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Effects of Processing Methods of *Jatropha curcas* Seed Meal on Growth Performance and Blood Profile of Broiler Finisher Chickens

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Authors' contributions

This work was carried out in collaboration between all authors. Authors MA and BY designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors MA, BY and RJW performed the statistical analysis and managed the analyses of the study. Author YHA coordinated data collection and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Two hundred Anak-2000 day old chicks were used to evaluate the effects of differently processed *Jatropha curcas* seed meal on growth performance, carcass characteristics, internal weight organ, haematological and biochemical indices of broiler chickens. Five experimental diets were formulated containing 0% Jatropha seed meal, 10% fermented Jatropha seed meal (FJM), 10% boiled Jatropha seed meal (BJM), 10% toasted Jatropha seed meal (TJM), and 10% soaked Jatropha seed meal (SJM) and were designated as T1, T2, T3, T4 and T5 respectively. The chicks were randomly allotted to five dietary treatments consisting of four replication of ten birds per replicate in a completely randomized design (CRD).The result of the anti-nutritional factors (ANFs)

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determined were higher in in the raw Jatropha seed meal. Crude protein (CP) content of raw, soaked, fermented, boiled and toasted *Jatropha curcas* seed meal is 32.61, 29.35, 42.38, 38.62 and 29.60% respectively. The ether extracts (EE and crude fibre (CF) values ranged from 4.36 – 34.21% and 2.10 – 11.28% respectively. Among the processing methods employed, fermentation and toasting recorded higher reduction in the concentration of these anti-nutritional factors. The result of all the growth parameters measured were significantly (P<0.05) affected by the processing methods except the initial weight. The performance of broiler birds on differently processed Jatropha seed meal was lower than those on the control diet. The parameters evaluated for carcass weight were significantly (P<0.05) higher in birds fed control diet There was no definite pattern in carcass characteristics however, birds fed the control diet, FJM and BJM were similar. The weights of kidney, liver and lungs showed significant differences (p<0.05) among processing methods. The haematogical parameters did not show significant (P>0.05) difference across the treatment groups except for PCV, MCH and WBC. It was concluded from the results that broiler birds can be fed with 10% inclusion level of fermented Jatropha seed meal.

Keywords: Jatropha curcas; processed; performance; carcass hematology; biochemical.

1. INTRODUCTION

The use of conventional protein and energy sources for livestock feed and human consumption has resulted in the increase of prices of these feedstuffs thereby increasing the cost of livestock production [1]. This has necessitated the use of alternative, non-conventional, cheap and readily available protein and energy sources to meet future demand in livestock feed industries [2]. One of such non-conventional protein and energy sources is *Jatropha curcas* seed.

Jatropha curcas is a member of the *Euphorbiaceae* family and drought resistant multipurpose tree of significant economic importance [3]. The seed has been reported to contain 53 - 58% crude protein [4].The relatively high protein content of *Jatropha curcas* can be explored in livestock production since it is not utilized by humans like other conventional protein and energy sources such as soybean and groundnut [4,5]. However, its potential is limited by anti-nutritional factors that must be reduced before the seed can be utilized. Among the known anti nutritional factors present in *Jatropha curcas* seed is phorbol ester, lectin, saponin, tannin, phytate and trypsin inhibitors which has been reported to have negative effect in the nutrient digestion and absorption in livestock [6].

Several processing methods such as toasting, cooking, soaking in water, treatment with urea, fermentation have been reported to reduce anti-nutritional factors in legumes [7,8,9]. Information on the use of differently processed *Jatropha curcas* seeds in broiler's diet is however scanty. Therefore, the study was carried out to evaluate the effect of feeding differently processed *Jatropha curcas* seed meal on the performance, carcass characteristics, internal organs, haematological and biochemical indices of broiler finisher chickens.

2. MATERIALS AND METHODS

2.1 Location of the Study

The study was conducted at the College of Agriculture, Livestock and Research Farm Jalingo, Taraba State. Jalingo is located between Latitude 8°3 [1]and Longitude 11°5 [1]E. The area is characterized with two main seasons; dry and rainy. Dry season starts early in November and end in March, while the wet season runs from April to October. The area has an average temperature of 30°C [10]

2.2 Collection and Processing of *Jatropha curcas* Seeds

Jatropha curcas seeds were collected from Jalingo and surrounding villages in Taraba State Nigeria. The seeds were subjected to different processing methods before the oil were extracted manually. The seeds were processed using four different processing methods: Fermentation, boiling, toasting and soaking in water. Fermentation was carried out by soaking the seeds in tap water for 48 hours and was placed in an air tight container. Toasting, the seeds were soaked in tap water for 48 hours, toasted for 30 minutes with constant stirring to maintain uniform heating until the whitish endosperm turns to light brown. Soaking, was achieved by placing the seeds in a container filled with tap water for 48 hours, thereafter removed and sun dried.

2.3 Experimental Design, Diets and Management

Two hundred (200) day-old *Anak* white strain unsexed broiler chicks were purchased from Otta Farms, Ogun State, Nigeria. The birds were randomly allotted to five dietary treatments of 40 birds per treatment replicated four times with 10 birds per replicate in a completely randomized design (CRD). The birds were managed on a deep litter throughout the period of the experiment. Daily management practices were carried out as described by [11]. Five experimental diets were formulated containing 0% *Jatropha* seed meal, 10% fermented Jatropha seed meal (FJM), 10% boiled Jatropha seed meal (BJM), 10% toasted Jatropha seed meal (TJM), and 10% soaked Jatropha seed meal (SJM) and were designated as T1, T2, T3, T4 and T5 respectively (Table 1).

2.4 Data Collection

2.4.1 Growth performance

Feed intake was determined as the difference between the left over and the quantity of feed offered. Similarly, weight gain was determined as the difference between the final weight and initial weight. Feed conversion ratio was measured as an index of feed utilization for each treatment group and calculated as the ratio of feed intake to weight gain.

2.4.2 Carcass evaluation

On the last day of the experiment 56th day, four birds from each replicate were randomly selected for carcass and internal organs measurements. The birds were tagged according to their replicates and fasted for 8 hours to reduce the gastro-intestinal contents [12]. The birds were individually weighed, slaughtered, plucked and eviscerated. Carcass weight, cut parts and internal organs weight were measured.

2.4.3 Haematological and biochemical analysis

At the end of the experiment, three birds were selected at random from each replicate. 5 mls of blood was collected from the wing vein of each bird into sterilized bottles containing Ethylene-diaminetetra-acetic acid (EDTA) for hematological parameters determination as described by [13]. The data generated from the blood analysis was used to calculate the erythrocytic parametres which include the mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular

Table 1. Ingredient composition of experimental diets

Ingredients	Dietary treatments				
	T1	T2	T3	T4	T5
Maize	53.91	54.83	53.83	54.83	54.83
Wheat bran	12.73	11.53	11.53	11.53	11.53
GNC	26.56	16.84	16.84	16.84	16.84
JSM	0.00	10.00	10.00	10.00	10.00
Fish Meal	3.00	3.00	3.00	3.00	3.00
Bone Meal	3.00	3.00	3.00	3.00	3.00
Premix*	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.20	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25	0.25
Calculated analysis					
Crude Protein	20.55	20.90	20.90	20.90	20.90
Crude Fibre	3.67	4.51	4.51	4.51	4.51
Calcium	0.93	1.31	1.31	1.31	1.31
Phosphorus	0.89	1.01	1.01	1.01	1.01
Lysine	1.30	1.31	1.31	1.31	1.31
Methionine	1.47	0.55	0.55	0.55	0.55
ME (Kcal/kg)	3032	3065	3065	3065	3065

**Vitamin-Mineral premix provides per kg the following: Vit. A 1500 IU; Vit D3 3000 IU; Vit.E; 30 IU; Vit.K 2.5 mg; Thiamine B_1 3 mg; Riboflavin B_2 6 mg; pyridoxine B_6 4 mg; Niacin 40 mg; Vit. B_{12} 0.02 mg; pantothenic acid 10 mg, Folic acid 1 mg; Biotin 0.08 g; chloride 0.125g; Mn 0.096 g; Antioxidant 0.125g; Zn 0.06g; Fe 0.024 g; Cu 0.006 g; 10.0014 g; Se 0.24 g; Co 0.240 g*

haemoglobin concentration (MCHC) as described by [14]. Similarly, 5mls of blood samples were also collected into sterilized bottles without (EDTA) for biochemical analysis. Parameters determined were total protein, serum albumin, creatinine, glucose, urea, cholesterol and globulin.

2.4.4 Chemical analysis

The chemical analysis of the experimental diets, differently processed *Jatropha curcus* seed meal and anti-nutritive factors were carried out according to the methods described by [15].

2.4.5 Statistical analysis

Data collected were subjected to analysis of variance [16], and significant differences between means were compared using Duncan's Multiple Range Test [17]

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Differently Processed *Jatropha curcas* Meal

The result of proximate composition of raw and differently processed *Jatropha curcas* seed meal is presented in Table 2. The result showed that the crude protein content of raw, soaked, fermented, boiled and toasted *Jatropha curcas* seed meal is 32.61, 29.35, 42.38, 38.62 and 29.60% respectively. The ether extracts (EE) and crude fibre (CF) values ranged from 4.36 – 34.21% and 2.10 – 11.28% respectively. Nitrogen free extract (NFE) for raw and processed *Jatropha curcas* seed meal were within the range of 16.45- 38.55%. The CP values of raw and differently processed *Jatropha curcas* seed meal is similar to the range of 29.56 – 43.56% reported by [18] but lower than the 47.97% reported by [19]. The CP content of BJM and SJM were lower when compared to FJM and TJM. This is an indication that during soaking and boiling processes, some nitrogenous substances in the seeds were solubilized. Similar result was reported by [20] when they subjected raw Jackbean to soaking and boiling processes. Higher CP observed in TJM and FJM could be attributed to heat applied during toasting and absences of leaching and vaporization of some nitrogenous compound during fermentation processing. The RJM had the lowest 2.10% CF content when compared to the other processing methods. This may be due to presence of oil in the seed. The CF value was within the range of 2.23 - 15.8% reported for tropical seeds [21,22]. The value of EE was observed to be lower among all the processing methods, when compared to the RJM. This implies negative correlation between EE and ash. Higher ash content observed on processed *Jatropha curcas* seed meal indicates that processing methods employed increased the concentration of minerals in the meal [23]. The Metabolizable energy of the processed *Jatropha curcas* seed meal was lower than the raw seed meal. This could be as a result of high EE in the raw seeds [24]. Variation in proximate composition of *Jatropha curcas* seed meal could be attributed to soil type, environmental factors, storage period and processing methods employed [23].

The result of all the anti-nutritional factors (ANF) determined was higher in the RJM. Among the processing methods employed, fermentation and toasting recorded higher reduction in the concentration of anti-nutritional factors. Reduction in trypsin inhibitors could be attributed to leaching out during processing. Similar result was reported by [25] when they subjected sorrel seed to different processing methods and observed reduction in trypsin inhibitors. Phytate, saponin and oxalate also showed reduction in concentration however, the methods of processing employed did not completely remove these anti- nutritive factors. The result agreed with the findings of [18,26] who reported partial reduction of anti- nutritional factors when *Detarium microcarpum* and Jatropha seeds were subjected to differently processing methods.

3.2 Growth Performance of Broiler Chickens Fed Differently Processed *Jatropha curcas* Seed Meal

The growth performance of broiler chickens fed raw and differently processed *Jatropha curcas* seed meal is presented in Table 3. The result of all the parameters measured were significantly ($P<0.05$) affected by the processing methods except the initial weight. The growth performance of broiler birds on differently processed Jatropha seed meal was lower than those on the control diet. This observation agreed with the reports of [18], who reported significant ($p<0.05$) depression in daily feed intake, daily weight gain and final body weights of broiler chicken fed differently processed *Jatropha curcas* seed meal. The range of the final weights (1134.80-1487.50 g), ADWG (18.00-24.35 g) and ADFI (54.35-64.73 g) were lower than the standard established by [28] for broiler finisher chickens in the tropics. However the range of FCR

(2.65-3.21) observed in this study was higher than the values of [28]. It was observed that the ADFI was influenced by the processing methods. Birds fed control diet had the highest ADFI (64.73 g). There was no definite pattern of ADFI across the treatment groups. However, the ADFI of birds fed T1 was significantly different (P<0.05) from that of T4 and T5 but similar to those fed T2 and T3.The feed intake decreased across the processing methods. This result agreed with the findings of [18] who fed differently processed *Jatropha curcas* meal at the inclusion level of 10.33% in the diet of broiler chickens and observed reduction in feed intake. The result also confirmed earlier reports of [29,30] who observed poor feed intake, dehydration, loss of weight on birds and rat when fed raw and processed Jatropha seed meal respectively. Although, it was observed that feed intake decreased among the processing methods but birds fed fermented (T2) and toasted (T4) seed meal had similar feed intake with control treatment. This implied that birds on these diets tolerated the residual quantity of anti- nutritional factors remaining in the seed meal after processing. Anti- nutritional factors such as tannin, saponins, lectin, phorbol ester trypsin inhibitor are known to affect feed intake, protein synthesis and utilization when fed on high concentration [31]. Feed conversion ratio (FCR) was similar and superior in birds fed T1 (2.65) and T2 (2.89) compared to those fed T3 (3.09), T4 (3.21) and T5 (3.02) diets. The superior FCR of birds fed T1 and T2 suggests that fermentation enhanced availability, digestion, absorption and utilization of the nutrients in broiler chickens [32].

Table 2. Proximate composition and anti nutritional factors of raw and processed *Jatropha curcas* seed

Composition	Processing methods				
	RJM	SJM	FJM	TJM	BJM
Dry matter	89.82	89.65	89.55	89.84	89.52
Moisture	10.18	10.35	10.45	10.16	10.48
Crude protein	32.61	29.35	42.38	38.62	29.67
Ash	7.33	8.77	8.34	8.22	8.63
Ether extract (EE)	34.21	4.36	11.34	9.58	5.12
Crude fibre	2.10	10.62	4.13	4.00	11.28
Nitrogen free extract	23.75	46.90	33.81	39.58	45.30
*ME (kcal/kg)	4820.70	3104.06	3686.85	3610.01	3120.66
Anti-nutritional factors mg/100 g					
Tannin	312.28	282.64	71.53	67.34	205.24
Trypsin inhibitor	22.16	14.65	4.45	4.37	4.65
Saponins	181.11	179.68	58.12	57.22	142.35
Phytates	264.12	235.67	48.64	42.27	186.64
Oxalates	95.37	84.23	27.46	23.15	78.34
Phorbolesters	2.80	1.26	1.06	1.16	1.20

**Metabolizable energy was calculated using the formula of [27]: ME (Kcal/kg) = 37 x CP (%) + 81 x EE(%) + 35.5 x NFE(%)*

RJM = Raw Jatropha seed meal; SJM = Soaked Jatropha seed meal; FJM = Fermented Jatropha seed meal; TJM = Toasted Jatropha seed meal; BJM = Boiled Jatropha seed meal

Table 3. Growth performance of broiler chickens fed differently processed *Jatropha curcas* seed meal

Parameters	Dietary treatments					
	T1	T2	T3	T4	T5	SEM
Initial weight (g)	124.00	123.40	125.75	123.84	126.80	2.80^{ns}
Final weight (g)	1487.50^{a}	1358.00^{ab}	1200.00^{b}	1187.50^{b}	1134.80^{b}	1273^{*}
Body weight gain (g)	1363.50^{a}	1234.60^{b}	1057.58^{b}	1063.66^{b}	1008.00^{c}	11.45^{*}
Daily weight gain (g)	24.35^{a}	20.62^{a}	19.19^{b}	18.99^{b}	18.00^{b}	0.22^{*}
Total feed intake g/bird	3625.39^{a}	3572.01^{b}	3216.09^{b}	3418.48^{b}	3043.53^{b}	33.75^{*}
Daily feed intake g/bird	64.73^{a}	63.79^{ab}	52.42^{b}	63.05^{ab}	54.35^{b}	0.59^{*}
FCR	2.65^{b}	2.89^{b}	3.09^{a}	3.21^{a}	3.02^{a}	0.02^{*}

*Means in the same row bearing different superscripts differ significantly (P<0.05), NS= not significant different (P>0.05) *=significantly different (P<0.05), SEM = Standard error mean*

Table 4. Carcass yield and internal organ characteristics of broiler chicken fed differently processed *Jatropha curcas* seed meal

Parameters	Dietary treatments					
	T1	T2	T3	T4	T5	SEM
Live weight	1487^{a}	1300^{ab}	1200^{b}	1187.50^{b}	1337.50^{ab}	13.02^{ns}
Plucked weight	1350^{a}	1187.50^{ab}	1110.75^{b}	1110.75^{b}	1162.50^{ab}	11.84*
Eviscerated weight	1175^{a}	1012.50^{ab}	900^{b}	912.50^{b}	1037.50^{ab}	10.07*
Carcass weight	987.50^{a}	875^{ab}	800^{b}	800^{b}	925^{ab}	8.75*
Dressing %	66.40	67.30	66.66	67.36	69.15	1.10^{ns}
Head weight	38.25	38.04	36.63	38.02	40.04	2.40^{ns}
Neck weight	78.47^{a}	61.48^{b}	54.72^{b}	48.53^{b}	56.08^{b}	5.12*
Breast weight	232.87^{a}	193.43^{ab}	163.75^{b}	159.96^{b}	186.26^{ab}	17.06*
Wings weight	116.73	112.83	107.51	108.44	116.91	6.75^{ns}
Thighs weight	173.45^{a}	146.95^{ab}	130.58^{b}	133.49^{b}	15.14^{ab}	9.14*
Drumstick weight	147.10^{a}	135.17^{ab}	118.68^{b}	121.07^{b}	136.063^{ab}	6.99*
Internal organs						
Liver	28.45^{a}	18.42^{ab}	27.43^{a}	16.52^{b}	26.87^{ab}	3.28*
Lungs	7.01^{b}	8.53^{a}	8.43^{a}	9.14^{a}	8.44^{a}	0.7*
Gizzard	49.31^{ab}	40.11^{ab}	41.62^{ab}	36.44^{b}	41.38^{ab}	11.67*
Kidney	5.79^{b}	7.16^{a}	8.44^{a}	7.91^{a}	7.55^{a}	1.14*
Large Intestine (g)	5.60^{a}	4.62^{ab}	3.11^{b}	2.47^{b}	3.08^{b}	0.67*
Large Intest (cm)	7.50^{b}	10.25^{a}	8.88^{ab}	7.13^{b}	8.85^{ab}	0.70*
Small Intestine (g)	66.43	63.52	65.99	51.68	60.50	6.97^{ns}
Small Intest (cm)	172	184	176.50	155.50	175	11.00*
Caecal (g)	7.13	6.39	6.29	5.73	6.21	0.50^{ns}
Caecal (cm)	24.00^{b}	28.25^{a}	28.25^{a}	26.48^{ab}	28.38^{a}	1.27*
Abdominal Fat (g)	36.22^{a}	12.71^{b}	20.75^{ab}	12.63^{b}	17.89^{b}	5.61*

*Means in the same row bearing different superscripts differ significantly (P<0.05), ns= not significant different (P>0.05) *=significantly different (P<0.05), SEM = Standard error mean*

3.3 Carcass Characteristics of Broiler Chicken Fed Differently Processed Jatropha Seal Meal

The result of carcass characteristics and internal organs measurements is presented in Table 4. The parameters evaluated for carcass weight were significantly (P<0.05) higher in birds fed control diet (T1).There was no particular pattern in carcass characteristics, however birds fed the control diet , FJM and BJM were similar The weights of kidney, liver and lungs showed significant differences (p<0.05) among processing methods. Heart and lungs observed in this study were higher than the range of 0.41-0.57% and 0.58- 0.61% reported by [33] respectively. The dressing percentage obtained in this study was slightly higher than that of [34] for toasted sesame seed meal. The poor carcass characteristics of birds on processed *Jatropha curcas* seed meal when compared to the control could be attributed to impaired nutrients utilization from the diets as a result of the residual effects of anti-nutritive factors. Ref [35,36] reported that nutrition exert several influence on the development of carcass trait, organs and muscular growth in broilers. Variation in internal weight of organs is as a result of increased metabolic rate of the organs in an attempt to reduce the toxic elements or to convert the anti -nutritional agents to non-toxi metabolites.

3.4 Haematological and Biochemistry of Broiler Birds Fed Differently Processed Jatropha Seed Meal

The results of haematological and biochemical parameters are shown in Table 5. The haematogical parameters did not show significant (P>0.05) difference across the treatment groups except for PCV, MCH and WBC. The Packed Cell Volume (PCV) values ranged from 24.25- 28.00% which fell within the normal range of 22.0 – 35.0% of broiler chicken as reported by [37]. According to ref [38], a reduction in the concentration of PCV in the blood is an indication of the presence of a toxic factor which has deleterious effect on blood formation. The values of PCV and Hb obtained in

Table 5. Biochemical and haematological indices broiler chicken fed differently processed *Jatropha curcas* seed meal

Parameters	Dietary treatments					
	T1	T2	T3	T4	T5	SEM
Haematological indices						
PCV	26.75^{ab}	28.00^{a}	27.00^{a}	24.25^{b}	27.00^{ab}	1.11*
Hb	8.83	9.28	7.35	8.00	9.08	0.66^{ns}
MCHC	33.25	33.78	32.63	32.95	32.43	0.55^{ns}
MCV	88.88	90.95	88.90	91.55	91.73	1.51^{ns}
MCH	28.75^{b}	31.08^{a}	29.63^{a}	30.18^{ab}	30.60^{ab}	0.67*
WBC	13.73^{a}	14.35^{a}	11.33^{b}	13.03^{b}	10.80^{b}	0.55*
RBC	2.98	3.05	2.45	2.65	2.93	0.21^{ns}
Heterophils%	48.50	51.75	47.75	48.50	47.75	2.56^{ns}
Lymphocytes%	47.50	46.75	48.75	48.50	48.25	2.56^{ns}
Monocytes%	1.00	1.50	1.25	1.00	1.00	0.17^{ns}
Eosinophiles%	1.25	1.00	0.75	0.75	1.00	0.32^{ns}
Basophils%	1.75	1.25	1.50	1.25	1.50	0.45^{ns}
Biochemical indices						
Glucose (MMOI/L)	9.87	10.18	11.43	10.15	9.65	0.73^{ns}
Urea (MMOI/L)	6.95	3.28	4.45	5.63	8.15	1.89^{ns}
Creatinine (MMOI/L)	20.05	25.43	23.88	21.73	20.38	4.49^{ns}
Cholesterol (MMOI/L)	3.70	3.68	3.30	3.68	3.15	0.22^{ns}
Albumin (g/l)	14.08^{ab}	16.23^{a}	8.48^{c}	9.40^{bc}	12.43^{abc}	1.63*
Total Protein (g/l)	25.20	26.15	23.40	24.04	25.05	2.11^{ns}

*Means in the same row bearing different superscripts differ significantly (P<0.05), NS= not significant different (P>0.05) *=significantly different (P<0.05), SEM = Standard error mean*

this study agreed with the assertions of [39] which shows that the diet contained relatively higher quality protein that can meet the bird's protein requirement. The values obtained for WBC were within the reference range of 9 – 31 x 103/mm^3 [40] for healthy birds. Decreased WBC below the normal range is an indication of allergic conditions, anaphylactic shock and certain parasitism or presence of foreign body in circulating system. Differential counts like heterophils, lymphocytes and basophiles were not (P>0.05) significantly different among the treatment groups. Cholesterol (mg/dl) values were low, but could be attributed to the presence of saponins and tannins in Jatropha seed meal which might have interfere with the absorption of dietary lipids and cholesterol resulting in overall cholesterol-lowering effect. Ref [41] reported that saponin and tannin in diets have been known to reduce the uptake of certain nutrients like glucose and cholesterol and help in reducing the metabolic burden that would have been placed on the liver.

4. CONCLUSION

From the result obtained in this study, it can be concluded that broiler chicken can be fed with an inclusion level of 10% fermented Jatropha seed meal.

ETHICAL CONSIDERATION

The study was conducted with permission from the animal welfare and ethics committee of Department of Animal Production, Taraba State College of Agriculture, Jalingo, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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