Replacement value of rubber seed (*Hevea brasiliensis*) meal for full-fat soya bean meal on performance, carcass characteristics and blood parameters of broilers.

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Abstract

Rubber seed meal (RSM) contains about 28.63% CP but also high in CF (20%). Rubber seed cake was extruded after the extraction of rubber seed oil from the Rubber Seed oil processing Department of Rubber Research Institute of Nigeria, Benin-City. The rubber seed cake was then milled to produce RSM. Soya bean meal (SBM) was prepared by processing sun-dried soya bean seeds in a combined toaster, grinder and extruder. The experiments reported in this study were to investigate the utilization of RSM as a replacement for SBM in the diets of broilers. In the first experiment, 225 seven days'-old broiler chicks of Anak strain were randomly allotted to five dietary treatments T_1 , T_2 , T_3 , T_4 and T_5 which had 100% SBM: 0% RSM, 75% SBM: 25% RSM, 50% SBM: 50% RSM, 25% SBM: 75% RSM and 0% SBM: 100% RSM respectively. The CP level was set at 24% and energy level at 2900kcal/kg. The birds were further sub-divided into three replicates of 15 birds each. The trial lasted for 28 days. In the second experiment, design and feed formulation were similar but the CP level was set at 21% and energy at 2700kcal/kg. 225 five weeks old broiler chicks from the first experiment were fed the broiler finisher diets. At the end of the 9th week, 2 birds were randomly selected from each of the replicates for carcass, organ weight and haematological evaluation. In experiment 1, feed intake of the birds on diets containing RSM up to 75% inclusion level compared favourably with the control (0%RSM). In the second experiment, feed intake increased significantly ($P<0.05$) with increase level of RSM inclusion up to 75%. Body weight gain, FCR and nutrients digestibility of birds fed diets containing RSM up to 50% inclusion level compared favourably with the control (0%RSM). The relative dressing percentage, heart weight and haematological parameters of the birds fed different levels of RSM based diets were comparable. The weight of the gizzard increased significantly ($P<0.05$) with increase level RSM inclusion. Dietary inclusion of RSM reduced the cost of producing 1 kg of feed. Therefore, RSM can be used to replace SBM at 50% inclusion level in the diets of broilers without any deleterious effect.

Keywords: Rubber seed meal, Performance, Carcass characteristics, Blood parameters, Broilers.

Introduction

Animal protein content in the diet of most Nigerians is very low and has reached a crisis level where average consumption of animal protein is estimated at 4.5g/head/day as compared with the minimum requirement of 35g/head/day (FAO, 2002). This poses a great challenge considering the inadequacy of livestock sub-sector which is further aggravated with the ban on the importation of both processed and live birds. Therefore, there

is need to meet the challenges of shortage in animal protein intake especially poultry products. It was suggested that the best logical solution to national meat scarcity is to increase poultry production, but one of the major constraints for the realization of this objective is the ever-increasing cost of broiler birds and poultry feeds arising from the high cost of feed ingredients (Babatunde, 1980). These challenges as imposed by high cost of feed ingredients

especially those of protein sources and the rising cost of poultry feeds have continued to be a major problem in the developing countries as feed cost is about 65% - 70% of the total cost of production as compared with about 50% - 60% in developed countries (Nurorgu *et al.*, 1991).

Soya bean meal (SBM) and groundnut cake (GNC) have played significant roles in poultry ration, but in recent times they are becoming scarce due to their high demand giving rise to a disproportionate increase in their prices. This invariably has escalated the price of animal products out reach of the common man (Mohammed and Rangappa, 1992; Emenalon and Udedibie, 1998). Therefore, there is need for animal nutritionists to explore the possibility of incorporating non-conventional protein ingredients to replace the conventional ones such as SBM and GNC. One of such non-conventional feed resources is rubber seed meal (RSM).

The rubber tree is a perennial plantation crop, although in many parts of Africa, the tree exists in a semi-wild state. The tree grows in a hot humid climate, maturing in about five years and can be tapped for rubber latex for up to twenty years. About four seeds are borne in dehiscent fruit which on drying disperses the seeds by an explosive mechanism. Rubber seed meal (RSM) is the residue collected from the rubber seed oil processing and it is known to be high in protein content (34 - 36%) and not used in human nutrition which makes it free from competition unlike other sources of plant protein.

This study was therefore carried out to investigate the utilization of RSM as a replacement for SBM in the diets of broilers.

Materials and methods

The rubber seed meal (RSM) used for this trial was collected from the rubber seed oil processing department of Rubber Research Institute of Nigeria, Iyanomo, Benin-City. Rubber seeds from the plantation were dried at 65-70 °C in the drier to remove excess moisture to a level suitable for storage. The undecorticated seeds were milled, then conditioned by heating at 200° C to facilitate oil extraction. The oil was then extracted and stored in a storage tank for industrial uses while the residue (Rubber seed cake) was extruded. The rubber seed cake was then milled, using a hammer mill with a sieve size of 3.36mm to produce rubber seed meal (RSM).

Soya bean meal (SBM) was prepared by processing sun dried-soya bean seeds in a combined toaster, grinder and extruder for the toasting, grinding and extrusion of the meal in pelleted form as full-fat soya bean cake which was further milled to produce soya bead meal (SBM).

Proximate analysis of the RSM and SBM were conducted using standard methods (AOAC, 1995) to determine their nutrients composition as shown in Table 1.

Experiment 1:

Two hundred and fifty (250) day-old broiler chicks of Anak strain were purchased and brooded collectively for 7 days and fed commercial feed before the start of the study. Brooding for 7 - 14 days before the start of the study was to minimize the hatchery and other sources of variations that could cause reduced performance and death which were independent of dietary treatments (Farrel *et al.*, 1973).

Two hundred and twenty five (225) seven days - old broiler chicks of Anak strain were randomly allotted to five dietary treatment groups of forty five birds in a completely randomized design. Each

treatment group was further sub-divided into three replicates of fifteen birds each. The treatment groups were designated as T₁, T₂, T₃, T₄ and T₅ which had 100% SBM: 0% RSM, 75% SBM: 25% RSM, 50% SBM, 50% RSM, 25% SBM: 75% RSM and 0% SBM: 100% RSM respectively as the main sources of protein. The CP level was set at 24% and the energy was also set at 2900kcal/kg such that the diets were iso-nitrogenous and iso-caloric. All the diets were supplemented with equal amounts of bone meal, oyster shell, methionine, lysine, salt and vitamin – mineral premix (Table 2). Heat was supplied during the brooding stage using electric bulbs and kerosene lanterns, feed and water were provided *ad-libitum*. Feed intake was recorded daily and the birds were weighed weekly. Other routine poultry management procedures were maintained. Metabolic trial was carried out at the 5th week of the experiment in metabolic cages equipped with separate feeders and drinking troughs. Three birds were randomly selected from each of the three replicates and housed together in a compartment. A five-day faecal collection was done.

Total droppings voided from each replicate group were weighed and recorded. Wet droppings were oven-dried at 65°C for 36 hours and dry matter content determined. Dried droppings from the same replicates were then thoroughly pooled and ground. Proximate composition of feed and droppings were determined using standard methods of AOAC (1995).

Experiment 2:

The processing and chemical analysis of SBM and RSM were the same as in experiment 1. Five broiler finisher diets were formulated to contain the same SBM and RSM percentages and the Feed ingredients as in experiment 1 but with the CP level set 21% and the energy level at

2700kcal/kg such that the diets were iso-nitrogenous and iso-caloric (Table 3).

Two hundred and twenty five (225), six – weeks old broiler chicks from experiment 1 were fed the broiler finisher diets. The design and the procedure were the same as that of experiment 1. Feed and water were provided *ad-libitum*. Feed intake was recorded daily and the birds were weighed weekly. Metabolic trial was carried out at the 9th week of the experiment.

Blood collection and analysis

Blood samples were collected separately from two birds per replicate in specimen bottles with Ethylene Di – amine Tetra Acetic Acid (EDTA) for serum analysis. Packed cell volume (PCV), haemoglobin concentration (Hb), total cholesterol and glucose were analysed according to Dacie and Lewis (1984).

Carcass evaluation

At the end of the ninth week, 2 birds were randomly selected from each of the replicates, starved for 10 hours, weighed, slaughtered and dressed. Dressed carcass weights and internal organ weights were also recorded.

All data generated from the two experiments were subjected to analysis of variance and Duncan's Multiple Range Test was used to separate the means using computer software package stratgraphics 2.0 (1987).

Results

Experiment 1: The chemical composition of rubber seed meal (RSM) and soya bean meal (SBM) is shown in Table 1, while the nutrient composition of the experimental diets is shown in Table 2. Data on performance and nutrient utilization of the broiler starter on the various dietary levels of RSM are presented in Table 4, while the economics of feed conversion of the birds is

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Table 1: Proximate composition of RSM and SBM

Constituents	Composition (%)	
	RSM	SBM
Moisture	7.69	6.77
Crude Protein	28.63	48.50
Crude fibre	20.00	5.71
Ether extract	24.44	19.10
Ash	4.64	5.06
Nitrogen free extract	14.60	15.36

Table 2: Composition of broiler starter diets with graded levels of rubber seed meal (RSM)

Ingredients	Replacement levels of RSM(%)				
	T ₁ (100:00)	T ₂ (75:25)	T ₃ (50:50)	T ₄ (25:75)	T ₅ (00:100)
Maize	58.74	53.54	46.58	36.83	22.22
Soybean meal	36.44	31.23	24.30	14.59	-
Rubber seed meal	-	10.41	24.30	43.76	72.96
Bone meal	2.80	2.80	2.80	2.80	2.80
Oyster shell	0.97	0.97	0.97	0.97	0.97
Mathionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
Common salt	0.35	0.35	0.35	0.35	0.35
*vitamin/mineral premix	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Crude protein (%)	23.55	23.48	23.40	23.29	23.11
ME (kcal/kg)	3001.01	2947.23	2875.31	2749.45	2623.51
Ether extract (%)	3.63	4.56	5.07	6.41	8.68
Crude fibre (%)	3.54	5.18	7.37	10.44	15.04
Calcium (%)	1.47	1.67	1.94	2.31	2.87
Phosphorus (%)	0.69	0.82	0.88	1.02	1.24
Determined analysis					
Dry matter (%)	96.04	98.00	95.00	98.50	99.00
Crude protein (%)	24.34	24.35	23.79	24.79	23.30
Crude fibre (%)	7.00	7.50	7.00	6.10	6.00
Ether extract (%)	2.70	2.81	2.85	2.60	2.77
Ash (%)	9.50	10.00	9.83	9.50	9.50
Nitrogen free extract (%)	52.50	53.34	51.56	55.54	57.43
ME (kcal/kg)	2750	2880	2750	2750	2780

*Commercial premix to provide the following per kg of feed:

Vitamin A, 12,000 iu; Vitamin K, 1.8mg; Vitamin B₂, 3.6mg; Biotin, 0.36mg; Vitamin B₁₂, 0.01mg; Chloride, 120mg; Chlotetracycline, 48mg; Manganese, 24mg; Iron, 48mg; Zinc, 96mg; Copper, 60mg; Iodine, 1.8mg; Cobalt, 0.4mg

Table 3: Composition of broiler finisher diets with graded levels rubber seed meal (RSM)

Ingredients	Replacement of levels of RSM (%)				
	T ₁ (100:00)	T ₂ (75:25)	T ₃ (50:50)	T ₄ (25:75)	T ₅ (0:100)
Maize	65.18	61.34	53.06	49.04	38.34
Soybean meal	30.00	22.50	21.06	10.73	-
Rubber seed meal	-	11.34	21.06	35.41	56.84
Bone meal	2.80	2.80	2.80	2.80	2.80
Oyster shell	0.97	0.97	0.97	0.97	0.97
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
Common salt	0.35	0.35	0.35	0.35	0.35
*Vitamin/Mineral premix	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis:					
Crude protein (%)	21.07	20.30	21.55	20.25	20.12
ME (kcal/kg)	3048.28	3003.09	2927.73	2876.70	2766.36
Ether extract (%)	3.66	4.39	4.99	5.92	7.28
Crude fibre (%)	3.25	4.96	6.64	8.76	12.14
Calcium (%)	1.46	1.67	1.87	2.46	2.54
Phosphorus (%)	0.66	0.73	0.83	0.92	1.08
Determined analysis					
Dry matter (%)	98.55	96.88	98.50	98.00	98.00
Crude protein (%)	21.00	21.73	21.08	20.40	20.55
Crude fibre (%)	9.50	9.50	9.50	9.80	12.50
Ether extract (%)	3.55	2.58	3.05	2.65	2.15
Ash (%)	9.50	9.80	10.50	9.55	9.75
Nitrogen free extract (%)	55.00	53.00	54.39	55.60	53.05
ME (kcal/kg)	2800	2750	2750	2800	2800

*Commercial premix to provide the following per kg of feed: Vitamin A, 12,000w; Vitamin K, 1.8mg; Vitamin B₂, 3.6mg; Biotin, 0.36mg; Vitamin B₁₂, 0.01mg; Cholin Chloride, 120mg; Chlotetracycline, 48mg; Manganese, 24mg; Iron, 48mg; Zinc, 96mg; Copper, 60mg; Iodine, 1.8mg; Cobalt, 0.4mg.

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Table 4: Performance and nutrient utilization of broiler starters fed Rubber seed meal (RSM) and soya bean meal (SBM) based diets.

Parameter	Replacement of levels of RSM					SEM
	T ₁ (100:00)	T ₂ (75:25)	T ₃ (50:50)	T ₄ (25:75)	T ₅ (00:100)	
Number of chicks	45	45	45	45	45	
Initial body weight at 7 days (g/bird)	77.55	77.55	73.33	77.55	77.55	1.89
Final body weight (g/bird)	820.00	842.22 ^a	813.33 ^a	828.89 ^a	337.78 ^b	218.65
Daily weight gain (g/bird)	26.52 ^a	27.31 ^a	26.43 ^a	26.83 ^a	9.29 ^b	4.61
Daily feed intake (g/bird)	27.50 ^a	32.07 ^a	33.07 ^a	35.83 ^a	4.89 ^b	10.09
Feed conversion ratio	1.04	1.17	1.25	1.34	0.53	0.56
Daily protein intake (g/bird)	3.47 ^a	3.63 ^a	3.64 ^a	4.02 ^a	0.92 ^b	2.56
Protein efficiency ratio	6.11 ^b	6.02 ^b	5.81 ^b	5.34 ^b	8.09 ^a	2.17
Mortality (%)	0.00	0.00	0.00	0.00	0.00	
Dry matter digestibility (%)	43.08 ^b	49.30 ^{ab}	46.14 ^b	55.26 ^a	13.24 ^c	2.01
Crude protein digestibility (%)	68.49 ^c	71.34 ^b	72.56 ^{ab}	75.56 ^a	40.40 ^d	2.66
Digestible ether extract (%)	34.10 ^b	43.49 ^a	44.73 ^a	47.83 ^a	10.88 ^c	2.93
Digestible crude fibre (%)	40.47 ^b	47.93 ^a	44.67 ^{ab}	44.41 ^{ab}	6.08 ^c	3.28
Digestible ash (%)	35.55 ^b	44.16 ^a	43.56 ^a	49.04 ^a	7.13 ^c	3.20
Digestible Nitrogen free extract (%)	41.32 ^{ab}	41.75 ^{ab}	34.72 ^b	48.82 ^a	23.65 ^c	2.27

a,b,c : Means within the same row with different superscripts differ significantly ($P < 0.05$)

presented in Table 5.

Feed intake increased numerically with increase in the levels of RSM up to 75% inclusion with no significant ($P > 0.05$) difference but with a significantly ($P < 0.05$) lower value at the 100% RSM level compared with other dietary treatments. Daily body weight gain, feed conversion ratio, daily protein intake, protein efficiency ratio and digestibility values of all the nutrients of the birds on diets containing RSM up to 75% inclusion compared favourably with the control (0% RSM) group but with a significantly ($P < 0.05$) lower values for birds on diet containing 100% RSM. Dietary inclusion of RSM reduced the cost of producing 1kg of feed. Cost of feed per unit daily weight gain was also reduced with increased level

of RSM inclusion. No mortality was recorded during this phase of the feeding trial.

Experiment 2: The chemical composition of RSM and SBM were the same as in experiment 1, while the nutrient composition of the experimental diets is shown in Table 3. Data on performance and nutrient utilization of the broiler finishers on the various dietary levels of RSM are presented in Table 6, while the economics of feed conversion of the broiler finishers is presented in Table 7. Data on the carcass characteristics and haematological parameters of the finishers are presented in Tables 8 and 9 respectively.

Feed intake of the dietary treatment groups were significantly ($P < 0.05$) different.

Table 5: Economics of feed conversion of broiler starter fed the experimental diets

Parameters	Replacement levels of RSM				
	T ₁ (100:00)	T ₂ (75:25)	T ₃ (50:50)	T ₄ (25:75)	T ₅ (00:100)
Cost of feed/kg (₦)	49.37	45.68	40.73	33.83	23.48
Cost of feed/g (₦)	0.049	0.046	0.041	0.034	0.023
Average daily feed intake/bird (g)	27.50	32.07	33.07	35.83	4.89
Cost of daily feed intake/bird (₦)	1.35	1.48	1.36	1.23	0.11
Daily weight gain (g)	26.52	27.31	26.43	26.83	9.29
Cost of feed intake/daily weight gain	0.051	0.054	0.051	0.046	0.012

Table 6: Performance and nutrient utilization of broiler finishers fed Rubber seed meal (RSM) and soya bean meal (SBM) based diets

Parameters	Replacement levels of RSM					SEM
	T ₁ (100:00)	T ₂ (75:25)	T ₃ (50:50)	T ₄ (25:75)	T ₅ (0:1000)	
Number of birds	45	45	45	45	45	
Initial body weight (g/bird)	820.00 ^a	842.22 ^a	813.33 ^a	828.89 ^a	337.78 ^b	218.65
Final bodyweight (g/bird)	2333.33 ^a	2333.33 ^a	2333.33 ^a	2000.00 ^a	722.22 ^b	698.32
Daily weight gain (g/bird)	54.05 ^a	53.25 ^a	54.29 ^a	41.83 ^b	13.73 ^c	17.41
Daily feed intake (g/bird)	111.78 ^b	141.03 ^a	139.64 ^{ab}	127.61 ^b	37.30 ^c	43.10
Feed conversion ratio	2.07	2.65	2.57	3.05	2.71	0.35
Daily protein intake (g/bird)	23.47 ^b	30.65 ^a	29.44 ^a	26.03 ^a	7.67 ^c	6.67
Protein efficiency Ratio	2.30	1.74	1.84	1.61	1.79	0.25
Mortality (%)	0.00	0.00	0.00	0.00	0.00	
Dry matter digestibility (%)	74.40 ^b	82.99 ^a	76.31 ^b	74.60 ^b	54.06 ^c	1.05
Crude protein digestibility (%)	76.98 ^b	85.07 ^a	81.87 ^{ab}	79.62 ^b	65.11 ^c	0.71
Digestible ether extract (%)	78.53 ^{ab}	81.41 ^a	75.98 ^{ab}	72.39 ^b	58.85 ^c	1.04
Digestible crude fibre (%)	87.33 ^b	89.13 ^a	85.22 ^{bc}	84.40 ^c	74.49 ^d	0.56
Digestible ash (%)	74.63 ^{ab}	78.36 ^a	73.17 ^b	72.91 ^b	51.57 ^c	0.99
Digestible Nitrogen free extract (%)	8.64 ^b	81.01 ^a	72.91 ^b	71.91 ^b	48.25 ^c	1

a, b, c, d : Means within the same row with different superscripts differ significantly (P<0.05)

Table 7: Economics of feed conversion of broiler finisher fed the experimental diets

Parameters	Replacement levels of RSM				
	T ₁ (100:00)	T ₂ (75:25)	T ₃ (50:50)	T ₄ (25:75)	T ₅ (00:100)
Cost of feed/kg (N)	47.83	44.49	41.18	36.09	28.48
Cost of feed/g (N)	0.048	0.044	0.041	0.036	0.028
Average daily feed intake/bird (g)	111.78	141.03	139.64	127.61	37.30
Cost of daily feed intake/bird (N)	5.37	6.21	5.73	4.59	1.04
Daily weight gain (g)	54.05	53.25	54.29	41.83	13.73
Cost of feed intake /daily weight gain	0.099	0.117	0.106	0.109	0.76

Birds on RSM – containing diets recorded significantly ($P<0.05$) higher feed intake except those on 100% RSM inclusion that recorded significantly ($P<0.05$) lower value than the control (0% RSM). Daily body weight gain, feed conversion ratio, daily protein intake and protein efficiency ratio of the birds on diets containing RSM up to 50% inclusion level compared favourably with the control (0% RSM), above which the differences were significant ($P<0.05$). There were significant ($P<0.05$) differences among treatment groups, though RSM – containing diets up to 75% inclusion level compared favourably with the control. Birds on 100% RSM inclusion level showed significantly ($P<0.05$) lower digestibility values for all the nutrients.

The cost of producing 1kg of feed decreased as the percentage dietary inclusion of RSM increased. T₂ (25% RSM) was the poorest in the economy of production by gaining 1g body weight with #0.117 while T₁ (0% RSM) was the best as #0.099 was expended to produce the same quantity of body weight among the treatment groups. However, there was no significant ($P>0.05$) difference across the dietary treatment groups. The variabilities among the birds fed different experimental diets for dressing percentage and heart were not significant ($P<0.05$). There were significant ($P<0.05$) differences in values obtained for liver, gizzard and abdominal fat among the birds fed diets containing different levels of RSM, though the diets

Table 8: Carcass characteristics of broilers (finisher) fed Rubber seed meal (RSM) and soya bean meal (SBM) based diets.

Parameters	Replacement levels of RSM					+ SEM
	T ₁ (100:00)	T ₂ (75:25)	T ₃ (50:50)	T ₄ (25:75)	T ₅ (0:100)	
Live weight (g/bird)	2330.00 ^a	2330.00 ^a	2200.00	2000.00 ^a	720.00 ^b	698.32*
Carcass (%)	82.96	84.41	87.88	90.00	81.25	2.30NS
Dressing (%)	75.13	76.80	78.73	77.95	76.99	1.23NS
Heart (%)	0.42	0.43	0.41	0.44	0.40	0.07NS
Liver (%)	1.84 ^a	1.88 ^a	1.70 ^a	1.98 ^a	0.55 ^b	1.17*
Gizzard (%)	1.19 ^b	1.13 ^b	1.20 ^b	2.29 ^a	2.55 ^a	0.22*
Abdominal fat (%)	1.17 ^a	0.86 ^a	0.82 ^a	0.86 ^a	0.00 ^b	0.12*

a,b: Means within the same row with different superscripts differ significantly ($P<0.05$)

Table 9: Haematological parameters of broilers (finisher) fed RSM and SBM based diets

Parameters	Replacement levels of RSM					+SEM
	T ₁ (100:0)	T ₂ (75:25)	T ₃ (50:50)	T ₄ (25:75)	T ₅ (0:100)	
Packed cell volume (%)	27.33	26.67	26.33	27.00	27.67	0.53 NS
Haemoglobin (g/dl)	8.87	8.73	9.20	8.87	9.30	0.19 NS
Total cholesterol (mg/l)	100.33	106.00	116.00	102.00	105.00	0.10 NS
Glucose (mg/l)	220.00	215.33	216.67	215.00	204.33	0.73 NS

NS: Not significant ($P>0.05$)

containing 75% RSM level compared favourably with the control for the values of the liver and abdominal fat. The data obtained for all the blood parameters measured were no significantly ($P>0.05$) different among the dietary treatment groups.

Discussion

The increased feed intake of the birds on diets containing RSM up to 75% inclusion in experiments 1 and 2 is understandable, because RSM contains high fibre which tends to increase the total fibre content of the diets thereby diluting other nutrients. Therefore, for the birds to meet their energy requirements to maintain rapid growth and development, they consumed more feed, hence the increased feed intake. This agrees with earlier findings of Esonu *et al.*, (2005). The relatively low feed intake observed in birds fed diets containing 100% RSM could be explained with earlier findings that depression in feed intake could be attributed to poor palatability of the diets which also reduces efficiency of feed and protein utilization as evidenced by reduced weight gain (Ani and Okorie, 2009). It could also be due to high dietary fibre level which may have exerted its depressive effect on nutrient intake by

causing early gut-fill (Kass, *et al.*, 1980) and that fibrous feed tend to spend a longer time in the digestive tract thereby resulting in reduced feed and nutrient intake (McDonald *et al.*, 1995). Depression in weight gain at 100% inclusion of RSM in experiments 1 and 2 could be attributed to decline in nutrient intake due to increased fibre content which could have resulted to the inability of the birds to meet their production and metabolic requirements. This agrees with the observations of McDonald *et al.*, (1995) that growth rate of an animal is obviously dependent on its level of feeding and that if the level is high, growth will be rapid and the animal reaches a specified weight at an early age.

Other factors implicated in the depression of weight gain with increased inclusion of RSM above 50% level are lesser availability of energy, protein and other nutrients due to high fibre contents of the diets as evidenced in the findings of Bajpai and Sharma (1999) who fed RSM-based diets to layers and observed loss of body weight during laying phase, drop in egg production and decrease in egg weight at higher level of inclusion (above 40%); Amino acid imbalance resulting in less availability of methionine (Narahari and Kothan daraman, 1984) and high free fatty

acid content of rubber seed and its products which might interfere with the biological availability of other nutrients required for improved weight gain (Sweeley and Bentley, 1992). The lower values of FCR obtained in experiments 1 and 2 for birds fed the control diets (0% RSM) implies a decline in efficiency of feed utilization with increasing level of RSM inclusion. This occurrence may be due to the high fibre content in RSM (20%) which invariably limits utilization by simple – stomached animal like broilers. This view was also established by Lamidi *et al.*, (2008).

The general poor performance of the broiler starter chicks (Experiment 1) on diets containing high levels of RSM was expected because, these diets had higher fibre content. This could be explained with the observations of Esonu *et al.*, (2008) that production of enzyme, efficacy and system of the birds at this stage are not yet fully developed to handle such high fibrous materials resulting in low digestibility of nutrients to supply their requirements for rapid growth and development.

In Experiment 2, broiler finishers fed diets containing RSM level up to 50% performed generally better than the group fed the control (0% RSM). The improved performance could be due to adequate crude fibre level which tends to activate the intestine and more occurrence of peristaltic movement and more production of enzyme resulting in better nutrient digestion. This agrees with earlier findings by Cheeke *et al.*, (1983); Adeniji, (2001); Esonu *et al.*, (2008).

The dressing percentage values obtained were higher than the range of 69.80% and 72.60% reported by Longe (1986) and 73.90% by Bolu and Balogun (2003) but comparable with the range of 74.82% - 77.39% reported by Esonu *et al.*, (2008) for broilers.

Non-significant ($P>0.05$) difference observed in the weights of the heart among the treatment means can be explained with observations of Hight and Barton (1965) as quoted by Sankyan *et al.*, (1991), in goats that the heart, being a vital organ attained most of its mature weight during development of the foetus. Therefore varying levels of protein do not significantly change heart weight in the later stages of growth. This was further established by Ijaiya and Fasanya (2004).

The increase in the weight of gizzard as the level of RSM (a highly coarsed feed stuff with high CF level) inclusion increased agrees with earlier findings by Mokaji (1994); Lamidi *et al.*, (2008) that high fibre content in the diet of birds ordinarily leads to the enlargement of the gizzard.

The non-significant ($P>0.05$) difference obtained in the blood parameters measured among the treatment groups indicates that the test ingredient (RSM) had no deleterious effect on them. This agrees with the observation of Gandhi *et al.*, (1996) that there were no acute toxic potentials in rubber seed meal and concluded that the consumption of rubber seed meal had no deleterious effect on the haematological profile of the animals.

The overall lower feed cost per gramme meat produced on the RSM-based diets suggest that the material is economically viable alternative feed material.

Conclusion

The results of this study indicated that RSM could be used as a replacement for SBM at 50% level in the diets of broilers without any deleterious effect.

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