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Effects of Differently Processed Jackbean (*Canavalia ensiformis*) Meals on the Performance of Grower Pigs

H. I. Emenike[1*], A. B. I. Udedibie[2] and O. O. Emenalom[2]

[1]Cooperative Information Network, Obafemi Awolowo University Campus, Ile-Ife, Osun State, Nigeria.
[2]Department of Animal Science and Technology, Federal University of Technology, P.M.B 1526, Owerri, Imo State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author HIE did the research work while authors ABIU and OOE design and supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

The proximate compositions of processed Jackbean (*Canavalia ensiformis*) meals and their effects on the performance on grower pigs was investigated. Whole jackbean seeds were divided into two batches; the first batch was cracked into pieces (2 – 4 parts/seed) while the second batch was soaked in water for 72 hours. The two batches were separately cooked for an hour, sun dried and ground into meal. Samples of the cracked and cooked jackbean (CACJ) and, soaked and cooked jackbean (SACJ) meals were analysed for their proximate compositions. Seven diets were formulated such that diet 1 (control) contained no jackbean. Diets 2, 3, and 4 contained CACJ at 15, 20, and 25%, respectively while diets 5, 6, and 7 contained 15, 20, and 25% SACJ, respectively. Forty nine grower pigs were divided into seven groups of seven pigs each, and randomly assigned to one of the seven diets. The processed seed meals had lower crude protein, ether extract, ash and nitrogen free extract but higher crude fibre values than the raw seeds. CACJ and SACJ meal diets significantly (P<.001) depressed feed intake and growth rate of the pigs even at lowest dietary level of 15%. Pigs fed SACJ diets performed slightly better than those fed CACJ

**Corresponding author: E-mail: emenike4sure2008@yahoo.com;*

diets. Feed conversion ratios were better in pigs fed the processed jackbean diets than the control. The result shows that the two processing methods used could not improve the nutritive value of jackbean for pigs and that the processed meals caused profound appetite and growth depressing effects on pigs at 15, 20 and 25% dietary levels. It is concluded that jackbean so processed should not be used in diets for pig due to their growth depressing effects. Further studies on lower dietary inclusion levels and factor(s) responsible for the rejection of processed jackbean diets by pigs are worthwhile.

Keywords: Pigs; crack; cooked; soaked; processing; jackbean.

1. INTRODUCTION

Pigs are one of the earliest domesticated animals that are known to be an integral part of the economy of a number of peasant farmers in the tropics. In Nigeria as in several African countries, intensive pig production has been practiced and found to play a significant role in the overall economic growth and feeding of an expanding urban population. This is because of the rapid development of pigs based on the fecundity of the species and fast growth rate. Pigs are very versatile at utilizing agro-industrial by-products and wastes that are not suitable for human consumption. However, under intensive management conditions, the bye-products are inadequate for increased productivity. The need to increase pig (pork) production as alternative source of protein supply for the growing Nigerian population, will therefore, demand increased use of feed ingredients and concentrates some of which are in high demand by humans. This has given rise to competitions between humans and animals over the available cereal grains and legumes and has resulted to high cost of feed ingredients and feed. It has therefore become imperative to seek for alternative sources of livestock feed ingredients that will be cost effective and has little or no competition between humans and animals. Jackbean (*Canavalia ensiformis)* has been identified as an indigenous legume which has shown promise as energy and protein source for livestock production in view of its high seed yield and protein content [1-4]. However, its potentials is limited by growth inhibiting proteins that must be denatured before the beans can be edible [4-10] Among the known toxic substances present in jackbean are *concanavalin A* (ConA) and lectins, [11] which has been reported to have negative effects on nutrient digestion and absorption. The bean has also been found to contain a thermostable poisonous alkaline amino acid canavanine, and other inhibitory substances such as saponin alkaloid, terpenoids and cynogenic glycosides [9,12-14]. These toxic substances among others have been found to limit the use of jackbean as feed ingredient for non-ruminants at certain dietary levels [15,16].

Many processing methods including; toasting, cooking, soaking in water before cooking, two-stage cooking [17,16,18,19], treatment with urea followed by heating and two- stage cooking [8,18] cracking the seeds before soaking in water and cooking [1,16], fermentation [20,21] among others [2,3,6,22,23] have been tried as means of improving the nutritive value of jackbean so as to render it valuable as a protein and energy feedstuff for monogastric animals. Cracking the seed before cooking for an hour and soaking the seed in water for 72 hours before cooking for an hour, eliminated the protease inhibitors and Con. A content of jackbean seeds and improved the performance of broiler chickens [1]. Meanwhile, information on the use of raw or processed jackbean meal in pig's diets is sketchy or not available. The aim of this research therefore, was to determine the proximate chemical compositions of cracked and cooked (CAC) and, soaked and cooked (SAC) jackbean meals and their effects on the performance of grower pigs.

2. MATERIALS AND METHODS

This experiment was carried out at the Teaching and Research Farm, School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri, Imo State Nigeria. The jackbean seeds used for the experiment were produced at the Sub-station of the National Root Crops Research Institute in Vom, Plateau state, north central, Nigeria. The other feed ingredients used for formulating the experimental diets were procured from local feedstuff dealers in the study area. These ingredients used for formulation were chosen because of its availability, cost effectiveness and NRC requirements for pigs.

The jackbean seeds used were divided into two batches and processed using the methods described by [19,24]. In the first batch, whole

jackbean seeds were broken into smaller pieces (2 – 4 parts/seed) using an ASKO A11 (manufactured by Nigerian electrical plants Ltd) grinding machine. The broken seeds were then cooked for 1 hour (timed from boiling point of water that covered the seeds in the vat), sun dried for 2 – 3 days to about 90% dry matter and ground into meal using a hammer mill to produce cracked and cooked jackbean meal (CACJM) while in the second batch, whole jackbean seeds were soaked in water for 72 hours (the soaking water was changed after 48 hours and replaced with fresh one to complete the remaining 24 hours). At the end of the soaking, the seeds were washed with fresh water and cooked for 60 minutes (counting from the time of boiling), sun dried and ground into meal as in the first batch to produce soaked and cooked jackbean meal (SACJM). Samples of the processed jackbean meals were analysed for their proximate chemical compositions using the method of [25] and incorporated into the diets of growing pigs at 15, 20, and 25% levels, respectively (Table 1)

Forth nine (49) weaned pigs of large white breed at week nine of age and weighing 5.5 kg were procured from University farm and used for the feeding trial. The pigs were divided into seven groups of seven (7) each according to weight and sex and randomly assigned to the seven experimental diets. Each group was kept in a cement-floored pen. Feed and water were provided *ad libitum*. The pigs were individually weighed at the beginning of the experiment and weekly thereafter. Feed consumption was recorded daily by obtaining the difference between the quantity of feed given and quantity remaining. Data on feed conversion ratio was obtained by dividing the average feed intake by the average weight gain. The experiment lasted for twelve weeks.

Data collected were subjected to a one way analysis of variance [26] where the analysis of variance indicated significant treatment effects, means were compared using Fishers Least Significant Differences (LSD) test [26].

3. RESULTS

Seven experimental diets were formulated (see Table 1) such that diet1, the control, contained no jackbean meal. Diets 2, 3 and 4 contained the cracked and cooked jackbean meals at 15, 20 and 25%, respectively. Diets 5, 6 and 7 contained the soaked cooked jackbean meal also at 15, 20, and 25% respectively. The ingredients were chosen based on the availability, cost effectiveness and NRC nutrient requirements for pigs.

Table 1. Ingredient composition of the experimental diets

Ingredients %	Control	CACJ 15	CACJ 20	CACJ 25	SACJ 15	SACJ 20	SACJ 25
Maize	50.00	40.00	38.00	36.00	40.00	38.00	36.00
Jackbean meal	0.00	15.00	20.00	25.00	15.00	20.00	25.00
Soybean meal	15.00	10.00	7.00	4.00	10.00	7.00	4.00
Spent grain	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Palm kernel cake	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Blood meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Wheat offal	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Bone meal	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vit/min primax*	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis (DM%)							
Crude protein	18.17	19.22	19.19	19.17	19.02	19.12	19.14
Crude fibre	4.14	4.61	4.72	4.84	4.59	4.70	4.82
Ether extract	6.15	5.31	4.84	4.37	5.28	4.78	4.29
ME (Kcal/kg)	2792.7	2751.24	2734.3	2717.84	2751.24	2734.54	2717.84

**To provide the following per kg of feed*

VitD3,4000,000TU, VitE, 8.00 g, Vitk3,0.40 g,VitB1, 0.32 g: VitB2, 0.096 g: VitB6, 0.56 g, VitB12,4.00 mg, Cal-Pathothonate,1.60 g. Folic acid, 0.16 g: Biotin, 8.0 mg, Chlorine,48.0 g, Zinc, 7.20 g, Copper,0.32 g: BHT,32.00 g: Iodine,0.25 g, Cobalt,36.00 mg: Selenum,16.00 mg, Oxytetracycline 100.00 g VitC, 25.oogkg-1

The proximate chemical compositions of both raw and processed jackbean meals are shown in Table 2 while the data on the performance of the pigs is shown in Table 3. Both crack and cook and, soak and cook processing methods reduced the crude protein, ether extract and ash contents of the seed meals but increased the crude fibre contents. Soaked and cooked seeds had the lowest proximate composition values when compared with the cracked and cooked seed except for nitrogen free extract.

Feed intake significantly (*P*<.001) dropped among the pigs fed the jackbean diets irrespective of the processing method used. The lowest feed intake among the jackbean diet groups was recorded in pigs fed 15% SACJ diet. The drop in feed intake was so drastic that the pigs were consuming only about 33% of the quantity of feed being consumed by the control group. Pigs fed the processed jackbean meal diets had a statistically similar feed intake values.

Weight gain was significantly (*P*<.001) higher in pigs fed the control diet, reflecting the higher feed intake value of the group. Jackbean diets at 15%, 20% and 25% levels for both SACJ and CACJ significantly (*P*<.001) depressed growth rate of the pigs. The depression in growth rate was most severe among the pigs fed CACJ diets than those fed SACJ diets. All the jackbean based diets promoted similar growth rate that were not significantly different (*P*>.001) from each other.

Feed conversion ratio of pigs fed the control diet was significantly (*P*<.001) inferior when compared with those of the groups fed jackbean diets, reflecting the higher feed intake of the group to those of the jackbean diet groups. Pigs fed SACJ diets had numerically better feed conversion ratio than those fed CACJ diets but the values were statistically similar (*P*>.001). No mortality was recorded in any of the treatment groups during the study.

4. DISCUSSION

The proximate compositions of both cracked and cooked, and soaked and cooked jackbean meals varied slightly from each other and from that of the raw bean. The crude protein values of CACJ and SACJ compared favourably with earlier values reported in literature [25,4,9,6] for cooked jackbean meal. The drop in protein content of processed jackbean meals were indications that

Table 2. Proximate composition of the processed and raw jackbean

Components (%)	Raw jackbean	CACJ	SACJ
Dry matter	86.53	87.35	88.22
Crude protein	28.54	26.44	25.94
Crude fibre	7.82	13.05	12.36
Ether Extract	3.84	3.16	3.02
Ash	4.92	4.01	3.89
NFE	57.69	53.34	54.79

Table 3. Mean values of performance data of pigs fed with the experimental diets

Parameters	Control	Treatments						
		CACJ 15%	CACJ 20%	CACJ 25%	SACJ 15%	SACJ 20%	SACJ 25%	SEM
Initial body weight (kg)	5.63	5.53	5.25	5.75	5.49	5.5	5.49	0.05
Final body weight (kg)	15.75[a]	11.10[b]	11.57[b]	11.50[b]	12.63[b]	12.75[b]	13.50[b]	0.08
Feed Intake (g/day)	593.30[a]	206.70[b]	207.11[b]	186.16[b]	184.15[b]	193.30[b]	190.18[b]	56.96
Growth rate (g/day)	180.71[a]	97.68b	116.07[b]	102.68[b]	127.50[b]	129.50[b]	143.03[b]	10.58
Feed conversion ratio	3.28[a]	2.11[b]	1.78[b]	1.81[b]	1.44[b]	1.49[b]	1.37[b]	0.025
Feed cost/Kg gain(#)	84.03[a]	44.22[b]	37.30[b]	32.31[b]	30.26[b]	29.25[b]	23.68[b]	

[ab]means within a row with different superscripts are significantly (P<.001) different

during the soaking and cooking processes or boiling, some nitrogenous substances in the raw beans were solubilised and removed. The drop in crude protein was higher in the soaked and cooked meal which tends to show that soaking the seeds in water for a long time before cooking caused more solubilisation of the nitrogenous substances. The amount of crude fibre was higher in CACJ and SACJ which were close to the values reported in earlier studies [25,4,16]. Values for ether extract and ash were lower in the processed meals than the control indicating that some of these nutrient elements may have been lost during soaking and /or cooking of the beans.

4.1 Performance of Experimental Pigs

The result of the feeding trial shows that addition of 15 - 25% CAC or SAC jackbean meals to grower pig diets adversely affected the growth rate and feed intake of the pigs. This tends to show that the two processing methods (CAC and SAC) could not completely eliminate the factor(s) in the jackbean responsible for depressed feed intake and growth rate. Trypsin and chymotrypsin inhibitors have been implicated in reducing protein digestibility but do not influence feed intake [27,5]. The two processing methods employed in this study easily eliminated the protease inhibitors [28,12]. So protease inhibitors could not be suspected as the factor responsible for the poor performance of the pigs. Phytochemical studies in Nigeria, Brazil, Columbia and Belguim [28,29,11] have shown that raw unprocessed jackbean seed contains saponins, cyanogenic, glycosides, terpenoids, alkaloids and tannic acid. However, the concentrations of these specialized secondary plant bio-molecules in jackbean seeds have also been reported to drop below detectable levels following one hour of cooking or autoclaving [28,24,15,30,13]. Therefore, they could not be blamed for the poor performance of the pigs.

Concanavalin A (ConA), the most celebrated of plant lectins was believed to be the most nutritionally important toxic and anti-nutritional factor in the raw unprocessed jackbean seed. Con A represents about 20% of the total protein of the seed [31]. In addition to its ability to agglutinate the erythrocytes of numerous animal spices, clump certain bacteria and precipitate glycogen and starch from solutions, *ConA*. Negatively affects nutrient utilization by different mechanisms [32-34,11]. It induces severe reduction in feed intake of non-ruminants under *ad libitum* feeding system [35]. Fortunately, the two processing methods tested in this study could probably have completely eliminated *ConA.* from the seeds [12,36,4].

Urease and canatoxin which also exist in jackbean seeds are unstable in the stomach media and therefore do not exhibit any toxic effect if orally administered [37,35] The only anti-nutritional factor in jackbean seed that could be blamed for the sharp drop in feed intake of the pigs is canavanine*.* Canavanine is an alkaline toxic amino acid (2-amino-4-guanidino-oxybutric acid), a naturally occurring analogue of L-arginine and constitutes about 5% of the weight of dry jackbean [9]. It is a potent inhibitor of insect development by competing with the indispensable amino acid arginine [11]. It has also been found to induce reduced feed intake in non-ruminants [36,21,37] and described as a natural feed-intake inhibitor for pigs [38,39] but it is believed to be solubilise in water. It therefore means that the process of soaking the seeds in water for 72 hours would have eliminated most of the canavanine in the seeds [40,1,18,15,24,41-43,12,3]. So canavanine cannot be blame for the reduced feed intake and poor growth rate of the pigs. On the other hand, the pigs were observed smelling and selecting the feed by moving their snout from one side of the trough to the other. This observation tends to implicate taste and odour as factor(s) responsible for the entire rejection of the processed (CAC and SAC) jackbean diets by the pigs and should be subjected to further studies.

The The very low feed intake of the pigs at 15% dietary level for both CACJ and SACJ showed that pigs are more sensitive to the anti-nutritional factor(s) in the jackbean than broilers. Processed jackbean meal significantly depressed feed intake of broilers and laying hens only at 30% dietary level [44,13,45-47]. The results tend to confirm earlier studies [48-50,21] that pigs are very sensitive to diets containing jackbean meal.

Pigs fed the processed jackbean diets had better feed conversion ratio than those fed the control diet. This could be attributed to the very low feed intake and weight gain of the pigs fed the jackbean meal diets which reduced the feed conversion ratio value. Low weight gain of the pigs was attributed to reduced feed intake and the reduction in feed intake contributed to better feed conversion ratio of pigs fed the processed jackbean diets when compared with the control group. There was no mortality in both control and

processed jackbean diet groups indicating that the processed jackbean meals though toxic as shown by depressed performance, were nonlethal to pigs.

5. CONCLUSION

It appears from the results of the current study that the two processing methods (CAC and SAC) are not effective in improving the nutritive value of jackbean seeds for pigs. The processed jackbean meals depressed pig performance at the lowest inclusion level of 15% and should not be considered as a source of protein and energy in the diet of pigs. The next logical step would be to determine the exact factor(s) in the seeds that are responsible for the rejection of the diets by the pigs and find ways of eliminating them. Until this is done, it would be difficult to recommend jackbean as feed ingredients for pigs.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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