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Performance and organoleptic properties of broilers fed replacement levels of rumen filtrate fermented shea nut (*Vitellaria paradoxa*) meal for groundnut meal

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ABSTRACT

This study investigated performance and organoleptic properties of broilers fed varying levels of rumen filtrate fermented shea nut meal (RFFSNM). One hundred and eighty (180) day-old Hubbard broiler chicks were randomly allotted to four dietary treatments using completely randomized design (CRD). Each treatment was replicated three times with 15 birds per replicate. T_1, T_2, T_3 and T_4 contained 0, 5, 10 and 15% replacement levels of RFFSNM for groundnut meal, respectively. Three (3) birds were randomly selected from each treatment, slaughtered and dressed while the meats were used to determine the organoleptic properties. The results obtained showed that there were no significant ($P > 0.001$) differences among the treatment groups in cumulative weight gain. Although, there were no significant difference in the mortality among the different treatment groups, T_1 recorded the highest mortality (24.45%). The organoleptic values for roasted and cooked meats showed no significant ($P > 0.05$) differences in the colour, tenderness, juiciness, flavour and overall acceptability among the treatment groups. However, birds fed diet with 5% RFFSNM recorded highest acceptability values in roasted (7.58) and cooked (6.45) meats. It was concluded that the use of RFFSNM at 5 to 15% levels as a replacement for groundnut meal did not have significant improvement on the growth performance and organoleptic properties of broiler chickens while an alternative method may be found to reduce the anti-nutritional factors in shea nut meal.

Keywords: Hubbard broiler, rumen filtrate, ferment, shea nut meal.

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INTRODUCTION

The cost of conventional protein and energy sources such as groundnut, soya bean, fish and maize for non-ruminant animals in many tropical countries have been on the increase, such that it is uneconomical to use these conventional feedstuffs in poultry feeds (Oduguwa et al., 2004). One possible source of cheap and available non-conventional feed ingredient is shea nut (*Vitelleria paradoxa*) seeds which may serve as an energy booster or protein concentrate in rations but for some anti-nutritional factors (tannin, saponin, theobromine and hydrocyanide). The shea tree, *Vitellaria paradoxa* syn. *Butyrospermum parkii*, *Butyrospermum paradoxum* (http://www.fao.org/docrep/008/y5918e/y5918e11.html) is typically a Savannah woodland tree species of the family Sapotaceae. Shea has multiple uses. The high linoleic acid and cinnamic acid content of shea butter makes it an ideal remedy against dry skin, rashes, dermatitis, sunburn, redness, chapping and eczema (http://www.ucheanudu.tripod.com/id18.html). The major nutritional limitation of shea nut meal for poultry is the anti-nutritional factors, particularly tannins that are in the range of 98.7 to 156.4 g/kg, saponins of 3.0 to 30.0 g/kg and theobromine of 4.5 g/kg (Annongu et al., 1996). Fresh shea nut meal was collected from local shea butter and the procedure for the fermentation of corn-cob as described by Adeyemi and Familade (2003) was used to ferment it with the following modifications - A cotton sieve of 0.25 mm size was used as filter for a freshly collected rumen ingesta from a slaughtered cow, well water was added to the filtrate in the ratio of 3:1, a big plastic

Table 1. Vaccination schedule for the broiler birds.

Age	Vaccine	Method	Dose
7th day	1st dose of Gumboro disease vaccine	Drinking water	200 doses in 2 L
14th day	1st dose of Lasota (NDV)	Drinking water	100 doses in 2 L
21st day	2nd dose of Gumboro disease vaccine	Drinking water	200 doses in 2 L
28th day	2nd dose of Lasota (NDV)	Drinking water	100 doses in 2 L

polythene bag was then placed in a plastic drum to take its shape and the blended mixtures of rumen filtrate with shea nut meal were packed inside the polythene bag. It was then tied securely with rope to make it air tight thus preventing exchange of gasses between the fermenting material and the environment for a 15-day anaerobic fermentation period. The fermented shea nut meal was sundried for 4 days on polythene sheets spread on concrete platform to prevent contamination with stones and dusts and re-milled to break the lumps before use. Shea nut meal was used because it is an alternative cheap source which can reduce the cost of feed and invariably reduce the cost of production lower than conventional groundnut meal. Moreover, the level of tannin in *Aspergillus niger* fermented shea nut meal diet were high enough to depress growth performance of the birds (Dei et al., 2008). Fermentation process can create conditions for the growth of microbes (*Aspergillus, Bacillus, Corynebacterium, Klebsiella, Penicillin, Fusarium* and *Candida*) that break down tannins (Reddy and Pierson, 1994) and these organisms are present in rumen filtrate. Hence, there is need to use rumen filtrate, which contains other microbes that can further degrade tannin in shea nut meal to improve broiler performance. This study was therefore carried out to study the growth performance and organoleptic properties of broilers fed with rumen filtrate fermented shea nut meal.

MATERIALS AND METHODS

A total of 180 day – old broiler starter chicks of Hubbard strain with an average initial weight of 37.22 ± 0.05 g were used in this study which lasted for 8 weeks. Before stocking, the poultry house was washed with Omo detergent, disinfected using Morrigad and allowed to dry before arrival of the birds. The pen was partitioned into 12 small units measuring 2 m × 3.2 m each. Washed and dried drinkers, feeding troughs and kerosene stoves / 100 watt electric bulbs were provided for water, feed and heat in the poultry house, respectively. The pen was completely covered with sacks and polythene sheets to conserve heat during brooding and to prevent birds from any environmental hazards and temperature fluctuations. Wood shavings were spread up to 5 cm deep on the floor as litter materials. Six (6) hours before the arrival of the birds, drinkers and feeders were in place with the 100 watt electric bulb switched on to warm the house before the chicks' arrival. On arrival, the chicks were randomly allotted to four treatment groups subdivided into 3 replicates of 15 birds each in a complete randomized design experiment. They were weighed, given antibiotics, multivitamin and glucose through their drinking water as anti-stress and source of energy to stimulate feed consumption. Feed and water were given *ad-libitum.* Other routine management operation include the removal of left-over feed, washing of drinkers, provision of clean drinking water and feed, calculation of the daily feed intake, checking of the sick birds and taking records of other activities that took place in the brooder house. However, the weekly management operation included weighing together of birds in each replicate divided by the number of birds in the replicate using 5 kg Hana The Big Boss Scale (made in China) for the first three weeks and 20 kg Camry Premium Scale (made in China) for the remaining six weeks, weekly, to know their weekly body weight gain. The birds were vaccinated and given medication as specified in Tables 1 and 2, respectively.

Feed and water were given *ad-libitum* and management practices were strictly observed. The birds were weighed at the beginning of the trial and weekly thereafter. Fresh shea nut meal was collected from local shea butter producers at Panti town in Lavun Local Government Area of Niger State, Nigeria during the dry season (November to March). The procedure for the fermentation of corn-cob as described by Adeyemi and Familade (2003) was used to ferment it with the following modifications - A cotton sieve of 0.25 mm size was used as filter for a freshly collected rumen ingesta from a slaughtered cow; borehole water was added to the filtrate in the ratio of 3:1; a big plastic polythene bag was then placed in a plastic drum to take its shape and the blended mixtures of rumen filtrate with shea nut meal were packed inside the polythene bag which was sealed tightly to make it air tight thus preventing exchange of gasses between the fermenting material and the environment for a 15-day anaerobic fermentation period. The fermented shea nut meal was sundried for 4 days on polythene sheets spread on concrete platform to prevent contamination with stones and dusts. It was re-milled to break the lumps before use. Four (4) diets were formulated to be *isocaloric* and *isonitrogenous* representing the four (4) treatments and these consist of substitution of rumen filtrate fermented Shea nut meal for groundnut meal. Broiler Starter meal (Table 3) for 0 to 4 weeks chicks and Broiler Finisher meal (Table 4) for 5 to 9 weeks were formulated with each having 4 diets. Diet 1 was the control diet without the rumen filtrate fermented shea nut meal. Diets 2, 3 and 4 contained 5, 10 and 15% replacement levels of rumen filtrate fermented shea nut meal for groundnut meal, respectively. The data obtained on cumulative weight gained and organoleptic values were subjected to Analysis of Variance (ANOVA) using SPSS (2007) version 15.0 while Duncan's Multiple Range Test was used to separate the means where they were significant ($P < 0.05$) difference by the same package. Samples of the shea nut meal were taken to National Cereals Research Institute, Badeggi, Bida, Niger State where anti-nutritional factors were analysed according to the procedures of AOAC (1984), before and after fermentation. Meat samples taken from twelve birds (three birds per treatment) were used for the sensory evaluation with 5 g of salt added to the meat before being subjected to either roasting or cooking. Roasting for fifteen minutes using an electric oven was done while cooking was done for ten minutes using a gas cooker. Twenty trained panellists were selected randomly and used to test for colour, tenderness, juiciness, flavour and overall acceptability for cooked, roasted and fried meats on a nine-point descriptive hedonic scale

Table 2. Medication schedule for the broiler birds.

Age (day)	Medication
1st	Antibiotics + Glucose + Virucine + Vitamin/mineral premix
2nd - 5th	Antibiotics + Coccidiostat + Virucine + Vitamin/mineral premix
6th	Virucine + Coccidiostat + Vitamin/mineral premix
7th - 9th	Vitamin/mineral premix
10th -13th	Vitamin/mineral premix
14th - 15th	Vitamin/mineral premix
16th - 19th	Coccidiostat + Antibiotics + Vitamin/mineral premix
20th	Coccidiostat + Vitamin/mineral premix
21st - 23rd	Vitamin/mineral premix
24th - 27th	Vitamin/mineral premix
28th - 30th	Vitamin/mineral premix
31st - 63rd	Vitamin/mineral premix

Table 3. Percentage composition of broiler starter diets (%).

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4
Maize	56.77	56.77	56.77	56.77
Groundnut cake	33.95	32.25	30.55	28.86
Rice offal	0.23	0.53	0.83	1.03
RFFSNM	0	1.7	3.4	5.09
Palm oil	1	0.7	0.4	0.2
Fish meal	4	4	4	4
Bone meal	2	2	2	2
Methionine	0.25	0.25	0.25	0.25
Limestone	1	1	1	1
Salt	0.3	0.3	0.3	0.3
Lysine	0.25	0.25	0.25	0.25
Vit./mineral premix*	0.25	0.25	0.25	0.25
Total	100	100	100	100
Cost/kg (₦)	115.8	113.56	111.31	109.12
Calculated analysis				
Protein (%)	23	22.94	23.03	22.96
Metabolizable energy (KCal/kg)	2999.96	3000.48	3001.04	3008.17
Calorie: Protein	130.43 : 1	130.78 : 1	130.31 : 1	131.02 : 1
Crude fibre (%)	2.96	3.07	3.15	3.22
Calcium (%)	1.46	1.68	1.89	1.96
Phosphorus (%)	0.93	0.71	0.75	0.82
Lysine (%)	1.17	1.14	1.11	1.08
Methionine (%)	0.6	0.59	0.58	0.59

*Biomix^R Starter supplied per Kg: Vit. A, 800 I.U.; Vit. D3, 1200 I.U.; Vit. E, 13 mg; Vit. K, 2 mg; Riboflavin, 3 mg; Cobalamin, 10 mg; Folic acid, 1.5 mg; Biotin, 0.25 mg; Antioxidant, 125 mg; Fe, 25 mg; Mn, 80 mg; Zn, 50 mg; Cu, 2 mg; Co, 0.2 mg and Se, 0.1 mg.
RFFSNM rumen filtrate fermented shea nut meal
Diet 1: 0% replacement of groundnut meal with rumen filtrate fermented shea nut meal.
Diet 2: 5% replacement of groundnut meal with rumen filtrate fermented shea nut meal.
Diet 3: 10% replacement of groundnut meal with rumen filtrate fermented shea nut meal.
Diet 4: 15% replacement of groundnut meal with rumen filtrate fermented shea nut meal.

(with 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely (http://www.sensorysociety.org /ssp/wiki/Verbal_Hedonic _Scale/). This was done for each treatment. Each scorer, after tasting the meat sample from a particular treatment group, recorded

Table 4. Percentage composition of broiler finisher diets (%).

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4
Maize	57.61	57.61	57.61	57.61
Groundnut cake	26.34	25.02	23.71	22.39
Rice offal	6	6.2	6.41	6.8
RFFSNM	0	1.32	2.63	3.95
Palm oil	2.00	1.8	1.6	1.2
Fish meal	4	4	4	4
Bone meal	2	2	2	2
Methionine	0.25	0.25	0.25	0.25
Limestone	1	1	1	1
Salt	0.3	0.3	0.3	0.3
Lysine	0.25	0.25	0.25	0.25
Vit./mineral premix*	0.25	0.25	0.25	0.25
Total	100	100	100	100
Cost / Kg (₦)	107.66	105.93	104.21	109.12
Calculated analysis				
Protein (%)	20	19.97	20.01	19.96
Metabolizable energy (KCal/kg)	2999.97	3002.61	3005.26	2994.2
Calorie: Protein	145.00 : 1	150.36 : 1	150.19 : 1	150.01: 1
Crude fibre (%)	4.95	3.07	5.08	5.22
Calcium (%)	1.46	1.68	1.89	1.96
Phosphorus (%)	0.93	0.71	0.75	0.82
Lysine (%)	1.05	1.02	1	0.98
Methionine (%)	0.67	0.66	0.65	0.65

*Biomix^R Starter supplied per Kg: Vit. A, 800 I.U.; Vit. D3, 1200 I.U.; Vit. E, 13 mg; Vit. K, 2 mg; Riboflavin, 3 mg; Cobalamin, 10 mg; Folic acid, 1.5 mg; Biotin, 0.25 mg; Antioxidant, 125 mg; Fe, 25 mg; Mn, 80 mg; Zn, 50 mg; Cu, 2 mg; Co, 0.2 mg and Se, 0.1 mg.
RFFSNM rumen filtrate fermented Shea nut meal
Diet 1: 0% replacement of groundnut meal with rumen filtrate fermented shea nut meal.
Diet 2: 5% replacement of groundnut meal with rumen filtrate fermented shea nut meal.
Diet 3: 10% replacement of groundnut meal with rumen filtrate fermented shea nut meal.
Diet 4: 15% replacement of groundnut meal with rumen filtrate fermented shea nut meal.

the score and rinsed his/her mouth with water before tasting another meat sample from another treatment group.

RESULTS AND DISCUSSION

The proximate analysis of rumen filtrate fermented Shea nut meal on Table 5 shows that only ether extract (24.55%) falls within the range (1.7 to 36.20%) reported by Belewu et al. (2008) while crude protein, (26.22%) and ash (10.35%) were slightly higher. Crude fibre (1.33 %) and nitrogen free extract (28.95%) were slightly lower than the values reported by the same authors. This could be due to the amount of fat extracted during processing, handling of the nuts prior to processing or seasonal effects on nut production (Belewu et al., 2008). The slight increase in the values of CP, CF and NFE for rumen filtrate fermented shea nut meal could be attributed to the effect of fermentation.

Table 6 shows the analysis of anti-nutritional factors in Shea nut meal and rumen filtrate fermented shea nut meal. The tannin value (0.21 g/kg) of shea nut meal is quite lower than the 98.7 to 156.4 g/kg reported by Dei et al. (2008). Van Soest (1994) reported that high temperatures, water stress, extreme light intensities and poor soil quality increase the tannin content of plants. The lower value of tannin (0.21 g/kg) observed in this study could be due to regional differences in terms of soil, temperature and soil moisture content. The general reduction observed in cyanide (82.90 to 0.65 ppm), alkaloids (3.41 to 1.38 g/100 g) and flavonoids (3.50 to 1.50 g/100 g) in the rumen filterate fermented shea nut meal might be due to the effect of anaerobic fermentation. Similarly, the increase in tannin (0.021 to 0.036 g/100 g) and phytate (5.94 to 5.96 g/100 g) could be due to the presence of rumen filtrate added for the fermentation process. This was reported by Álvarez del pino et al. (2001) that tannins are more abundant in new leaves and flower parts of the plant that are more likely to be eaten by herbivores and thus, a high source of tannin

Table 5. The proximate composition of rumen filtrate fermented shea nut meal (%).

Parameter	Rumen filtrate fermented shea nut meal
Dry matter	91.47
Moisture	08.53
Crude protein	27.42
Crude fibre	02.75
Ether extract	18.98
Ash	09.51
Nitrogen free extract	32.81

Table 6. Anti-nutritional content of rumen filtrate fermented shea nut meal.

Sample description	Cyanide(ppm)	Phytate (g/100 g)	Tannin (g/100 g)	Alkaloid (g/100 g)	Flavonoids (g/100 g)
Rumen filtrate fermented shea nut meal	70.65	5.96	0.036	1.38	1.5

Table 7. Cumulative weight gain of broiler chickens fed replacement levels of rumen filtrate fermented shea nut meal for groundnut meal.

Parameter	Replacement levels of rumen filtrate shea nut meal for groundnut meal, %				SEM	LS
	0	5	10	15		
Week 1	36.59	32.89	42.38	36.25	1.48	Ns
Week 2	60.44	48.54	37.35	47.47	3.18	Ns
Week 3	64.30	61.70	71.73	79.53	2.93	Ns
Week 4	85.03	33.10	66.47	78.91	10.87	Ns
Week 5	40.60	17.30	13.53	-29.65	10.53	Ns
Week 6	163.18	222.14	208.79	214.37	13.66	Ns
Week 7	190.53	174.45	142.53	106.61	16.86	Ns
Week 8	326.70	161.45	175.56	180.81	39.17	Ns
Feed conversion ratio	2.75	2.86	2.92	3.04	0.08	Ns
Mortality (%)	24.45	13.37	20	22.22	3.18	Ns

NS No significant difference (P > 0.001)
SEM, Standard error of means.
LS Level of significance.

in the rumen filtrate.

The result of the growth performance of broiler chickens fed dietary levels of rumen filtrate fermented shea nut meal are shown in Table 7. The cumulative weight gained showed no significant (P > 0.001) differences among the treatment groups. This is not in agreement with Adeogun (1989) who reported growth depression when shea nut meal was included beyond 5% level in broiler chicks' diet. The result of the growth performance of this work agrees with that of Dei et al. (2008) who stated that broilers fed shea nut meal-based diets had lower weight gain (P < 0.001) than those fed the control diet. The lower value recorded for mortality (13.37 to 22.22%) in birds fed diets containing between 5 and 15% rumen filtrate fermented shea nut meal when compared to the 24.45% recorded for the control could be due to the effect of tannin which can have beneficial effects in animal nutrition and health (Crozier et al., 2009). The beneficial effects as reported by Koleckar et al. (2008), Lisonbee et al. (2009) and Buzzini et al. (2008) include anti-oxidative, anti-helmintic and anti-microbial effects, respectively.

Table 8 shows the organoleptic properties of broiler meat fed replacement levels of rumen filtrate fermented shea nut meal for groundnut meal for the roasted and cooked meats. These values showed no significant (P > 0.05) differences in the colour, tenderness, juiciness, flavour and overall acceptability among the treatment groups. The results also showed that in cooked meat, the value for juiciness increases as the level of inclusion increases and in roasted meat, the values for tenderness, flavour and overall acceptability decreases as the

Table 8. Organoleptic properties of broiler chickens fed replacement levels of rumen filtrate fermented shea nut meal for groundnut meal.

Parameter	Replacement levels of rumen filtrate shea nut meal for groundnut meal, %				SEM	LS
	0	5	10	15		
Roasted						
Colour	7.23	6.83	6.90	6.83	0.10	Ns
Tenderness	7.48	7.23	7.13	6.98	0.10	Ns
Juiciness	6.93	7.10	6.93	6.75	0.11	Ns
Flavour	6.53	7.08	6.80	6.50	0.11	Ns
Overall acceptability	7.30	7.58	7.40	7.03	0.10	Ns
Cooked						Ns
Colour	5.65	5.63	5.88	5.88	0.16	Ns
Tenderness	6.73	6.60	6.73	6.60	0.15	Ns
Juiciness	6.10	6.20	6.33	6.43	0.15	Ns
Flavour	5.70	5.83	5.68	5.93	0.15	Ns
Overall acceptability	6.18	6.45	6.30	6.45	0.16	Ns

NS, No significant difference (p > 0.05)
SEM, standard error of means.
LS, level of significance.

replacement level increases from 5 to 15%. The decrease in the values of tenderness in roasted meat as the rumen filtrate fermented shea nut meal increases shows its ineffectiveness in roasted meat. Similarly, the increase in sensory values of tenderness in cooked meat observed as the level of inclusion increases could be attributed to a positive effect of rumen filtrate fermented shea nut meal. The non-significant (P > 0.05) difference on the organoleptic qualities among the treatment groups is in agreement with Nwanbunwanne (2010) who reported a similar trend in the meat of broiler chickens fed with 2% shea butter oil in juiciness, flavour, texture, colour and general acceptability.

CONCLUSION

The overall observation from this study showed that there was no significant (p > 0.001) difference in cumulative weight gain and organoleptic properties among the treatment groups. It was concluded that the use of rumen filtrate fermented shea nut meal at 5 to 15% levels as a replacement for groundnut meal did not have significant improvement on the growth performance and organoleptic properties of broiler chickens. However, an alternative method may be found to reduce the anti-nutritional factors in shea nut meal, particularly, phytate and tannin**.**

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