EFFECT OF GRADED LEVELS OF DIETARY RAW SESAME SEEDS ON GROWTH PERFORMANCE, SERUM BIOCHEMISTRY AND NUTRIENT DIGESTIBILITY OF BROILER CHICKENS.

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ABSTRACT

This experiment was conducted to investigate the effect of dietary inclusion of raw sesame seeds (RSS) on performance, serum biochemistry, carcass characteristics and digestive physiology of broiler chickens between hatch and 35 days of age. Three inclusion levels (0, 5 or 10 g/kg) of RSS were included in the starter, grower and finisher diets on either wheat- or maize-based diets. At first 10 days, birds tended ($P < 0.06$) to eat more with increasing concentrations of RSS. At day 35, there was an interaction ($P < 0.05$) between the level of RSS and the grain, depressing the serum cholesterol in birds that received RSS at the medium concentration in wheat-based diets. The RSS and the grain tended ($P = 0.056$) to interact arising from the relatively higher triglycerides in birds on wheat-based diets supplemented with medium level of RSS. There was an interaction ($P < 0.05$) between the level of RSS and the grain, indicating the lowest gross energy digestibility in the birds that received RSS at the highest concentration in maize-base diets. Increasing concentrations of RSS in the diets decreased ($P < 0.05$) the apparent digestibility of protein and nitrogen at 35 days of age. The results provided evidence that beyond providing nutrients for growth, sesame seeds can maintain feed intake and regulate the cholesterol level.

Key words: Sesame, broiler, productivity, blood, nutrient digestibility

تاثير اضافة مستويات مختلفة من السمسم الخام الى العليقة على الاداء الانتاجي و المحتوى الكيميائي لمصل الدم و معامل الهضم لدجاج فروج اللحم

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المستخلص

اجريت هذه التجربة لدراسة مدى تاثير اضافة حبة السمسم الخام على الاداء الانتاجي و المحتوى الكيميائي لمصل الدم و صفات الذبيحة و فسلجة الهضم لفروج اللحم من الفقس الى عمر 35 يوم. تمت اضافة ثلاث مستويات مختلفة (0، 5 ، 10 غم لكل كغ علف) من حبة السمسم الى العلف البادئ و النامي و الناهي المكونة اساسا من الحنطة او الذرة. اذ اثبتت النتائج زيادة استهلاك العلف خلال العشرة ايام الاولى كلما زاد مستوى السمسم في العليقة. في عمر 35 يوم كانت هناك تداخلا معنويا بين مستوى السمسم و المحصول الاساس للعليقة حيث ادت التداخل الى انخفاض معنوي في مستوى الكوليسترول في الطيور التى غذيت على العلف المكون اساسا من الحنطة التي احتوت على المسوى المتوسط من السمسم الخام. اضافة الى ذلك ، التداخل بين مستوى السمسم والمحصول الاساس للعليقة كانت قريبة لتكون معنويا منتجة زيادة الدهون الثلاثية في الطيور التي غذيت على العلف المكون اساسا من الحنطة والتي احتوت على المستوى المتوسط من السمسم. ايضا التداخل بين عوامل التجربة كانت معنوية بحيث ادت الى انخفاض معامل الهضم للطاقة في الطيور التي غذيت على العلف المكون اساسا من الذرة التي احتوت على المستوى الاعلى من السمسم. معامل هضم البروتين و النيتروجين انخفض معنويا كلما زاد مستوى السمسم في العليقة. نتائج التجربة اثبتت انه بالاضافة الى القيمة الغذائية للسمسم المهمة لنمو الطيور، الى انه اضافة حبة السمسم الى علف الدواجن قد تحافظ على معدل استهلاك العلف و تنظم مستوى الكوليسترول في مصل الدم.

كلمات مفتاحية: علف ، طيور ، الهون ، كفاءة التحويل الغذائي ، الحنطة ، الذرة الصفراء ، الكوليسترول.

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INTRODUCTION

Sesame seeds are the most popular seeds in the world, due to the fact that they are loaded with health-promoting nutrients and elements. Sesame is probably the most ancient oilseed used by humans as a food source (20). Sesame is traditional healthy food ingredient due to its high content of edible oil (40) with excellent stability (42) and high quality polyunsaturated stable fatty acids (19).The seed contains 50-60% oil compared to 20% in soybean (2, 25). The oil has excellent stability and resistance against the oxidative deterioration, due to the presence of lignans, pinoresinol, tocopherols, lecithin, myristic acid and linoleate that have been identified as the major antioxidants (41). In addition sesamolin, sesamin and sesamol that are present in the composition of sesame are excellent natural antioxidants (25). Sesamin also has anti-bacterial activities (21). Sesame seed also contains a reasonable amount of carbohydrates 10 to 15% carbohydrate (26). Therefore, its high content of oil together with its content of carbohydrates makes sesame seeds to be valuable source of metabolizable energy which was ranged in between 4963 to 5832 Kcal/Kg (14, 33). Sesame seed also contains a reasonable amount of minerals and vitamins such as manganese, copper, calcium, vitamin B1 and vitamin E (32) in addition to the highly absorbable spectrum of vitamin E, they increase its bioactivity in the body (12). Sesame seed is a rich in protein and minerals. Full fat seeds has been reported to have 18-25% (11, 44). The meal after oil extraction contains 44% crude protein (28, 35). However a 52.9 % of CP was recorded by (22). The amino acid profile of sesame protein is similar to that of soybean meal with the exception of lower lysine (28) and higher methionine (15).Therefore, sesame seeds may constitute to be good vegetable protein sources for use in poultry diets in regions where they are readily available and relatively inexpensive. Feeding the high methionine content sesame seed meal together with the high lysine containing soybean meal, will make a balanced diet with respect to lysine and methionine (33). The SSM could partially replace soybean meal in the diet as a source of plant protein for chicks (9, 23, 34) and ducklings (13, 16). Sesame meal could be a potential alternative to soybean meal in boiler diets when used at a level of not more than 15% (23).The main objectives of the present study were to test the efficacy of the addition of different levels of raw sesame seed as a complementary ingredient on either maize-soy or wheat-soy diets on the broiler performance and its subsequent physiology.

MATERIALS AND METHODS

Experimental design, diets, and bird husbandry

This experiment was designed to investigate the effect of dietary raw sesame seeds (RSS) on broiler performance and physiology up to 35 days of age. Three inclusion levels of RSS (0, 5, 10 g/kg) diet were used in either maize- or wheat-based diets which were fed from hatch to 35 d of age. Three phases of feeding were adopted, a starter diet from 1 to 10 d, grower diets from 11 to 24 d, and finisher diets from 25 to 35 d. All diets were formulated to meet the requirements for Ross 308 broiler chickens. (Tables 1, 2 and 3). In a 3 × 2 factorial arrangement, a total of 240 Ross 308-d-old broiler chicks (initial weight, 41.0 ± 0.92 g) were randomly assigned to 6 groups, each with 4 replicates, 10 birds per replicate. Birds were reared in floor pens bedded with softwood shavings. Feed and water were provided *ad libitum*. The room temperature was gradually decreased from 33 °C on d 1 to 24 °C ± 1 °C at 35 d. Eighteen hours of lighting were provided per d throughout the duration of the experiment, apart from d 1 to 7 when 23 hours of lighting were provided. On d 10, 24 and 35, the feed leftover and birds were weighed to measure the body weight, weight gain, feed intake and feed conversion ratio. Mortalities were recorded as they occurred, and feed per gain values were corrected for mortality.

Sample collection and processing

Two birds per replicate on day 35 were randomly selected, weighed and euthanized by cervical dislocation. Thereafter, the birds were dissected to remove the small intestine. The weights of immune-related organs (liver, spleen, bursa of Fabricius and thymus) were recorded and calculated as mass per unit of live body weight (g/100 of live body weight). Carcass weight and the weight of breast, thighs and drumsticks were recorded. The relative weights were calculated as an indication of mass per unit of body weight (g/kg body weight).

Serum biochemical parameters

Blood samples (approximately 5 ml) from the jugular vein were collected in non-heparinized tubes. Blood samples were then allowed to clot at room temperature for 2 h and centrifuged at 3,000 rpm for 15 minutes. Subsequently, serum was harvested and collected into Eppendorf tubes and immediately frozen until biochemical assays were performed. Serum biochemical parameters including total protein, albumin, cholesterol, triglycerides and high density lipoprotein were determined by colorimetric enzymatic methods following the procedures provided in the used corresponding commercial kits purchased by (BIOLABO, Maizy, France).

Table 1.Ingredient and nutrient composition of the starter diets

Ingredients	1	2	3	4	5	6
Maize	50.00	0.00	50.00	0.00	50.00	0.00
Wheat	0.00	59.70	0.00	59.70	0.00	59.40
Protein conc.[1]	8.00	5.80	7.50	5.00	7.00	4.80
SBM[2]	35.52	28.00	35.52	28.30	35.52	28.30
Oil	2.40	2.70	2.40	2.70	2.40	2.70
Limestone	1.50	1.22	1.50	1.22	1.50	1.22
DCP[3]	1.00	0.90	1.00	0.90	1.00	0.90
DL. Methionine	0.15	0.15	0.15	0.15	0.15	0.15
L lysine	0.15	0.15	0.15	0.15	0.15	0.15
Enzyme	0.10	0.20	0.10	0.20	0.10	0.20
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vit .premix	0.80	0.80	0.80	0.80	0.80	0.80
Anti-fungal	0.08	0.08	0.08	0.08	0.08	0.08
Sesame	0.00	0.00	0.50	0.50	1.00	1.00
Nutrient composition						
Crude Protein	23.80	23.37	23.69	23.27	23.58	23.24
ME (kcal/kg)	3021.26	3021.10	3022.21	3021.75	3023.16	3021.05
Methionine	0.85	0.73	0.83	0.71	0.81	0.70
Lysine	1.71	1.58	1.70	1.56	1.68	1.55
Tryptophan	0.34	0.32	0.34	0.33	0.34	0.33
Meth+cyst	1.11	0.96	1.08	0.93	1.06	0.92
Threonine	0.90	0.80	0.90	0.81	0.90	0.80
Arginine	1.47	1.44	1.47	1.45	1.47	1.45
Ca	1.35	1.15	1.33	1.12	1.31	1.11
Available p	0.67	0.62	0.66	0.60	0.65	0.60
Sodium	0.39	0.36	0.38	0.34	0.37	0.34
Chloride	0.22	0.24	0.22	0.24	0.22	0.24

[1]protein conc = protein concentrate (see the composition in table 4); [2]SBM= soybean meal; [3]DCP= Di-calcium phosphate

Table 2. Ingredient and nutrient composition of the grower diets

Ingredients	1	2	3	4	5	6
Maize	57.25	0.00	56.15	0.00	56.60	0.00
Wheat	0.00	65.50	0.00	65.00	0.00	64.50
Protein conc.[1]	5.00	4.00	5.50	4.00	4.00	4.00
SBM[2]	31.00	22.97	31.00	22.97	31.55	22.97
Oil	3.20	4.00	3.30	4.00	3.30	4.00
Limestone	1.20	1.20	1.20	1.20	1.20	1.20
DCP[3]	1.00	0.90	1.00	0.90	1.00	0.90
DL. Methionine	0.15	0.15	0.15	0.15	0.15	0.15
L lysine	0.15	0.15	0.15	0.15	0.15	0.15
Enzyme	0.10	0.20	0.10	0.20	0.10	0.20
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Vit.premix	0.60	0.60	0.60	0.60	0.60	0.60
Anti-fungal	0.10	0.08	0.10	0.08	0.10	0.08
Sesame	0.00	0.00	0.50	0.50	1.00	1.00
Nutrient composition						
Crude Protein	21.20	21.18	21.39	21.20	21.17	21.22
ME (kcal/kg)	3143.19	3147.74	3142.51	3145.94	3146.18	3144.14
Methionine	0.71	0.63	0.73	0.63	0.67	0.63
Lysine	1.46	1.37	1.48	1.37	1.44	1.37
Tryptophan	0.32	0.30	0.32	0.30	0.33	0.30
Meth+cyst	0.92	0.82	0.94	0.82	0.89	0.82
Threonine	0.84	0.73	0.84	0.72	0.85	0.72
Arginine	1.34	1.30	1.33	1.29	1.36	1.29
Ca	1.07	1.02	1.08	1.02	1.03	1.02
Available p	0.57	0.55	0.58	0.55	0.55	0.55
Sodium	0.29	0.29	0.30	0.29	0.27	0.29
Chloride	0.19	0.21	0.19	0.21	0.19	0.21

[1,2,3] as shown in table 1

Table 3. Ingredient and nutrient composition of the finisher diets

Ingredients	1	2	3	4	5	6
Maize	64.25	0.00	64.25	0.00	63.55	0.00
Wheat	0.00	73.65	0.00	73.55	0.00	73.35
Protein conc.[1]	4.00	2.90	3.50	2.50	3.60	2.20
SBM[2]	25.00	16.00	25.00	16.00	25.00	16.00
Oil	3.00	3.80	3.00	3.80	3.10	3.80
Limestone	1.50	1.32	1.50	1.32	1.50	1.32
DCP[3]	1.10	1.10	1.10	1.10	1.10	1.10
DL. Methionine	0.15	0.15	0.15	0.15	0.15	0.15
L lysine	0.15	0.15	0.15	0.15	0.15	0.15
Enzyme	0.10	0.20	0.10	0.20	0.10	0.20
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Vit.premix	0.40	0.40	0.40	0.40	0.40	0.40
Anti-fungal	0.10	0.08	0.10	0.08	0.10	0.08
Sesame	0.00	0.00	0.50	0.50	1.00	1.00
Nutrient composition						
Crude Protein	18.71	18.72	18.60	18.63	18.66	18.57
ME (kcal/kg)	3181.94	3183.65	3182.89	3184.05	3185.11	3183.90
Methionine	0.61	0.52	0.59	0.51	0.59	0.49
Lysine	1.24	1.14	1.22	1.12	1.22	1.11
Tryptophan	0.31	0.28	0.31	0.28	0.31	0.28
Meth+cyst	0.78	0.67	0.76	0.65	0.76	0.64
Threonine	0.81	0.66	0.80	0.66	0.80	0.65
Arginine	1.15	1.11	1.15	1.11	1.15	1.10
Ca	1.01	0.91	0.99	0.90	1.00	0.89
Available p	0.50	0.50	0.48	0.49	0.49	0.48
Sodium	0.24	0.24	0.23	0.23	0.23	0.22
Chloride	0.36	0.34	0.34	0.32	0.34	0.31

[1,2,3] as shown in table 1

Table 4. Nutrient composition of the protein concentrate used in this study

Nutrients g/kg	
Moisture	80
Crude protein	400
ME Poultry	2239 Kchal/Kg
Fat	50
Ash	244
Amino acids g/kg	
Lysine	38.5
Methionine	37
Meth+cyst	41.4
Arginine	25.5
Tryptophan	4.3
Threonine	17.0
Valine	17.3
Minerals g/kg	
Ca	38.3
P Available	53.4
Sodium	25.0
Chloride	38.3
Choline	6.073,00 mg/Kg
Mn	1.600,00 mg/Kg
Zn	1.200,00 mg/kg
Fe	1.000.00 mg/kg
I	20.00 mg/kg
Se	5.00 mg/kg
Salinomycine	1.200,00 mg/kg
Vitamins	
Vit A	200.000,00 I.U
Vit D3	60.000,00 I.U
Vit B1	600.00 mg/kg
Vit B2	140,00 mg/kg
Vit B6	80,00 mg/kg
Vit B12	700,00 mcg
Biotin	2,00 mg/kg
Niacin	800,00 mg/kg
Vit K3	50,00 mg/kg
Folic acid	20,00 mg/kg

Nutrient digestibility

On days 33, 34 and 35 of bird's age, feces samples of each pen were collected into plastic container and immediately freeze stored until analyses. All samples were analyzed in duplicate. The protein content of feed samples was directly determined by Agri check method using NIR as described by AOAC for undigested samples. Nitrogen content was determined by the Kjeldahl method (7). Then the nitrogen content was measured by Kjeldahl nitrogen analyzer and converted to equivalent CP by a numerical factor of 6.25. Apparent digestibility coefficients of nutrients (protein, nitrogen and energy) were calculated for each pen using routine procedures (30). The nutrients apparent digestibility values corresponded to the difference between their values in diets and their loss in feces. The digestibility percentage of nutrients was estimated according to the following formula

$$\text{Digestibility \%} = \frac{\text{Nutrient in feed - Nutrient in feces}}{\text{Nutrient in feed}} \times 100$$

Statistical analysis of data

All data collected were analyzed using the General Linear Models (GLM) procedure of Minitab version 17 for the main effect of RSS level, grain, along with their interactions.

Differences between mean values were determined using Duncan's multiple range test.

RESULTS AND DISCUSSION

Gross response : In general there was no significant effect of treatments on FI, BW, WG and FCR of broiler chickens at day10 (Table 5). The RSS level tended to have a significant ($P < 0.06$) effect on feed intake. In general, feed intake was higher in birds fed on diets containing RSS than those on control diets. At day 24, feed intake was significantly increased ($P < 0.02$) in birds on wheat-based diets (Table 6). The experimental factors and their interaction had no significant effect on the performance parameters presented in Table (6). In a general, the inclusion of RSS expressed some positive effects on the broiler performance up to the grower phase.

Table 5 Feed intake (FI, g/bird), body weight (BW, g), weight gain (WG, g) and FCR (g feed/g weight gain) of birds between hatch and 10 days after placement on diets supplementing with different levels of sesame seeds fed with different grains

Grain	Sesame Level g/kg	FI	BW	WG	FCR
		Response			
Wheat	0	267.0	239.8	195.9	1.37
	5	278.4	235.9	192.6	1.44
	10	268.3	240.1	196.4	1.37
Maize	0	256.3	232.6	189.3	1.36
	5	273.8	237.7	194.2	1.41
	10	267.5	241.5	197.7	1.36
SEM		1.01	1.19	1.19	0.093
Level	0	261.6	236.2	192.6	1.36
	5	276.1	236.8	193.4	1.42
	10	267.9	240.7	196.9	1.36
Grain	Wheat	271.2	238.6	195.0	1.39
	Maize	265.8	236.9	193.3	1.37
Source of variation					
Grain		0.26	0.84	0.85	0.65
Level		0.06	0.83	0.85	0.33
Grain× Level		0.68	0.81	0.84	0.96

Each value represents the mean of 4 replicates. SEM = Standard error of mean.

When assessed over the 35 days experimental period, no significant impact of the treatments was observed in terms of FI, BW, WG and FCR of broiler chickens (Table 7). However, the grain type used tended to increase ($P < 0.07$) the feed intake arising from the relatively higher feed intake in birds on the wheat-based diets. The same trend ($P < 0.07$) has been fond for the FCR, when it was relatively better in birds on maize-based diets.

Table 6. Feed intake (FI, g/bird), body weight (BW, g) weight gain (WG, g) and FCR (g feed/g weight gain) of birds between hatch and 24 days after placement on diets supplementing with different levels of sesame seeds fed with different grains

Grain	Sesame Level g/kg	FI	BW	WG	FCR
		Response			
Wheat	0	1403.4	1128.8	1084.9	1.29
	5	1426.5	1121.4	1078.1	1.32
	10	1416.5	1149.2	1105.4	1.28
Maize	0	1288.4	1070.7	1027.3	1.26
	5	1367.2	1080.1	1036.6	1.32
	10	1342.8	1093.5	1049.7	1.28
SEM		2.71	2.75	2.75	0.069
Level	0	1345.9	1084.3	1056.1	1.28
	5	1396.8	1120.8	1057.3	1.32
	10	1379.6	1111.7	1077.6	1.28
Grain	Wheat	1415.4^{a}	1133.1	1089.5	1.30
	Maize	1332.8^{b}	1081.4	1037.9	1.29
Source of variation					
Grain		0.02	0.15	0.15	0.50
Level		0.46	0.85	0.85	0.21
Grain × Level		0.78	0.98	0.98	0.78

Each value represents the mean of 4 replicates. ^{a,b,c} Mean values in the same column not sharing a superscript letter are significantly different at the P-level shown for the main effect. SEM = Standard error of mean.

This study shows the possibility of feeding RSS without detrimental effect on growth performance of broilers. Although not significant, supplementation of RSS in the starter and grower periods showed some positive effects. The inclusion of RSS led to some increase in feed intake and an improvement in body weight in an early age and continued to the subsequent grower age. This could be attributed to the role of methionine present in sesame seeds promoting growth and yielding good feed efficiency. However this effect disappeared in the finisher phase particularly in wheat based diets. This was in line with (29) when up to 10% of raw sesame seed meal was fed to broiler chickens. However, in contrast (27) stated that the weight gain was significantly increased when roasted sesame hull was fed to broiler chickens. Rahimian (36) reported that body weight and weight gain of broiler chickens were improved when sesame seed meal was incorporated to their diet. Feed conversion ratio, body weight and weight gain were significantly improved in rabbits that were offered diets containing sesame seed meal (17). Al-Harthi and EI-Deek, (4) obtained a significant decrease in live body weight and weight gain when sesame seed meal was replaced soybean meal in broiler diets. Although of having anti-nutrient factors mainly phatic acid in its composition. The incorporation of such additions of RSS had no adverse effect on the performance broiler chickens throughout the experimental period. Sesame seed meal may not be suitable as a main source of protein but could be used up 30% of total dietary protein for broilers and 23.6% for laying hens to achieve optimal performance (39). This study demonstrated that supplementation of young broiler diets with small amount of RSS could be beneficial, especially with the presence of phytase which could eliminate the negative effects of phystic acid. In addition birds are consuming little amount of feed in this particular age compared to the finisher phase.

Table 7. Feed intake (FI, g/bird), weight gain (WG, g) and FCR (g feed/g weight gain) of birds between hatch and 35 days after placement on diets supplementing with different levels of sesame seeds fed with different grains

Grain	Sesame Level g/kg	Response FI	BW	WG	FCR
Wheat	0	2840.5	1865.0	1821.0	1.51
	5	2632.8	1813.5	1770.3	1.49
	10	2800.0	1845.5	1801.8	1.55
Maize	0	2558.9	1817.3	1773.9	1.44
	5	2702.1	1845.8	1822.3	1.48
	10	2576.1	1809.0	1765.2	1.44
SEM		4.12	3.01	3.01	0.088
Level	0	2699.7	1833.2	1789.7	1.46
	5	2688.3	1839.6	1796.3	1.49
	10	2667.4	1829.9	1786.1	1.50
Grain	Wheat	2757.9	1836.6	1793.1	1.51
	Maize	2612.4	1832.6	1789.1	1.47
Source of variation					
Grain		0.07	0.82	0.82	0.07
Level		0.94	0.96	0.96	0.85
Grain × Level		0.16	0.60	0.60	0.36

Each value represents the mean of 4 replicates. SEM = Standard error of mean

Visceral organ weight

Overall, there was no significant effect of sesame level, grain type used and their interaction on the relative weight of visceral organs at day 35 of broiler age. However, there was a tendency for the relative weight of bursa to get significantly ($P < 0.07$) higher in the birds on wheat-based diets than those on maize-based diets (Table 8). In the present study the relative weight of visceral organs was not affected by the experimental factors. The inclusion of RSS in this study did not appear to have an impact on the weight of the visceral organs. The results were in accordance to those of (45) who reported that there was no significant effect of dietary supplementation of sesame meal on the weight of internal organs of broiler chickens. In contrast, Agbulu (1) found that the relative weight of most of internal organs were significantly affected by graded level of sesame seeds in the broiler diets.

Table 8. Relative weight of visceral organs of broiler chickens at day 35 of age fed different sesame seed levels supplemented to either maize- or wheat-based diet

Grain	Sesame level g/kg	Gizz[1]	Smal.int[2]	Liver	Spleen	Bursa
Wheat	0	2.21	4.94	2.77	0.13	0.17
	5	2.59	5.29	2.64	0.12	0.15
	10	1.82	5.96	3.62	0.17	0.22
Maize	0	2.50	5.67	2.95	0.14	0.15
	5	2.24	5.74	2.74	0.13	0.14
	10	2.40	5.73	2.96	0.12	0.13
SEM		*0.200*	*0.348*	*0.269*	*0.051*	*0.068*
Level	0	2.35	5.30	2.86	0.13	0.16
	5	2.41	5.52	2.69	0.13	0.14
	10	2.11	5.84	3.29	0.14	0.18
Grain	Wheat	2.20	5.40	3.01	0.14	0.18
	Maize	2.38	5.71	2.88	0.13	0.14
Source of variation						
Grain		0.35	0.57	0.69	0.40	0.07
Level		0.38	0.72	0.32	0.48	0.42
Grain × Level		0.13	0.76	0.52	0.11	0.27

Each value represents the mean of 4 replicates.[1]Gizz=Gizzard; [2]smallint=small intestine. SEM = Standard error of mean

Serum lipid profile

The RSS level and the grain type used significantly ($P < 0.02$) interacted, depressing the serum cholesterol content in diets supplemented with RSS (Table 9). Across the 35 days trial, the interaction between RSS level and the grain type used showed a tendency ($P = 0.056$) arising from the relatively higher TRG in birds fed on wheat-based diets that included the medium level of RSS. The lower TRG content was recorded for the birds offered the maize-based diet supplemented with the higher level of RSS. Considering the single main effects neither the RSS level nor the grain type used, influenced the lipid profile of serum. The results of the current study showed that the inclusion of medium level of RSS in the wheat-based diets had a hypocholesterolemic effects on broiler chickens. However, triglycerides were higher in the birds that were offered the maize-based diets that included the medium level of RSS. Sesame seed inhibits the intestinal absorption of cholesterol and its synthesis in the liver (46). This could be due to the presence of biological active compound such as sesamin and sesamolin in sesame seeds are known to have a hypocholesterolemic action. Sesame oil is also known to maintain the level of high density lipoprotein and low density lipoprotein (6). Furthermore, the hypo-cholesterolemia effects of the lignans and lignin glycosides isolated from sesame seeds and oil have also been reported by (24). Such cholesterol inhibitory actions of sesame may decrease the deposition of cholesterol in poultry products which in turn may decrease the health problems in human following the consumption of these products (8). The results were in line with those of (45) who found a linear decreasing of serum cholesterol when broiler were fed on diets containing different levels of toasted sesame meal. A reduction in the serum cholesterol was also reported by (4) when sesame seed meal was included to the broiler diets. Similarly, (3) reported a significant reduction in the serum cholesterol when sesame oil was added to the diet of layer chicken. The reduction in the lipid profile was further confirmed in the milk composition when sesame meal was fed to Awassi sheep (43). However in contrast to the results of the current study, they found a significant reduction in the serum triglycerides and a significant increase in the serum HDL contents of the layers. Agbulu (1) reported that the serum cholesterol was not affected by feeding of sesame seeds to the broiler chickens.

Serum biochemistry

Inclusion of RSS in the diets had no significant effect on the serum biochemical contents including (total protein, glucose, albumin, globulin, albumin/globulin ratio) of broiler chickens (10). In general the serum protein level was higher in RSS supplemented broiler than those on control diets. The results were in contrast to the finding of (45) who reported a significant increase in serum glucose and a significant decrease in serum total protein when broiler were offered diets supplemented with various levels of toasted sesame meal. They also found a linear decreasing in albumin content in the serum of sesame meals supplemented birds. Agbulu (1) found a significant decrease in serum protein and albumin content of broiler that were fed on diets containing sesame seed meal. In general, the measured biochemical parameters were higher in sesame seed supplemented birds than control.

Table 9. Effect of dietary supplementation of sesame seeds in maize- and wheat-based diets on the serum lipid profile of broiler chickens at 35 days of age

Grain	Sesame Level g/kg	TRG[1]	CHOL[2]	HDL[3]
Wheat	0	42.2	122.0[ab]	65.7
	5	37.6	100.1[c]	69.0
	10	48.4	104.3[abc]	78.0
Maize	0	42.3	115.2[abc]	70.7
	5	50.5	124.5[a]	67.7
	10	31.2	104.9[bc]	65.0
SEM		0.933	0.96	1.22
Level	0	42.2	118.6	68.2
	5	44.1	112.3	68.3
	10	39.8	104.7	70.6
Grain	Wheat	42.7	109.3	70.9
	Maize	41.4	114.9	67.5
Source of variation				
Grain		0.77	0.25	0.67
Level		0.75	0.13	0.92
Grain × Level		0.056	0.05	0.62

Each value represents the mean of 4 replicates. [a,b,c] Mean values in the same column not sharing a superscript letter are significantly different at the P-level shown for the main effect. [1]TRG= Triglycerides; [2]CHOL= Cholesterol; [3]HDL= High density lipoprotein. SEM = Standard error of mean

Table 10. Serum biochemistry of broiler chickens on either maize or wheat based diets supplemented with graded level of sesame seeds and fed for 35 days

Grain	Sesame Level g/kg	Response				
		Glucose	TP[1]	Albumin	Globulin	A/G[2]
Wheat	0	223.3	2.27	0.92	1.35	0.68
	5	238.1	2.41	0.99	1.42	0.69
	10	258.1	2.41	1.01	1.40	0.73
Maize	0	232.1	2.51	1.04	1.47	0.71
	5	250.6	2.86	1.20	1.66	0.72
	10	245.1	2.47	1.10	1.40	0.77
SEM		1.49	0.176	0.113	0.139	0.068
Level	0	227.1	2.39	0.98	1.41	0.70
	5	244..4	2.63	1.09	1.52	0.71
	10	251.6	2.44	1.04	1.40	0.75
Grain	Wheat	2.38.2	2.36	0.97[b]	1.39	0.70
	Maize	242.6	2.61	1.10[a]	1.51	0.73
Source of variation						
Grain		0.81	0.09	0.03	0.19	0.13
Level		0.24	0.35	0.30	0.37	0.12
Grain × Level		0.63	0.53	0.58	0.54	0.99

Each value represents the mean of 4 replicates. [a,b,c] Mean values in the same column not sharing a superscript letter are significantly different at the P-level shown for the main effect. 1TP= Total protein; 2A/G= Albumin/Globulin ratio.SEM = Standard error of mean

Nutrient digestibility

No interactions were observed between experimental factors in terms of protein digestibility (Table 11). Dietary RSS resulted in a lower protein digestibility than those on control diets. However it was only significant ($P < 0.01$) in birds that had received diets contained the highest level of RSS independent to the grain type used. Protein digestibility was significantly ($P < 0.01$)

higher in maize-based diet birds than those on wheat-based diets. A significant ($P < 0.01$) interaction was noticed between RSS level and the grain type when energy digestibility was assessed across the 35-d study. Energy digestibility decreased in birds that had received the maize-based diets that contained the highest level of RSS. Over all, energy digestibility numerically decreased as the RSS level increased. Furthermore, energy digestibility was relatively higher in maize based diet birds than those on wheat based diets. The results of the present study demonstrated that the digestibility of nutrients was affected by the treatments. The most important observation was the interaction between the RSS level and grain type on the digestibility coefficient of energy and protein, whereby the lowest values were seen in the chicken groups that consumed the highest level (10 g/kg) of RSS on maize-based diets compared to the control and other experimental groups. There was a dose-dependent decrease in the protein digestibility with increasing levels of RSS. This may be due to the low net protein utilization of RSS as well as low lysine and high phatic acid content (38). Rama Rao (37) also reported that the non-linear decrease in food efficiency in broilers fed diets containing higher levels of SSM may have been due to the reduction in the utilization of nutrients at higher levels of SSM in diet. The results were in contrast with those of (31) who reported a non-significant effect of dietary supplementation of sesame meal on the nutrient digestibility of awassi lambs. Furthermore, the digestibility of crude protein significantly increased in rabbits that were fed on diets containing sesame seed meal (17)**.** Protein digestibility was higher in the birds on maize-based diets than those on wheat-based diets. The activity of digestive enzymes can be influenced by the form (18) and type of cereal grains (5) used in diets for poultry. Therefore, variation in the digestibility of certain nutrients between the two grain-based diets could be due to the differences in the chemical composition of the grains, including the nature of antinutritional factors such as NSP in wheat.

Carcass yield and its parts weight

There were no significant effects or interactions from RSS level or the gain type on the dressing percentage and the relative weight of carcass parts of broiler chickens at 35 d of age (Table 12). Overall, the dressing percentage and the relative weight of carcass parts were marginally higher in broiler chickens fed on diets contained RSS than those in control groups. The results of the current study showed that supplementation of RSS to the diets had no significant effect on the meat yield in terms of weight of breast, thighs and drumsticks of broilers on either grain-based diets. Dressing percentage was improved to some extent due to RSS feeding. Inclusion of RSS in the diets of broiler chickens on either maize- or wheat-based diets marginally improved the carcass parts weight, especially breast and drumsticks. A medium level of sesame seeds in wheat-based diet produced the best outcomes. This may have been due to the complementary effects of amino acids of SSM and SBM in this combination. Which may results in better protein absorption and deposition in muscle tissue. Total protein and albumin were higher in the serum of the sesame supplemented birds than the other experimental groups. Bamgbose (8) reported that total protein and albumin are indicators of the total protein reserve in an animal body. The results of the current study are in line with the finding of Agbulu (1) who observed that the inclusion of sesame hull in broiler diet marginally improved carcass yield and the breast weight.

Table 11. Apparent protein, nitrogen and energy digestibility of 35 days broiler chickens given sesame seeds at different supplementation levels in either maize or wheat based diets

Grain	Sesame level g/kg	Response		
		Protein	Nitrogen	Energy
Wheat	0	0.57	0.57	0.43^{abc}
	5	0.54	0.59	0.42^{bc}
	10	0.52	0.53	0.46^{ab}
Maize	0	0.67	0.67	0.48^{ab}
	5	0.63	0.65	0.49^{a}
	10	0.55	0.55	0.41^{c}
SEM		0.064	0.064	0.058
Level	0	0.63^{a}	0.62^{a}	0.46
	5	0.58^{ab}	0.62^{a}	0.45
	10	0.54^{b}	0.54^{b}	0.44
Grain	Wheat	0.54^{b}	0.56^{b}	0.44
	Maize	0.61^{a}	0.62^{a}	0.46
Source of variation				
Grain		0.01	0.01	0.27
Level		0.01	0.01	0.56
Grain × Level		0.29	0.33	0.01

Each value represents the mean of 4 replicates. a,b,c Mean values in the same column not sharing a superscript letter are significantly different at the P-level shown for the main effect. SEM = Standard error of mean

Table 12. Dressing percentage and the weight of breast, thigh and drumsticks of broiler chickens at d 35 at various sesame seeds supplementation levels on either maize- or wheat-based diets

Grain	Sesame Level g/kg	% of body weight			
		Carcass yield	Breast	Thighs	Drumsticks
Wheat	0	69.8	23.6	10.9	8.4
	5	75.3	25.8	11.5	9.4
	10	71.2	29.6	13.3	11.0
Maize	0	73.9	28.1	11.0	8.7
	5	71.6	26.6	9.8	9.0
	10	73.2	25.8	10.9	8.7
SEM		0.57	0.70	0.44	0.41
Level	0	71.9	25.8	11.0	8.5
	5	73.4	26.1	10.6	9.2
	10	72.3	27.6	12.1	9.9
Grain	Wheat	72.2	26.2	11.9	9.6
	Maize	72.9	26.8	10.6	8.8
Source of variation					
Grain		0.62	0.78	0.15	0.29
Level		0.66	0.79	0.37	0.37
Grain × Level		0.10	0.36	0.53	0.32

Each value represents the mean of 4 replicates. SEM = Standard error of mean

Understanding the response of chickens to dietary inclusion of raw sesame seeds is essential to maximizing its use in diets for young birds. The present study highlights the benefits of using raw sesame seed. The results reported in this study show that feeding of raw sesame seeds (RSS) can influence the growth performance, digestive physiology and serum lipid profile at an early age and throughout the broiler production cycle. Early feeding of RSS has important nutritional roles in young developing chicks. Dietary RSS improved the feed consumption of broiler in the starter and subsequent grower phase. In addition the cholesterol content obviously reduced throughout the broiler production cycle. Feeding RSS negatively influenced the digestibility of nutrient without any negative impacts on the productive performance of broilers. There is a need to determine the optimal inclusion levels of raw sesame in the starter, subsequent grower and finisher diets of broiler chickens.

REFERENCES

1. Agbulu O.N., A.M. Gyau, and J.B. Abakura. 2010. Effect of replacement of sesame seed for methionine in broiler production in middle belt region-Nigeria. J, Emerg. Tren. Educat. Res. Poli. Stud. 1:16-21

2. Ahmed M.F. 2005. Sesame production technology and strategies to increase production in Nigeria. A paper presented at the National Sesame Seed Forum Stakeholders Meeting, Le Meridien, Abuja, Nigeria. 29-30 August 2005

3. AL-Fadhli, M.K., R.H. Razooki, and A.T. Theabe. 2015. Effect of addition of sesame oil to diets on blood lipid profile of laying hens. Diyala. J. Agri. Sci. 7: 20-26

4. Al-Harthi, M.A., and A.A. El-Deek. 2009. Evaluation of sesame meal replacement in broiler diets with phytase and probiotic supplementation. Egy. Poult. Sci. 29: 99-125

5. Almirall M., M. Francesch, A.M. Perez-Vendrell, J. Brufau, and E. Esteve-Garcia.1995. The differences in intestinal viscosity produced by barley and beta-glucanase alter digesta enzyme activities and ileal nutrient digestibilities more in broiler chicks than in cocks. J. Nutr. 125: 947-955

6. Anilakumar K.R., A. Pal, F. Khanum, and A.S. Bawa. 2010. Nutritional, medicinal and industrial uses of sesame (Sesamum indicum L.) seeds – An overview Agriculturae. Conspectus.Scientificus. 75: 159-168

7. AOAC. 2005. Official methods of analysis 5th Edition. Association of Official Analytical Chemists, Washington DC

8. Bamgbose A.M., S.O. Nwokoro, and O.O. Tewe. 2003. Serum metabolites and nutrient utilization of boilers fed extruded full fat soya bean diets. J. Arid. Agric. 13:167–171

9. Bell D.E., A.A. Ibrahim, G.W. Denton, G.G. Long, and G.L.B. Bradley.1990. An evaluation of sesame seed meal as a possible substitute for soybean oil meal for feeding broilers. Poult. Sci. 69 (Suppl.1): 157

10. Biswas T.K., N.K. Sana, R.K. Badal, and E.M. Hugue. 2001. Biochemical study of some oil seeds (Brassica, Sesame and Linseed). Pak. J. Biol. Sci. 4:1002-1005

11. Borchani C., S. Besbes, C.H. Blecker, and H. Attia. 2010. Chemical characteristics and oxidative stability of sesame seed, sesame paste, and olive oils. J. Agri. Sci. Tech. 12: 585-596

12. Cooney R.V., L.J. Custer, L. Okinaka, and A.A. Franke. 2001. Effects of dietary sesame seeds on plasma tocopherol levels. Nutr. Cancer. 39: 66-71

13. Dey B.C., M.A. Hamid, and S.D. Chowdhury. 1982. Effect of boiled sesame-cake and water-hyacinth leaves on the performance of ducklings. Indi. Anim. Sci. 53: 988–990

14. Diarra S.S., B.A. Usman, I.D. Kwari, and A. Yisa. 2007. Effect of processing methods on the antinutrional factor and the nutritional composition of sesame seed. Sahel.Vet. Sci. 7: 16-20.

15. Dipasa N.L. 2003. Sesame honey bits. www.dipasa.nl/seshobit.htm

16. El-Husseiny O.M., A.G. Abdallah, and T.A. El-Baz. 2001. Performance of Muscovy ducks fed diets containing sesame seed meal or extruded full-fat soybean. Egypt. Poult. Sci. 21: 901 – 920

17. El-Nomeary Y.A.A., R.I. El- Kady, and A.A. El-Shahat. 2015. Effect of some medicinal plant seed meals supplementation and their effects on the productive performance of male rabbits. Int. J. ChemTech Res. 8: 401-411

18. Gabriel I., S. Mallet, and M. Leconte. 2003. Differences in the digestive tract characteristics of broiler chickens fed on complete pelleted diet or on whole wheat added to pelleted protein concentrate. Br. Poult. Sci.. 44: 283-290

19. Gagan Rani. 2014. Studies on quality characteristics of sesame and sunflower oil and their seed cake

20. Gharbia A.H.A., A.A.Y. Shehata, and F. Shahidi. 2000. Effect of processing on oxidative stability and lipid classes of sesame oil. Food. Rev. Int. 33: 331-340

21. Home cooking. 1998. Seasme seeds. Homecooking.about.com /library/ weekly/ aa060898.htm

22. Kaneko K., K. Yamasaki, Y. Tagawa, M. Tokunaga, M. Tobisa, and M. Furuse. 2002. Effect of dietary sesame meal on growth, meat ingredient and lipid accumplation in broilers. J. Poult. Sci. 39: 156-162

23. Kang M.H., Y. Kawi, and M. Naito. 1999. Osawa dietary defatted sesame flour decreases susceptibility to oxidative stress in hypercholesterolemic rabbits. Nutr.129: 1885–1890

24. Kapadia G.J.,M.A. Azuine, H. Tokuda, M. Takasaki, T. Mukainaka, T. Konoshima, and H. Nishino. 2002. Chemopreventive effect of resveratrol, sesamol, sesame oil and sun flower oil in the Epstein-barr virus early antigen activation assay and the mouse skin two-stage carcinogenesis. Pharma. Res. 45: 499-505

25. Kato M., J.A. Chu, L.B. Davin, and N.G. Lewis. 1998. Biosynthesis of antioxidant

lignans in *Sesamum indicum* seeds. Phytochem. 47: 583-591

26. Lee S.C., S.M. Jeong, S.Y. Kim, K.C. Nam, and D.U. Ahn. 2005. Effect of far-infrared irradiation on the antioxidant activity of defatted sesame meal extracts. Agri. Food. Chem. 53: 1495-1498

27. Mahmoud K.Z., B.S. Obeidat, and M.A. Ishmais. 2015. Roasted sesame hulls improve broiler performance without affecting carcass characteristics. Itali. J. Anim. Sci. 14: 3957

28. Mamputu M., and R.J. Buhr. 1991. Effects of substituting sesame meal for soyabean meal on layer performance. Poult. Sci. 70: 77

29. Ngele G.T., E.O. Oyawoye, and U.D. Doma. 2011. Performance of broiler chickens fed raw and toasted sesame seed (*sesanum indicum*, l) as a source of methionine. Continental. J. Agri. Sci. 5: 33 – 38

30. Noblet J., W.H. Close, R.P. Heavens, and D. Brown.1985. Studies on the energy metabolism of the pregnant sow. 1. Uterus and mammary tissue development. British journal of nutrition 1985; 53: 251-265

31. Obeidat B.S., and F.F. Gharaybeh. 2011. Effect of feeding sesame hull on growth performance, nutrient digestibility, and carcass characteristics of black goat kids. Asian-Australas. J. Anim. Sci. 24: 206 – 213

32. Ojiako O.A., C.U. Igwe, N.C. Agha, C.A. Ogbuji, and V.A. Onwuliri. 2010. Protein and amino-acid composition of *Sphenostylis stenocarpa, Sesamum indicum, Monodora myristica* and *Afzelia Africana* seeds from Nigeria. Pak. J. Nutr. 9: 368-372

33. Olomu J.M. 1995. Monogastric animal nutrition: Principles and Practices. A Jachem Publication Pp. 131-186

34. Pan Y., L. Hy, and Q. Gao. 1992. The optimum allowance of sesame cake meal for broilers. Chin. J. Anim. Sci. 28: 26-27

35. Peace C. 1990. New crop production handbook, information collection and exchange; Yermanos, D.M. (ed). Washington, DC 20526, USA

36. Rahimian Y., and N. Tabatabaie, M.R. Valiollahi, M. Toghiani, F. Kheiri, A. Rafiee, F. Zamani, Y. Miri. 2016. Effect of use cumulative levels of sesame (Sesamum Indicum-L) meal with phytase enzyme on performance of broiler chicks. Scholar. J. Agri. Sci. 3: 526-534

37. Rama Rao S.V., M.V.L.N. Raju, A.K. Panda, N.S. Poonam, G. Shyam, Sunder, and R.P. Sharma 2008. Utilisation of sesame (Sesamum indicum) seed meal in broiler chicken diets. Br. Poult. Sci. 49: 81-85

38. Ravindran V., and R. Blair. 1992. Feed resources for poultry production in Asia and the Pacific. 2. Plant protein sources. World. Poult. Sci. J. 48: 205-231

39. Reddy C.A. 1999. Feeding sesame seed meal. Poult. Int. 38: 90-94

40. Sankar D., M.R. Rao, G. Sambandam, and K.V. Pugalendi. 2006. Effect of sesame oil on diuretics or Beta-blockers in the modulation of blood pressure, anthropometry, lipid profile, and redox status. Yale j biol med. 79: 19-26

41. Sihyung P., R. Sunoh, B. Youngmin, K. Hocheol, J.E. Simon, and K. Kwansu. 2010. Antioxidant components as potential neuroprotective agents in sesame (*Sesamum indicum* L.). Food. Rev. Int. 26: 103

42. Sirato–Yasumoto S., M. Katsuta, and Y. Okuyama. 2001. Effect of sesame seed rich in sesamin ans sesamolin on fatty acid oxidation in rat liver. J. Agri. Food. Chem. 49: 2647–2651

43. Suliman H.A., M.N. Abdulla, N.Y. Abo, and S.S. Faraj. 2014. Effect of feeding sesame oil cake and milking periods on milk production and chemical composition in awassi sheep. The journal of Kerkuk University for the agriculture sciences 4(2): 26-33

44. Tunde-Akintunde T.Y., M.O. Oke, and B.O. Akintunde. 2012. Sesame seed, oilseeds. Uduak G. Akpan (Ed.), ISBN: 978-953-51-0665-4, InTech, http://www.intechopen.com/books/oilseeds/sesameseed

45. Yakubu B., and B. Alfred. 2014. Nutritional evaluation of toasted white sesame seed meal *Sesamum Indicum* as a source of methionine on growth performance, carcass characteristics, haematological and biochemical indices of finisher broiler chickens. J. Agri. Vet. Sci. 7: 46-52

46. Yamauchi K., M. Samanya, K. Seki, N. Ijiri, and N. Thongwitta. 2006. Influence of dietary sesame meal level on histological alternatives of the intestinal mucosa and growth performance of chickens. Appl. Poult. Res. 15: 266-273.