was more drastic than that of intake when the level of inclusion reached 30 %, suggesting that the low weight gain at higher levels of inclusion was not due mainly to limited intake but probably to poor utilization of the feed or presence of toxic components. This is at variance with the observation with chicks and pigs that the reduction

in growth rate is first preceded by a reduction in the feed intake (BELMAR and MORRIS, 1994b).

Poor utilization of the jack bean diets at high levels of inclusion of jack bean seed may be attributed to canavanine and Concanavalin A (Con A), the major antinutritional factor in jack bean seed (UDEDIBIE and CARLINI, 1998). Canavanine and Con A have been shown to reduce feed intake and weight gains of non-ruminants at high levels of inclusion in diets (D'MELLO *et al.*, 1989; ENNEKING *et al.*, 1993; MICHELANGELI and VARGAS, 1994; MELCION *et al.*, 1994). The processing method used for jack bean in the current study justifies the suspicion that canavanine and Con A might be the major factors responsible. This is because these factors are not always completely removed by heat alone but are highly resistant to heat treatment and can remain stable even up to autoclaving temperatures of 130°C (D'MELLO, 1995a,b). Canavanine in heat-processed jack bean is readily absorbed from the digestive tract of poultry (Leon *et al.*, 1990) to appear in systemic circulation (D'MELLO *et al.*, 1990). Chicks fed such diets show rapid and severe reduction in growth and efficiency of nitrogen utilization (D'MELLO, 1995a). Con A has also been fingered to have a negative effect on nutrient utilization (JAFFE, 1980), especially in *ad libitum* feeding systems (UDEDIBIE and CARLINI, 1998).

The generally high levels of DM and nutrient digestibilities obtained in this study suggest that jack bean is well digested in rabbits and that canavanine and Con A act more through their effects on feed utilization and nutrient absorption. In their study, WYSS and BICKEL (1988) also reported that there was no obvious difference in feed digestibility among rations containing 0, 5, 10 and 20 % jack bean. In most of the other studies on utilization of jack bean in non-ruminants (mainly with avian species, pigs and rats), the mechanism of the adverse effects of jack bean in diets has generally been linked to feed intake. The high digestion in rabbit could be a contributory factor to the ability of the animal to digest jack bean-based diets.

The haematological parameters are within normal ranges (CCAC, 1980), except for the 30 % jack bean diet which had a PCV value that was below normal. The minor variability among the haematological parameters of the rabbits on the different diets may result because the antinutritional factors in jack bean that are responsible for haemolytic activities (e.g. saponins (BELMAR and MORRIS, 1994b)) are easily deactivated by heat. The high level of WBC in the 30 % jack bean diet indicated some immunological responses of the animals to exogenous substances (HARPER *et al.*, 1979) and is typical of a nutritional stress condition. Significantly reduced level of total protein, albumin and globulin at higher levels (20 and 30 %) of jack bean inclusion in the diet indicated some alterations in the

protein metabolism. Serum protein and albumin syntheses are related to the amount of available protein (IYAYI and TEWE, 1998). The protein in jack bean, though well digested, was not evident in the serum of the rabbits at the higher levels of jack bean inclusion. Canavanine in heat-treated jack bean causes malfunction of protein synthesis and activities (D'MELLO *et al.*, 1989; LEON *et al.*, 1991; LARUE-ACHAGIOTIS *et al.*, 1992). Rising levels of GOT and GPT due to toxic substances have been reported in chicks (OLOGHOBO *et al.*, 1982). In the present study, the levels of GOT and GPT did not vary very widely among the diets.

### CONCLUSION

This study has demonstrated that jack bean is a potential raw material for concentrate feed formulation of rabbits. The oil cakes can be replaced up to 10 % of the diet with heat-processed jack bean in concentrate feeds of rabbits without any adverse effects on feed intake, weight gain and nutrient utilization and metabolism of the animals. Better processing such as longer duration of soaking and boiling plus extraction with  $\text{KHCO}_3$  may permit incorporation of higher levels of jack bean in the diets. At the small-scale levels of rabbit production currently prevailing, the economics of any detoxification method need to be well evaluated to suit the circumstances of the rabbit keepers.

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