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Growth performance, haematological parameters and serum biochemistry of broiler starter chicks fed sesame (*Sesamum indicum. L*) seed meal diets

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***Target Audience**: Researchers, farmers, nutritionist and policy makers.*

Abstract

The inadequacy of protein in human diets in developing countries especially Nigeria is as a result of high cost of animal feeds. Inadequate protein intake as recommended by Food and Agriculture Organization is more rampant in developing countries which has adverse effects on their citizens. Today, the world is suffering from a serious shortage of feed ingredients such as soya beans because of rapid competition and increase in human population. Therefore, provision must be made to solve the problem of increase in population and food availability quickly. The study was conducted to evaluate the growth performance, haematological parameters and serum biochemistry of broiler starter chicks fed varying levels of sesame seed meal (SSM) diets. A total of one hundred and fifty (150) Anak-2000, 1-day-old chicks were randomly allotted to five dietary treatments containing 0%, 25%, 50%, 75% and 100% level of inclusion of sesame meal in diets 1, 2, 3, 4 and 5 respectively. Each treatment was replicated thrice with ten birds per replicate in a Completely Randomized Design experiment. The experiment lasted for four weeks. Feed and water were supplied ad libitum. There was significant difference (P<0.01) in the average daily feed intake and average daily weight gain with the highest being 73.35 g/b/d and 50.45 g/b/d respectively observed in T5, which also had the least feed conversion ratio. Results on haematological indices also revealed that there were statistically significant (P<0.05) differences across the dietary treatment means with T5 having higher values of 31.20%, 2.84 $\times 10^6/\mu l$, 9.43 g/dl, 31.60 Pg, 107.41 fl and 28. 13 g/dl for PCV, RBC, Hb, MCH, MCV and MCHC respectively. Serum biochemistry parameters of the experimental animals were significantly (P<0.05) affected by the varying dietary treatment levels. The total protein, plasma protein, albumin, globulin, creatinine and urea decreased with increasing levels of inclusion of inclusion from T1 to T5. Treatment containing 100% replacement of soya bean meal with SSM had higher average daily feed intake, average daily weight gain, better feed conversion ratio and better haematological parameters. It can be concluded that sesame seed meal diet has the potential to completely replace soya bean meal at 100% inclusion level in the diet of broiler starter chicks without any detrimental effect on growth performance, haematological parameters and serum biochemistry.

***Key words:** Broiler, Chicks, Performance, Haematology, Serum biochemistry.*

Description of problem

The inadequacy of protein in human diets in developing countries especially Nigeria is as a result of high cost of animal feeds. Inadequate protein intake as recommended by Food and Agriculture

Organization (1) is more rampant in developing countries which has adverse effects on their citizens. Today, the world is suffering from a serious shortage of feed ingredients such as soya beans because of rapid competition and increase in human population. Therefore, provision must be made to solve the problem of increase in population and food availability quickly. The competition between man and animal for available grains has been established with animals always at a losing end. Thus, combining available feed ingredients in the best possible way becomes paramount because feeding birds with poor quality feed due to high cost of feeding will result in physiological imbalance and yield poor carcass.

Over the years, the pre-occupation of animal nutritionists has been to research alternative feed sources for animals and their implication on production, health and management. This has yielded results in terms of competitive sources of ingredients for energy and protein in animal ration formulation. Reduction in dependence on importation of livestock feed in Nigeria has led to increase in the demand and cost of conventional feedstuff. Hence, the need to explore the use of non-conventional feed sources such as sesame that have the capacity to yield the same output as conventional feeds, and perhaps at cheaper cost.

The poultry industry in Nigeria, in the past decade has been greatly affected by high cost of feed. The provision of feed alone has been reported to account for 60-80% of the total cost in most livestock production in developing countries such as Nigeria. All animals require protein for growth, production and reproduction depending on the age, productivity of the animal and their environment (2). The conventional protein feedstuff for poultry such as soya bean mean, groundnut cake and fish meal are very scarce coupled with high level of competition between humans, animals and other industrial uses. Hence, this necessitated the need to explore some unconventional protein sources such as sesame so as to the augment growing demand of the teeming population.

Sesame (*Sesamum indicum L.*) is labelled as the queen of oilseeds because of its high oil content, delicious nutty aroma, and flavor and is traditionally categorized as a healthy food in Asian countries (3). Sesame seed is used for a wide array of edible products in raw or roasted form and also for industrial uses such as soaps, lubricants, lamp oil, an ingredient in cosmetics; pharmaceutical uses and animal feed (4). It contains a considerable amount of oil, proteins, carbohydrates, essential minerals, a high amount of methionine and tryptophan, fibre as well as secondary metabolites such as lignans, saponins, flavonoids and phenolic compounds. Moreover, the seeds are good source of calcium, phosphorus, and iron and are rich in vitamin B, E and small amount of trace elements (3).

Worldwide sesame seed consumption was USD 6559.0 million in 2018, and it will reach USD 7244.9 million by 2024, with a CAGR (Compound Annual Growth Rate) of 1.7% (5). Global sesame consumption is steadily increasing mainly due to changing consumer's consumption patterns and increasing health awareness. Nowadays, the consumers mostly prefer the high nutritive value products. Consequently, the demand of sesame seeds is higher since it has several nutritional characteristics such as vitamins, minerals, fibre, healthy fat and protein. About 70% of the world's sesame seed is used to produce oil and meal. Total annual oil and food consumption is about 65% and 35%, respectively (Morris, 2002). Tanzania is the highest sesame seed consuming country (21% based on tonnes), followed by China (19%), Sudan (9%), Myanmar, India, Ethiopia and Nigeria (6% each) with almost 74% of the global consumption.

Haematological studies are very important in diagnosing the structural and functional status of the animal's body (6). Haematological changes are routinely used to determine various influences of environmental, nutritional and or pathological factors (7). High PCV (%) and high Hb (g/dl) are indicators of high feed conversion efficiency (8). The haematological parameters of healthy birds are influenced by many factors which include feed restriction and nutritional conditions (9), environmental factors (10), thirst (11), nutritional contents (12), water and feed restriction (13, 14), age (15), continuous supplementations of vitamin E (16), administration of drugs (17, 18), breed (19) and aflatoxin (20). Thus, the study was conducted to evaluate the performance, haematological and serum biochemistry of broiler starter chickens fed sesame-based diets.

Materials and Methods

Study Location

The experiment was conducted at the Abubakar Tafawa Balewa University Poultry Teaching and Research Farm Bauchi, Bauchi State. The Poultry Teaching and Research Farm is located within the geographic coordinates of 10^{o} 18′ 37.2″ N and 9^{o} 50′ 38.0″ E. It is 616 metres above sea level, characterized by two well defined season (May - October) raining season and (November - April) dry season. It has an average annual rainfall of 1009 mm with the highest relative humidity of 94% in August and lowest 35% in February. Ambient temperatures are between 13-17oc (December-February) and 36-37oc (March-April).

Experimental animals and their management

A total of one hundred and fifty (150) Anak 2000, 1-day old chicks were obtained from Zartech, Jos Plateau State. The chicks were brooded for seven days on deep litter system using 200-watt electric bulb and charcoal pots. The birds were fed commercial feed during the seven days brooding period. Feed and water were supplied *ad libitum*. After the brooding period, the chicks were randomly assigned to five experimental treatments each replicated thrice with ten birds per replicate in a Completely Randomise Design. Necessary vaccines (Lasota and Gumboro) were administered at appropriate time. Anti-stress was also administered to the birds on arrival to the farm.

Experimental Diets

The experimental diets were formulated to contain 0%, 25%, 50%, 75% and 100% level of inclusion of sesame meal representing diets 1, 2, 3, 4 and 5 respectively as a replacement of soya bean meal.

Design of Study

The design to be used for this study is a Completely Randomized Design (CRD) using treatments as the factor of interest. The linear model of the design is:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:

Y_{ij}= individual observation.

μ= population mean

T_{ij}= treatment effect

eij= Random error assumed to be independently, identically and normal distributed with zero means and constant variance.

Table 1: Percentage composition of the experimental diet fed to broiler chicks at the starter phase (1-4 weeks)

Ingredients	1	2	3	4	5
Maize	45.51	45.51	45.51	45.51	45.51
Groundnut cake	10.00	10.00	10.00	10.00	10.00
Full fat soya bean	35.49	26.62	17.75	8.83	0.00
Sesame meal	0.00	8.83	17.75	26.62	35.49
Wheat offal	2.00	2.00	2.00	2.00	2.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	3.25	3.25	3.25	3.25	3.25
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Total	**100**	**100**	**100**	**100**	**100**
Calculated analysis					
Crude protein (%)	24.75	22.25	19.81	17.3	14.83
ME (Kcal/kg)	2709.22	2725.71	2743	2759.26	2776.26
Crude fibre (%)	4.68	4.64	4.61	4.57	4.54

Data Collection

Data was collected for a period of four weeks. The following parameters were measured;

Determination of Growth parameters

Weight determination

Initial and final body weights of the chickens was measured on arrival to the experimental site. Subsequently, body weights and other growth performance parameters were taken at weekly interval throughout the study. All weight measurements were done using digital weighing scale (10kg capacity of 0.01 sensitivity)

Initial body weight: the weight of the chickens at the beginning of the experiment. This was done using single pan electronic balance.

Final body weight: the weight of the chickens at the end of the experiment. This was done using triple beam balance (kg).

Daily weight gain/bird/day (g):

$$\frac{\text{Final live weight - initial weight}}{\text{No of birds x Number of experimental days}}$$

Feed intake/bird/day (g):

$$\frac{\text{Quantity of feed given – leftover}}{\text{No of bird x No of experimental days}}$$

Feed conversion ratio:

$$\frac{\text{Quantity of feed consumed}}{\text{Weight gained}}$$

Blood collection procedure

For the haematological and serum biochemistry analysis, an initial 2mls of blood was collected through the wing vein into a labelled sterile vacutainer tube containing ethylene-diamine-tetra-acetic (EDTA) as anti-coagulant which was used for haematological analysis. Another 2mls of blood was collected into labelled sterile sample bottles without EDTA which was used for the serum biochemical analysis. The Red Blood Cells (RBC), White Blood Cells (WBC), Haemoglobin (Hb) and Packed Cell Volume (PCV) were determined. Blood constants (MCV, MCH and MCHC count) were determined using appropriate formula as described by (21). Serum was obtained by allowing the blood sampled to clot at room temperature for 30 minutes, after which it was centrifuged for ten minutes at 3, 000 revolutions per minute using a table centrifuge. The clear serum supernatant was then carefully aspirated with syringe and needle and stored in a clean sample bottle. Decanted sera from the coagulated blood samples were saved by freezing at -180c until analysed for serum biochemistry according to (22). The serum biochemical indices that were considered includes; total protein, globulin, albumin, plasma protein, creatinine and urea.

Mean Corpuscular Volume (MCV) =

$$\frac{\text{Packed Cell Volume (PCV)} \times 10}{\text{RBC}}$$

Mean Corpuscular Haemoglobin (MCH) =

$$\frac{\text{Haemoglobin (Hb)} \times 10}{\text{RBC}}$$

Mean Corpuscular Haemoglobin Concentration (MCHC) =

$$\frac{\text{Haemoglobin (Hb)} \times 100}{\text{PCV}}$$

Data Analysis

The data generated were subjected to Analysis of Variance (ANOVA) technique as described by (23). Differences between treatment means were further separated using Duncan Multiple Range Test (DMRT) as described by (24). Statistical computations were done using IBM SPSS (20th Edition).

Results

Table 2: Performance of broiler starter chicks fed varying levels of sesame seed meal diet at the starter phase (1-4 weeks)

	Dietary treatments					
Parameters	**1**	**2**	**3**	**4**	**5**	**SEM**
Feed intake (g/b/d)	69.90^c	60.16^b	71.05^b	72.29^b	73.35^a	1.36
Weight gain (g/b/d)	40.28^c	43.35^c	46.51^b	47.71^b	50.45^a	0.91
Feed conversion ratio	1.97	1.95	1.93	1.88	1.87	0.02

^{abc} Means in the same row with different superscript are significant (P<0.05)
SEM=Standard Error Mean

Table 3: Haematological indices of broiler starter chicks fed varying levels of sesame based diet (1-4 weeks).

	Treatments					
Indices	**1**	**2**	**3**	**4**	**5**	**SEM**
Packed Cell Volume (%)	22.23^e	25.30^d	28.57^c	30.43^b	31.20^a	0.12
Red Blood Cell (×106/μl)	2.46^c	2.60^b	2.61^b	2.63^a	2.84^a	0.31
White Blood Cell (×106/μl)	34.40^a	24.07^b	12.41^c	10.09^d	8.71^e	1.81
Haemoglobin (g/dl)	5.54^d	8.09^c	8.11^c	8.56^b	9.43^a	0.08
MCH (Pg)	24.24^e	26.11^d	29.17^c	31.53^b	31.60^a	0.16
MCV (fl)	81.11^e	107.40^a	104.03^c	102.21^b	107.41^a	1.08
MCHC (g/dl)	18.21^e	20.02^d	23.14^c	26.03^b	28.13^a	0.11

^{abc} means on the same row with different superscripts are significantly different (P<0.05), MCH: Mean Corpuscular Haemoglobin, MCV: Mean Corpuscular Volume, MCHC: Mean Corpuscular Haemoglobin Concentration, SEM: Standard error of mean.

Table 4: Serum biochemical indices of Broiler starter chicks fed varying levels of sesame seed meal diet (1-4 weeks).

	Treatments					
Indices	**1**	**2**	**3**	**4**	**5**	**SEM**
Serum Total Protein (g/dl)	3.93[a]	3.49[b]	3.21[c]	3.05[c]	2.72[d]	0.09
Plasma Protein (g/dl)	4.18[a]	4.14[a]	3.55[b]	3.44[b]	3.14[c]	0.11
Albumin (g/dl)	1.75[a]	1.39[b]	1.34[c]	1.33[c]	1.28[d]	0.04
Globulin (g/dl)	2.18[a]	2.10[b]	1.87[c]	1.72[c]	1.44[d]	0.05
Creatinine (mg/dl)	0.48[a]	0.30[b]	0.31[b]	0.21[b]	0.16[c]	0.03
Urea (mg/dl)	13.94[a]	6.17[b]	4.38[c]	2.28[d]	0.66[e]	1.43

[abc] means on the same row with different superscripts are significantly different (P<0.05), SEM: Standard error of mean.

Results and Discussion

The result of the study on the growth performance of broiler starter chicks fed sesame seed meal diet revealed that there was significant (P<0.05) difference across the dietary treatment means. Experimental animals fed T5 had higher feed intake and average weight gain than other treatment groups. The highest value of 73.35 g/b/d and 50.45 g/b/d for average daily feed intake and average daily weight gain respectively were recorded in T5, while the lowest value of 69.90 g/b/d and 40.28 g/b/d for average daily feed intake and average daily weight gain respectively were recorded in T1 (Control). The result showed that broiler starter chickens performs better when higher levels of protein (sesame seed meal diet) were included in the diet. Protein functions mainly in tissue growth of animals, this may also be the reason why T5 had the highest value for average weight gain compared to T1, T2, T3 and T4.

There was significant (P<0.05) difference across the haematological parameters such as the Packed Cell Volume (PCV), Red Blood Cell (RBC), Haemoglobin (Hb), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) differed significantly among treatment means. T5 had the highest pack cell volume, red blood cell, haemoglobin, mean corpuscular haemoglobin, mean corpuscular volume and mean corpuscular haemoglobin concentration, while T5 had the least value for white blood cell (Table 3). The values obtained in the haematological parameters increases across the dietary treatment means with increasing level of inclusion of sesame seed meal except for red blood cell which decreases as the level of inclusion of sesame meal increases as presented in Table 3. In PCV, the highest value of 31.20% was recorded in T5, while the least was recorded in T1 (control). The PVC value range of 22.23-31.20% obtained in the study is within the range of 24.9-45.5% reported by (25) and also within the range of 30.75-34.25% obtained by (26) for healthy birds. The results are equally within the normal range of PCV values for chickens of 22-35%. This indicate that sesame meal inclusion in the diet of the birds did not cause any health impairment. The PCV is an indication of the proportion of blood that is made up of cells, which is expressed as a percentage of cells in the blood. The determination of PCV is to identify if the fed diets has detrimental health implications on the broiler chickens as a result of possible nutritional disorder from the tested diets.

In RBC count, the highest value of 2.84 $\times 10^6 \mu l$ was recorded in T5, while 2.46 $x10^6 \mu l$, 2.60 $x10^6 \mu l$, 2.61 $x10^6 \mu l$ and 2.63 $x10^6 \mu l$ was recorded in T1, T2, T3 and T4 respectively. The values obtained are higher than the normal range of RBC for chickens of 2.5-3.5$x10^6 \mu l$ (27). The highest value recorded in T5 suggest that higher inclusions level of sesame meal improves RBC production in broiler starter, hence RBC values increases with increasing levels of sesame meal. Red blood cell is produced in the bone marrows of long bones of the body, and adequate production is dependent on the amount of iron absorbed from the digested food. White blood cells (WBC) were significantly (P<0.05) higher in broilers chicken fed T5. White blood cell is essential component of the blood necessary for defence against infectious disease, and for immune system. High amount above normal range may indicate pathogenic disease. The WBC count recorded the highest value of 34.40 g/dl was recorded in T1 (control), while 24.07 g/dl, 12.41 g/dl, 10.09 g/dl and 8.71 g/dl were recorded in T2, T3, T4 and T5 respectively. The results on WBC are higher than the normal range of WBC values for chickens of 12-13 g/dl.

Results from haemoglobin concentration of the experimental birds, the highest value of 9.43 g/dl was recorded in T5, while 5.54 g/dl, 8.09 g/dl, 8.11 g/dl and 8.56 g/dl were recorded in T1, T2, T3 and T4 respectively. The results agreed with the findings of (28) who observed that high minerals and vitamin content of feed materials like leaves stimulate the synthesis of haemoglobin leading to its increase in the blood. The results equally fall within the normal range of Hb values for chickens of 7-13 g/dl. The values obtained for haemoglobin (8.09-9.43g/dl) for broiler starter chickens fed T1 to T5 fell within the normal range of (8.0-13.0g/dl), while 0% (control) had lower value of haemoglobin than the normal. This signifies that the birds had good aerobic capacity and were not anaemic.

The significant variation in red blood cell, packed cell volume and haemoglobin indicates that sesame meal had an effect on erythropoiesis and transportation of oxygen, chemicals and nutrients essential for life. The continual increase in PCV, Hb and RBC levels of birds fed experimental diet is an indication of improved oxygen carrying capacity of the cells which translate to a better availability of nutrients to the birds and consequently affecting their well-being positively.

Deviation of packed cell volume from normal is an indication of anaemia in birds and packed cell volume decreases when chickens are exposed to heat stress. The decrease in white blood cell indicate decrease in production of bone marrow or destruction due to viral infection or toxic reaction.

Results presented from the studies showed an increased in PCV, having direct effects with corresponding increase in RBC and haemoglobin. The PCV values obtained from the experimental diets were within the physiological range of 26 to 33 and 24.87 to 32.75% as stated respectively by (29) and (30).

Decreased WBC with increasing level of inclusion as presented Table 3 may be an indication of prophylactic active ingredients. Since white blood cells serve to phagocytic function similar to their mammalian counterparts (31).

The serum biochemistry of the experimental animals revealed that there was significant (P<0.05) difference across the treatment means in all the measured parameters. The values for serum total protein, plasma protein, albumin, globulin, creatinine and urea decreased as the level of inclusion of sesame meal increases (Table 4). The result shows that significant ($P<0.05$) difference exists in Total Protein, Plasma Protein, Albumin, Globulin, Creatinine and Urea. The highest values for serum total protein, plasma protein, albumin, globulin, creatinine and urea were recorded in T1 (control) which decreases as the inclusion levels increases. The blood protein and creatinine depend on the quality of dietary protein. Increase in the total protein showed beneficial synergistic effect of phenolic and flavonoids on protein metabolism.

According to (32), serum total protein values of broilers tend to be lower than those of mammals, ranging from 25.00 to 45.00 g/l. Among numerous factors that influence the concentration of serum proteins, age plays an important role in the physiology. Generally, concentration of proteins is significantly lower in young animals than in adults (33). Urea and creatinine are nitrogenous end products of metabolism. Urea is the primary metabolite derived from dietary protein and tissue protein turnover. Creatinine is the product of muscle creatinine metabolism. The blood urea nitrogen is roughly one-half (0.47) of the blood urea. The normal range of urea nitrogen in blood or serum is 5 to 20 mg/dl or 1.8 to 7.1 mmol urea per litre. The normal serum creatinine varies with the subject body muscle mass and with the technique used to measure it. The normal range of serum creatinine is 0.6 to 1.2 mg/dl, or 53 to 106 µ mol/l by the kinetic or enzymatic method, and 0.8 to 1.5 mg/dl, or 70 to 133 µ mol/l by other older manual Jaffe reaction.

Albumin values obtained were below normal standard range (2.0 to 3.5 g/dl) as reported by (34). Globulin concentration showed significant ($P<0.05$) differences among treatment, the highest globulin concentration recorded among broiler chicks fed control diet, and it gradually decreased with increased inclusion. Creatinine content of broiler chicks fed experimental diet differed ($P<0.05$) among treatment levels. Broiler chicks fed control diet had the highest creatinine concentration and decreased gradually with increased inclusion levels. Urea blood levels were significant ($P<0.05$) among treatment. The blood urea blood content showed highest value for chicks fed control diet, and this decreased with increased level of inclusion. The urea blood levels obtained with broiler chicks fed diet 2, 3, 4 and 5, were between standard normal range (2 to 8mg/dl) with that of healthy broiler chicks reported by (34) for biochemical indices. Table 4 present data on glucose levels, enzymes, cholesterol and triglycerides. All parameters differed ($P<0.05$) significantly among treatment. The total protein, albumin and globulin is within the range reported by (35) and (36). The total protein, globulin, albumin, creatinine and urea values obtained in these studies is lower than the values reported by (37).

Conclusion and Application

1. Sesame seed meal can replace soya bean meal at 75-100 % inclusion level without any detrimental effect on the performance of broiler starter chicks, haematological parameters and serum biochemical indices.

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