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Evaluation of Jatropha (*Jatropha curcas* L.) Seed Cake Meal as Feed for Rabbit

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Abstract – **An eight week feeding trial was conducted to evaluate the nutritional value of fermented jatropha seed cake meal (JSCM) for growing rabbits to find a use for this less utilized by product of biodiesel production. The JSCM fermented by *Aspergillus niger* using solid state method was substituted for either 25% (diet 2), 50% (diet 3) or 75% (diet 4) soybean meal (wt/wt) in the control diet (diet 1) formulated for growing rabbits. Sixty mixed sex, crossbred (Newzealand × Flemish giant) rabbits average 877±4g were divided into four groups of 15 rabbits each and assigned to any of the four diets in a completely randomized design. Data were collected on production performance, mortality, production cost, nutrient digestibility, carcass yield and organ weight. Data were analyzed by one way analysis of variance using SAS soft ware package. Results showed that average daily weight gain of the rabbits that received diet 2 (14.37g) and diet 5 (13.14g) were similar to that of the control (14.35g) while the value obtained for those that received diet 3 (16.7g) were higher (P<0.05). Feed conversion efficiency, final weight and live weight followed the same trend. Feed cost increased with increase JSCM in the diets. Production cost was lower (P<0.05) at 50% substitution level than in control diet but higher (P<0.05) at 25% and 75%. Crude fibre was poorly digested at 75% substitution level. Feeding fermented JSCM to rabbits reduced liver and spleen size. It was concluded that up to 75% soybean meal can be replaced with fermented JSCM in growing rabbit diet without adverse effect on growth but for economic reason 50% should be replaced.**

Keywords – **Feed Conversion Efficiency, Nutrient Digestibility, Solid State Fermentation, *Aspergillus Niger*, Weight Gain.**

I. Introduction

The animal protein intake of an average Nigerian has been estimated to be 7.5g/caput/day [1] which greatly fall short of the minimum value of 35g/caput/day recommended for an adult [2]. This can be attributed to many reasons among which is high cost of production emanating from escalating cost of soybean and maize which constitute the bulk of compound feed. A rapid increase in animal protein production at an affordable price is one of the pragmatic approaches of correcting this anomaly. This placed rabbit at a vantage position because they possess high fecundity, rapid growth, short generation interval and ability to utilize a lot of forage. Intensive rabbit production however requires concentrate pellet feed since forage alone cannot sustain the level of production of improved breeds of rabbit.

Rabbit production is also facing food/feed crisis that is being witnessed in pig and poultry production. The use of novelty plant protein crops has been suggested as a way of solving this problem. Jatropha is one of the numerous novelty crops that abound in Nigeria. This crop that belongs to the family of euphorbiaceae is gaining wider publicity due to the fact that its oil is being used for biodiesel production. The preference for biodiesel is premised on the fact that it is safer and does not have much environmental impact because its byproducts do not destroy earth ozone layer. One of the major byproducts of biodiesel production from jatropha seed is jatropha seed meal. This byproduct is likely to increase with the increase in the production of biodiesel with the consequence of causing pollution problem.

Jatropha seed cake byproduct of biodiesel production is rich in nitrogen and can be an excellent plant protein source [3] that can spare the use of conventional plant proteins like soybean cake and groundnut cake if properly detoxified. Amino acid profile and mineral content of *Jatropha curcas* is reported to be comparable to those of other seeds [4]. However, the presence of anti-nutritional factors such as lectins, saponins, tannins, phytic acids, trypsin inhibitors, hydrocyanides and phorboesters is the greatest constrain to its use [5]. Different processing methods have been used to reduce the toxic compounds in jatropha seed meal. One of the most promising of them however is solid state fermentation. The use of jatropha seed cake meal will go a long way in solving pollution problem that is likely to attend the production of biodiesel on large scale. Several studies have been carried out on the use of jatropha seed meal for poultry but information on its use as feed for rabbit is scanty. The present study was therefore conducted to fill this gap.

II. Materials and Methods

A. *Experimental site*

The study was conducted at the Rabbitary Unit of the Teaching and Research Unit, Ladoke Akintola University of Technology, Ogbomoso Oyo State, Nigeria during the rainy season (August-September, 2013). Ogbomoso fall within the derived savanna belt of Nigeria and lies between latitudes $8^0$07'N and $8^0$12'N and longitudes $4^0$04'E and $4^0$15'E. The mean annual rainfall is 1247mm with relative humidity of between 75 and 95%. The location is situated at about 500m above the sea level with a mean annual temperature of 26.2^{0}C.

B. *Collection and processing of jatropha seed*

The unshelled seed were collected from a Jatropha trader and processor in Ibadan. The seeds were sun-dried until they attained about 13% moisture content. The unshelled seed were milled, defatted and cake dried in the sun to avoid mould. The dried cake was then referred to as Jatropha seed cake meal (JSCM).

C. *Source and culture of* Aspergillus niger *and inoculation procedure*

Isolated and purified culture of the fungus *Aspergillus niger* was obtained from the Department of Pure and

Applied Biology Laboratory, Ladoke Akintola University of Technology, Ogbomoso. The fungus culture was grown in potato dextrose agar (PDA) which was supplemented with 20% sucrose at PH of 5.5 with temperature of 30^0C and then preserved in a refrigerator at 4^0C. Aqueous spore suspension of *A niger* was prepared by culturing the fungus in an inoculums medium for 7 days. The moisture content of JSCM was raised to 60% and sterilized in a fermenter fabricated locally with 24kg carrying capacity of the substrate. Sterilization was done at 121^0C for 3 hrs and the JSCM was allowed to cool, then inoculated *A niger* and then left to ferment for 6-7 days at 30 ± 1^0C. Prior to autoclaving each plate containing JSCM was covered with muslin cloth and aluminium foil.

D. Preparation Experimental diets

Four experimental diets were formulated. Control diet (diet 1) was formulated to contain soybean as a major source of protein while *Jatropha curcas* meal was used to replaced 25% (diet 2), 50% (diet 3) and 75% (diet 4) soybean meal respectively in the three remaining diets. The diets were iso-caloric and iso-nitrogenous and meet the minimum requirements recommended for the growing rabbits [6]. All the diets were processed into pellet form using 4mm pelleting machine to ensure adequate feed intake and avoid wastage. The composition of the diet is shown in Table 1.

Table 1: Gross composition of experimental diets

Parameter	Level of JSCM substitution (%)			
	0 (diet 1)	25 (diet 2)	50 (diet 3)	75 (diet 3)
Maize	10.0	10.0	10.0	10.0
Corn bran	18.0	18.0	18.0	18.0
Wheat offal	28.8	28.8	28.8	28.8
Palm kernel cake	21.8	21.8	21.8	21.8
Soy bean meal	3.0	2.1	1.5	0.7
Fish meal	2.0	2.0	2.0	2.0
Rice bran	14.0	14.0	14.0	14.0
Common salt	0.2	0.2	0.2	0.2
Oyster shell	3.0	3.0	3.0	3.0
JSCM	0.0	0.9	1.5	2.25
Total	100	100	100	100
Crude protein (%)	16.04	15.82	15.47	15.49
Crude fibre (%)	9.33	9.27	9.27	9.57
[1]Metabolizable energy	2487.87	2463.57	2447.37	2427.12

[1]Calculated value; JSCM = Jatropha seed cake meal

E. Animals and Management

Sixty (60) cross bred of Newzealand and Flemish giant and mixed sex growing rabbits average 877±4g were used for the study. The rabbits were divided into four groups of fifteen rabbits of about equal weight and assigned randomly into the four experimental diets in a completely randomized design. The rabbits were housed in a metal hutches measuring 60×50×45cm. Feeds and water were supplied *ad libitum* using clay pot containers twice daily (8.00am and 400pm). Hutches were washed with germicide, properly disinfected and dried in the sun before the commencement of the study. The rabbits were also treated for endo-parasites and ecto-parasites using ivomectin injection and allowed to acclimatized. The duration of the study was eight weeks.

F. Data collection

Data were collected on feed intake, weight gain, feed conversion efficiency, mortality, feed cost and feed cost/kilogram weight gain.

G. Feed intake

A known quantity of feed was supplied to the rabbits daily and the rejected feed collected and weighed the following morning using weighing scale. The actual feed consumed was then determined by difference.

Feed consumed = Feed supplied – Feed rejected

H. Weight gain

Weight of each rabbit was taken at the beginning of the experiment and thereafter every week to monitor the growth of the animals. Weight gain was then calculated by subtracting the weight of the animal in the previous week from that of a particular week.

Weight gain = Weight of the rabbit in the present week - Weight of the rabbit in the previous week

I. Feed conversion efficiency

This was determined as weight gain per unit feed consumed.

Feed conversion efficiency = Weight gain/Feed intake

J. Mortality

Record of mortality was taken throughout the duration of the study and expressed as the percentage of the total number of rabbits in a treatment at the beginning of the study.

K. Feed cost

Cost of feed was determined in Naira per kilogram from the cost of individual ingredients used for feed preparation and expressed as Naira per kilogram of feed. Cost of Jatropha seed meal was calculated from the cost of procurement, transportation and processing (including fermentation).

L. Feed cost per kilogram weight gain

This was determined from weight gain and feed cost and feed consumed.

M. Digestibility trial

A digestibility study was conducted using 6 rabbits per treatment. The rabbits were housed in individual hutches with facility for watering, feeding and faecal collection. A three day pre-collection period was allowed followed by another five days collection period. Feed intake and faecal output were recorded using total collection method. Faeces collected were weighed daily and oven-dried at 65^0C for 2 days. Faeces of each replicate was bulked, milled and the representative samples collected and kept in a sealed bottles for laboratory analysis.

N. Carcass evaluation

Five rabbits were selected from each treatment for carcass evaluation. The rabbits were fasted for 24 hours, weighed, stunned, bled, cleaned and dressed. Dressed weight were taken and expressed as the percentage of the live weight. Internal organs (Liver, kidneys, pancreas and heart) were carefully severed, cleaned and weighed using electronic weighing balance. Weights of the internal organs were expressed as the percentage of the live weight.

O. Laboratory analysis

Feeds, faeces, and fermented jatropha seed meal were analyzed for dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract using the methods of AOAC [7]. The gross energy of the fermented jatropha seed meal was determined using adiabatic bomb calorimeter.

P. Statistical analysis

Data collected were analyzed by one-way analysis of variance using the soft ware package of [8]. Significance was determined at P<0.05 and where significance were indicated, Duncan's option of the same software was used to separate the means.

III. RESULTS

The proximate composition of the JSCM used in this study is shown in Table 2. Jatropha seed cake meal contains substantial amount of nutrients. The contents of crude protein, crude fibre, ether extract, ash and nitrogen free extract were 23%, 8.11%, 29.2%, 8.4% and 31.29% respectively.

Table 2: Chemical composition of Jatropha seed cake meal

Component	Percentage
Dry matter	90.11
Crude protein	23.00
Crude fibre	8.11
Ether extract	29.2
Ash	8.4
NFE	31.29
[1]Gross energy	6145

NFE=Nitrogen free extract; [1]Kilocal/Kg

The performance and economic implication of substituting Jatropha seed cake meal for soy bean in the diet of growing rabbits is shown in Table 3.

Table 3: Performance and economic implication of feeding Jatropha seed cake meal to rabbits

Parameter	Level of JSCM substitution (%) 0 (diet 1)	25 (diet 2)	50 (diet 3)	75 (diet 4)	SEM
Initial wt (g)	876	879	875	878	6.0
Final wt(g)	1680^{b}	1683^{b}	1810^{a}	1613^{b}	75
A D G (g)	14.35^{b}	14.37^{b}	16.7^{a}	13.14^{b}	15
Feed intake (g)	87.82	88.67	89.01	86.12	5.0
FCE	0.17^{ab}	0.16^{b}	0.19^{a}	0.15^{b}	.025
Mortality (%)	2.8	2.9	3.0	3.2	0.6
Feed cost (N/Kg)	79.1^{d}	80.1^{c}	84.1^{b}	86.3^{a}	0.5
Cost/kg wt gain (N)	483.30^{c}	495.01^{b}	448.25^{d}	565.27^{a}	7.0

abcd: Means bearing different superscripts along the same row are significantly different (P<0.05); JSCM = Jatropha seed cake meal; N = Nigerian Naira; ADG= average daily gain; FCE= Feed conversion efficiency; Wt = Weight.

Rabbits that were fed diets in which JSCM replaced 50% soybean meal in their diets had higher final weight and average daily weight gain than those fed no JSCM (control diet) while those fed 25%JSCM and 75%JSCM had similar (p>0.05) values with the control. Feed conversion efficiency of the rabbits that were fed 50% JSCM in replacement for soybean meal was also higher (P<0.05) than that of the group fed no JSCM while the values obtained for those that were fed 25% and 75% JSCM diets were similar to the values obtained for the control. Feed cost increased with increase level of JSCM substitution in the diet. Feed cost per kilogram weight gain of the rabbits that were fed 25% and 75% JSCM in replacement for soybean meal were significantly (P<0.05) higher than that of the group that received diet that contained no JSCM (control). The value obtained for those that received diet that contained 50% JSCM was however lower (P<0.05). No significant effect of diets was observed on feed intake and mortality.

The nutrient digestibility by the rabbits fed JSCM in replacement for soybean meal is shown in Table 4.

Table 4: Nutrient digestibility of rabbits fed Jatropha seed cake meal

Parameter	Level of JSCM substitution (%) 0 (diet1)	25 (diet2)	50 (diet3)	75 (diet4)	SEM
Dry matter (%)	71.08	68.33	72.66	69.44	5.5
Crude protein (%)	80.07	75.08	74.34	76.46	7.0
Crude fibre (%)	49.62^{a}	48.89^{a}	46.80^{a}	42.40^{b}	3.0
Ether extract (%)	87.17	84.24	87.12	84.53	4.0
N F E (%)	75.2	74.5	75.1	74.4	2.0

ab: Means bearing different superscripts along the same row are significantly different (P<0.05); JSCM = Jatropha seed cake meal; NFE= Nitrogen free extract

Dietary treatments had no significant (P>0.05) effect on the digestibility of dry matter, crude protein, ether extract and nitrogen free extract. Significant effect of diets was however observed in crude fibre digestibility. Rabbits that received diet in which 50% soybean meal was replaced with JSCM digested crude fibre better than others (control inclusive).

The carcass characteristics and internal organ weights of the rabbits fed JSCM in replacement for soybean meal is presented in Table 5.

Table 5: Carcass characteristics and internal organ weight of rabbits fed Jatropha seed cake meal

Parameter	Level of JSCM substitution (%)				
	0 (diet1)	25 (diet2)	50 (diet3)	75 (diet4)	SEM
Live wt (Kg)	1.67[b]	1.68[b]	1.80[a]	1.62[b]	0.09
Carcass yield (% live wt)	47.8	46.66	49.27	50.39	4.5
Kidneys (% live wt)	0.33	0.33	0.30	0.34	0.1
Liver (% live wt)	2.96[a]	2.38[b]	2.30[b]	2.48[b]	0.40
Heart (% live wt)	0.21	0.19	0.18	0.19	0.05
Spleen (% live wt)	0.08[a]	0.05[b]	0.04[b]	0.05[b]	0.02
Lung (% live wt)	0.61	0.46	0.51	0.50	0.2

ab: Means bearing different superscripts along the same row are significantly different (P<0.05); JSCM = Jatropha seed cake meal; Wt=weight

The live weight of the rabbits that were placed on 50% JSCM (diet3) was higher (P<0.05) than others (diets 1, 2 and 4). Livers of the rabbits that were fed control diet and 25% JSCM (diet 2) were similar in weight and larger (P<0.05) than those that were fed 50% and 75% JSCM. The spleen of the rabbits that were fed JSCM were smaller (P<0.05) than that of the group fed soybean meal as sole protein source.

IV. Discussion

The high protein content of JSCM makes it a potential protein feed resource for livestock animals if the anti-nutrients in it can be properly processed to a tolerable level for livestock animals. The crude protein and fibre content of JSCM used in this study was lower than that reported by [9] for seed cake prepared from jatropha seeds collected from different regions of Ghana. The fat and nitrogen free extract were however higher than that reported by the same author while the ash content was similar.

In this study rabbits that received 25%JSCM diet and 75%JSCM diet performed as well as those that received control diet while those that received 50% even performed better than the control. This indicates that up to 75% soybean meal can be replaced with JSCM meal in rabbit diet without any adverse effect on growth performance. A better performance observed in the rabbits on 50%JSCM could be due to better amino acid balance in this diet which probably favour higher growth. Earlier report by [10] indicates that amino acid composition of jatropha seed is excellent. Also the higher efficiency of feed utilization observed in the same group of rabbit could be due to the same reason. The results of this study disagree with that of [11] who reported a decrease in the growth of broiler chicken fed fermented jatropha curcas seed meal. This difference could be due to the fact that rabbits practice caecothrophy which is absent in chicken.

The results obtained in this study showed that there was no difference in the feed intake of the rabbits that received diets that contained JSCM and those that received control diet. This contradict the report of [12] who demonstrated that rats fed alkali and heat treated seed meal of jatropha curcas had reduced appetite and low feed intake. This could be due to physiological adaptation resulting from difference in species. It can also mean that fermentation using *Aspergillus niger* is a better processing method for reducing anti-nutritional factors in JSCM than alkali and heat treatment method.

This study revealed that there was no difference in the mortality of the rabbits that were fed diets that contained jatropha seed cake meal and those fed only soybean meal diet. This is in line with the report of [11] who also observed zero mortality in broiler chicken fed jatropha seed cake meal processed by fermentation and the one autoclaved, refluxed by hexane before soaking in methanol.

Higher cost of the feeds that contain JSCM can be attributed to higher cost of JSCM used in the study. A high cost was incurred in the processing of the jatropha seed to meal for the purpose of this study. The seed meal from biodiesel industry is therefore expected to be cheaper than the one used for this study. That notwithstanding, production cost was lower in the rabbits that were fed 50% JSCM compared with those that received control diet.

The results of this study revealed that there was no adverse effect on nutrient digestibility by growing rabbits when soybean meal was replaced by JSCM in their diets. This further confirm that rabbits can tolerate JSCM in their diets.

In this study, the liver and spleen observed in the rabbits that were fed diets that contained JSCM were smaller than those that were fed only soybean as the major source of protein in their diet. This can be attributed to the residual anti-nutritional factors like lectins, saponins, tannins, phytic acids, trypsin inhibitors, hydrocyanides and phorboesters in JSCM [5]. A regressive changes in the kidney and liver was also reported by [13] when sheep were fed diets containing dried and crushed fruit shell of jatropha curcas in substitution for Mombaca grass hay.

Similarly, atrophy of vital organs was reported in rats fed alkali and heat treated jatropha seed meal [12].

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