

## Effects of Feeding Various Protein Concentrates on Performance, Haematological and Serum Biochemical Indices of Broiler Chickens.

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**Target Audience:** Farmers, Animal Nutritionists and Researchers

### Abstract

A four-week feeding trial was conducted to evaluate the effects of different protein concentrates on the performance, haematological, and serum biochemical indices of broiler chickens. A total of 120 broiler chickens, were randomly distributed to four treatments (diets) at four weeks of age, each consisting of 30 birds with three replicates (10 birds per replicate) in a Completely Randomized Design (CRD). The experimental diets included T1 (commercial protein concentrate, control), T2 (groundnut cake-based concentrate), T3 (soya bean meal-based concentrate), and T4 (50% groundnut cake-based concentrate + 50% soya bean meal-based concentrate). Performance parameters assessed were feed intake, weight gain, and feed conversion ratio. At the end of the trial, three birds per treatment were randomly selected for haematological and serum biochemical analysis. The productive performance of the birds showed no significant ( $P>0.05$ ) difference across treatments except for final body weight. Final body weights were 1528.30, 1823.00, 1980.00, 1890.00 g/bird T1, T2, T3 and T4 respectively, with T3 (Soya bean meal-based concentrate diet) recording the highest value. Significant differences ( $P<0.05$ ) were observed in packed cell volume, haemoglobin concentration, and red blood cell counts, but no significant differences were found for other haematological parameters. The serum biochemistry differed significantly in most parameters, except for urea, conjugated bilirubin, total bilirubin, and alkaline phosphatase. Conclusively, diets compounded with commercial concentrates and on-farm formulated concentrates can be fed to broiler chickens without detrimental effects on performance and health.

**Keywords:** Concentrates, Broiler chickens, Performance, Haematology and Serum biochemistry

### Description of problem

The major problem facing developing countries especially Nigeria, is the exponential growth in population without a corresponding increase in food production. It is therefore necessary to increase the production of food especially animal protein sources in order to meet the demand of our rapidly growing population and to enhance foreign exchange earnings as well. For these

to be achieved, it is essential to intensify production using improved breeds of animals with short production cycle, notably poultry, swine and rabbit.

In developing countries, almost five million children under the age of five die of malnutrition-related causes every year and as a result of that, agriculturists and nutritionists generally agreed that developing poultry industries is the safest means of bridging the

protein gap prevailing in the country (1). The advantage of poultry over other livestock is primarily due to the short and relatively quick turn over on investments and high quality protein products (2). In poultry production, feed cost accounts for 70-80% of total variable cost of production (3). It has been reported that one of the major problem of poultry production in Nigeria is high cost of feeding (4). The high cost of feed has necessitated the use of unconventional feedstuffs and the use of locally available alternative feedstuffs to supplement feed (5). The use of formulated concentrate has been recommended based on the awareness that it could be used with maize to formulate a cost effective diet for poultry.

The objective of the study is to evaluate the performance, haematological and serum biochemical indices of broiler chickens fed various protein concentrates.

## Materials and Methods

### Study Site

The study was carried out at the Teaching and Research Farm, Department of Animal Science, University of Maiduguri, Maiduguri, Borno State. Maiduguri is located between latitude 11°5 and 12° North and longitude 13°05 and 14° East at an altitude of about 353m above the sea level (6).

### Experimental Stock and Their Management

A total of one hundred and twenty (120) day-old chicks (broilers) were purchased from a reputable hatchery in Maiduguri and used for the study. Standard routine management practices were carefully observed. Water and feed were provided *ad-libitum*

### Experimental Design

At four weeks of age, the birds were distributed to four experimental diets in a Completely Randomized Design (CRD). Each diet (treatment) contained three (3) replicates of 10 birds each.

### Experimental Diets

The chicks were brooded for two weeks and were fed commercial diet for four weeks. Afterwards, they were distributed to four experimental diets; one commercial concentrate diet and three different formulated concentrate diets. Each of the three formulated concentrate diets were combined with maize to give a complete ration. Likewise, the commercial concentrate was also mixed with maize which served as the control diet of the experiment as illustrated below:

T1. Commercial concentrate + Maize

T2. Groundnut cake-based concentrate + Maize

T3. Soya bean meal-based concentrate + Maize

T4. 50% Groundnut cake -based concentrate + 50% Soya bean meal-based concentrate + Maize.

The ingredient composition and calculated analysis of the on-farm formulated concentrates are presented in Table 1.

**Note:** The experiment only reflects the finisher phase of the bird's cycle (5-8 weeks).

### Data Collection

#### Performance parameters

The weight gain, feed consumption and feed conversion ratio constituted the performance parameters.

#### Feed intake

A known quantity of feed was given to the

**Table 1: Ingredients Composition of the on-farm formulated concentrates**

Ingredients (%)	Treatments		
	T2	T3	T4
GNC	35.48	0.00	16.14
SBM	0.00	29.58	16.14
Fish Meal	43.46	49.36	46.68
Wheat Offal	12.68	12.68	12.6
Bone Meal	6.14	6.14	6.14
Salt	0.78	0.78	0.78
Lysine	0.60	0.60	0.60
Methionine	0.46	0.46	0.46
Premix	0.46	0.46	0.46
Metabolizable energy(kcal/kg)	2338.52	2295.33	2315.49

**Calculated analysis of the concentrates**

Ingredient	T1	T2	T3	T4
Metabolizable energy (kcal/kg)	2400.00*	2338.5	2295.33	2315.49
Crude Protein (%)	40.00*	39.99	40.00	38.10
Fat (%)	5.00*	4.53	7.84	6.34
Crude Fibre (%)	6.00*	3.29	3.05	3.16
Calcium (%)	3.00*	2.78	5.36	2.87
Available Phosphorus (%)	0.80*	2.32	2.61	1.22

\*= As provided by the manufacturer

T1=Commercial concentrate-based diet

T2= Groundnut cake-based concentrate diet

T3= Soya Bean Meal-Based concentrate diet

T4=50% Groundnut cake-based+50% Soya bean Meal-Based concentrate Meal-Based concentrates) diet

**Table 2: Composition of the Experimental Diets**

Ingredient (%)	Experimental diets			
	T1	T2	T3	T4
Maize	58.06	58.06	58.06	58.06
Concentrates	41.94	41.94	41.94	41.94
<b>Total</b> =	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

T1=Commercial concentrate based diet

T2= Groundnut cake-based concentrate diet

T3= Soya Bean Meal-Based concentrate diet

T4=50% Groundnut cake-based+50% Soya bean Meal-Based concentrate Meal-Based concentrates) diet

birds at the finisher stage. The feed intake was then obtained by subtracting the leftover from the quantity of feed given. The amount consumed per bird was then calculated for each treatment on a weekly basis by dividing the total feed intake by the number of birds per treatment.

Feed intake = Feed given – Left over

**Body weight gain**

The birds were weighed at the beginning of the experiment and at the end of every week. All birds were weighed individually in order to obtain their weekly weight gain by subtracting weight of the previous week from weight of the current. Daily weight gain was calculated for each treatment by dividing the

average weekly gain by seven (7).

Body weight gain = Final weight – Initial weight

### **Feed conversion ratio (FCR)**

The feed conversion ratio is the ratio of the quantity of feed consumed to weight gained. It was determined at the end of the experiment using total feed consumed and total weight gain. It was calculated using the formula:

$$\text{Feed conversion ratio} = \frac{\text{feed intake}}{\text{weight gain}}$$

**There was no case of mortality throughout the duration of the experiment.**

### **Blood Collection**

At the end of the experiment, three birds were selected from each treatment that is one from each replicate (four treatments, three replicates, that is, twelve birds were selected) for the determination of haematological and serum biochemical indices. Blood was collected via the left wing vein of the birds with sterile needles and syringes. The blood sample was divided into two parts; first part was collected in the bottles containing Ethylenediaminetetraacetic acid (EDTA) for haematological analysis while the second part was collected in plain bottles for serum biochemical analysis and kept in slanting position at room temperature until the serum was clearly visible

### **Haematological and Serum Biochemical Indices Analysis**

The haematological parameters measured include packed cell volume (PCV), haemoglobin concentration (HB), red blood cell count (RBC), white blood cell count (WBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH),

mean corpuscular haemoglobin concentration (MCHC) while the biochemical indices that were analyzed are total protein, serum albumin, serum globulin, glucose, urea, alanine aminotransferase (ALAT), aspartate amino transferase (ASAT), creatinine, total bilirubin, conjugate bilirubin and alkaline phosphate (Alph). They were all determined using the method of(7).

### **Cost benefit analysis**

The economic implication of feeding diets based on the four concentrates to the broiler chickens was assessed by calculating the;

- I. Cost per kilogram of diet.
- ii. Cost of feeding the broilers.
- iii. Cost per kilogram of weight gain by the broiler chickens.

### **Statistical Analysis**

All data collected were subjected to analysis of variance using completely randomized design with analytical software statistix 8.0 (2003). Significant differences between treatment means were compared using least significant difference (LSD).

### **Results and Discussion**

The Initial body weight shows no significant differences among treatments. Final body weights ranged from 1528.30 to 1980.00 g/bird, with significant differences ( $P < 0.05$ ) among treatments. The highest weights were observed in T3 (soyabean meal-based concentrate diet), T4 50% T2 (groundnut cake-based concentrate diet) and 50% T3 (Soya bean meal-based concentrate diet), T2 (groundnut cake-based concentrate diet) while the lowest weight was observed in T1 (commercial concentrate-based diet). Feed intake (106.18-122.14 g/bird/day) and daily

**Table 3: Productive Performance of Broiler Chickens fed Diets (Finisher, 5-8 weeks of age) Compounded with Commercial Concentrates and on-farm Formulated Concentrates**

Parameters	Experimental Diets				SEM
	T1	T2	T3	T4	
Initial body weight (g)	611.67	621.67	603.33	628.33	36.83 <sup>NS</sup>
Final body weight (g)	1528.30 <sup>b</sup>	1823.00 <sup>a</sup>	1980.00 <sup>a</sup>	1890.00 <sup>a</sup>	76.56*
Daily feed intake (g)	108.18	113.51	106.90	122.14	18.54 <sup>NS</sup>
Daily weight gain (g)	32.94	42.90	48.81	45.06	7.78 <sup>NS</sup>
Feed conversion ratio	3.30	2.65	2.19	2.71	0.87 <sup>NS</sup>
Mortality (%)	0	0	0	0	NSA

a, b= Means within the same row bearing different superscripts differ significantly (P<0.05)

\*=Significant (P<0.05), NS= Not Significant (P>0.05)

NSA= Not statistically analyzed

SEM= Standard Error of the Mean

T1= Commercial concentrate based diet

T2= Groundnut cake-based concentrate diet

T3= Soya Bean Meal-based concentrate diet

T4=50% Groundnut cake-based+50% Soya bean Meal-Based concentrate Meal-Based concentrates) diet

weight gain (32.74-48.81 g/bird/day) showed no significant differences among treatments. The feed conversion ratio (2.19-3.30) also showed no significant differences among treatments.

### **Haematological parameters of Broiler Chickens Fed Diets Compounded with Commercial Concentrates and On-Farm Formulated Concentrates**

The results of the haematological parameters are presented in Table 4. The haematological indices among others packed cell volume, red blood cell and haemoglobin were significantly (P<0.05) different while other indices fell within the normal range. The packed cell volume (23.67-67%) showed broiler chickens fed with T1 (Diet compounded with commercial concentrate) has the highest value while the least was observed in T4 (50% GNC and 50% SBM based concentrate). The values are within the normal range (22-35%) reported by (8). The haemoglobin concentration values obtained

(7.87-11.77 g/dl) were within the normal range (7-13g/dl) reported by (9) for healthy broiler chickens. The red blood cell counts ranged 3.94 to 5.9 x10<sup>6</sup>/μl which is higher than the values obtained (2.5-3.5 x10<sup>6</sup>/μl) by (8). The white blood cell counts ranged 10.20 to 11.67 x10<sup>3</sup>/μl which fell within the normal range (9-31 x10<sup>3</sup>/μl) reported by (9). The results of the erythrocytic indices showed no significant (P>0.05) difference among the treatment groups. Mean corpuscular volume ranged from 59.88-64.50 fl, mean corpuscular haemoglobin (19.86-19.97 pg) and mean corpuscular haemoglobin concentrate (33.12-33.30%). They are within the normal range of values reported by (9) for healthy broiler chickens.

### **Serum Biochemical Indices of Broiler Chickens Fed Diets Compounded with Commercial Concentrates and On-Farm Formulated Concentrates**

The results of serum biochemical indices are presented in Table 5. The serum biochemical parameters showed no significant (P>0.005)

difference for urea, conjugate bilirubin, total bilirubin and alkaline phosphatase but the rest of the parameters indicated significant ( $P < 0.005$ ) difference among the treatment

groups. Total protein values were 59.00, 42.33, 43.00 and 44.00 for T1, T2, T3 and T4 respectively. There were significant ( $P < 0.05$ ) differences among the

**Table 4: Haematological indices of Broiler Chickens Fed Diets Compounded with Commercial Concentrate and on-farm Formulated Concentrates**

Parameters	Experimental Diets/Treatments				SEM
	T1	T2	T3	T4	
PCV (%)	35.33 <sup>a</sup>	28.67 <sup>b</sup>	25.67 <sup>bc</sup>	23.67 <sup>c</sup>	2.01*
RBC ( $\times 10^6/\mu\text{l}$ )	5.90 <sup>a</sup>	4.78 <sup>b</sup>	4.28 <sup>b</sup>	3.94 <sup>c</sup>	0.34*
HB (g/dl)	11.77 <sup>a</sup>	9.53 <sup>b</sup>	8.50 <sup>bc</sup>	7.87 <sup>c</sup>	0.67*
WBC ( $\times 10^3/\mu\text{l}$ )	10.20	11.20	11.67 <sup>ab</sup>	10.33	0.98 <sup>NS</sup>
MCV (fl)	59.88	59.98	59.98	64.50	7.45 <sup>NS</sup>
MCH (pg)	19.95	19.94	19.86	26.67 <sup>b</sup>	0.58 <sup>NS</sup>
MCHC (%)	33.30	33.25	33.23	28.67 <sup>b</sup>	0.083 <sup>NS</sup>
<b>Differential count</b>					
Neutrophil (%)	34.67	28.67	27.33	23.00	6.26 <sup>NS</sup>
Eosinophil (%)	1.67	0.67	0.00	0.00	0.97 <sup>NS</sup>
Lymphocyte (%)	75.00	72.67	70.67	65.33	5.96 <sup>NS</sup>
Monocytes (%)	0.33	0.00	0.00	0.00	0.94 <sup>NS</sup>

a, b and c = Means within the same row bearing different superscripts differ significantly ( $P < 0.05$ )

\*=Significant ( $P < 0.05$ ), NS= Not Significant ( $P > 0.05$ )

SEM= Standard Error of the Mean

PCV= Packed Cell Volume, Hb= Haemoglobin Concentration, RBC = Red Blood Cell Count, WBC = White Blood Cell Count, MCV = Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration.

experimental groups. The values ranged from 42.33-59.00 g/dl which exceeded the values (16-34 g/dl) reported by (10).

Albumin levels for T1, T2, T3 and T4 were 37.67, 28.00, 28.00 and 25.33 respectively. There were also significant ( $P < 0.05$ ) differences among the treatment groups. The values were also higher than the values (20-35 g/dl) reported by (11).

Globulin levels for T1, T2, T3 and T4 were 21.33, 14.33, 15.00 and 18.67 respectively. The values were within the range (15-35g/dl) reported by (12) for normal healthy broiler chickens. The values recorded for globulin showed that there were significant ( $P < 0.05$ ) differences among the treatment groups.

Glucose levels for T1, T2, T3 and T4 were

4.77, 4.70, 4.60 and 3.77 respectively. The values were lower than the values (10.36-12.95 mmol/L) reported by (13). The values recorded for blood glucose showed that there were significant differences among the treatment groups.

The levels of urea for T1, T2, T3 and T4 were 4.80, 5.80, 5.60 and 5.67 respectively. There were no significant ( $P > 0.05$ ) differences among the treatment groups. The values ranged from 4.80-5.80. They were found to be lower than the range (6.5-7.6) reported by (14).

The values obtained for alanine aminotransferase indicated that there were significant differences ( $P < 0.05$ ) among all the treatment groups. Alanine

**Table 5: Serum Biochemical Indices of Broiler Chickens Fed Diets Compounded with Commercial Concentrate and on-farm Formulated Concentrates**

Parameters	Experimental Diets/Treatments				SEM
	T1	T2	T3	T4	
Total protein (g/dl)	59.00 <sup>a</sup>	42.33 <sup>b</sup>	43.00 <sup>b</sup>	44.00 <sup>b</sup>	2.92*
Albumin (g/dl)	37.67 <sup>a</sup>	28.00 <sup>b</sup>	28.00 <sup>b</sup>	25.33 <sup>b</sup>	2.27*
Globulin (g/dl)	21.33 <sup>a</sup>	4.33 <sup>b</sup>	15.00 <sup>b</sup>	18.67 <sup>a</sup>	0.91*
Glucose (g/dl)	4.77 <sup>a</sup>	4.70 <sup>ab</sup>	4.60 <sup>ab</sup>	3.77 <sup>b</sup>	0.29*
Urea(mmol/l)	4.00	5.80	5.60	5.67	0.37 <sup>NS</sup>
ALAT (IU/L)	51.67 <sup>a</sup>	36.00 <sup>ab</sup>	29.00 <sup>ab</sup>	26.67 <sup>b</sup>	7.26*
ASAT (IU/L)	37.00 <sup>ab</sup>	74.00 <sup>a</sup>	33.00 <sup>b</sup>	28.67 <sup>b</sup>	11.83*
Creatinine (mmol/l)	63.67 <sup>a</sup>	42.67 <sup>b</sup>	39.33 <sup>b</sup>	41.33	4.86*
Conjugate Bilirubin (mmol/l)	1.97	1.37	1.700	1.600	0.34 <sup>NS</sup>
Total Bilirubin (mmol/l)	3.40	2.50	2.93	2.87	0.49 <sup>NS</sup>
AKL pho. (IU/L)	76.67	76.00	103.00	72.00	12.32 <sup>NS</sup>

a, b = Means within the same row bearing different superscripts differ significantly (P<0.05)

\*=Significant (P<0.05), NS= Not Significant (P>0.05)

SEM= Standard Error of the Mean

ASAT= Aspartate Aminotransferase, ALAT= Alanine Aminotransferase, ALK pho= Alkaline phosphate.

aminotransferase levels for T1, T2, T3 and T4 were 51.67, 36.00, 29.00 and 26.67 respectively. The values were higher than the values 16.87-26.57 reported by (15).

Aspartate aminotransferase levels for T1, T2, T3 and T4 were 37.00, 74.00, 33.00 and 28.67 respectively. The values obtained showed significant (P<0.05) differences among the experimental groups. The values for T1, T3 and T4 were within the range (18.00-53.33) reported by (15) while that of T2 was found to be higher than the range.

The values obtained for creatinine indicated that there were significant differences (P<0.05) among the experimental groups. Creatinine levels for T1, T2, T3 and T4 were 63.67, 42.67, 39.33 and 41.33. The values for T1, T3 and T4 were higher than the range (16.97-23.25) reported by (16).

Conjugate bilirubin levels for T1, T2, T3 and T4 were 1.97, 1.37, 1.700 and 1.600

respectively. The results showed that there were no significant (P>0.05) differences among the experimental groups. The results obtained were within the range (2.0-4.0 mmol/l) obtained by (10).

Total bilirubin level for T1, T2, T3 and T4 were 3.400, 2.50, 2.93 and 2.87 respectively. The results showed no significant (P>0.05) differences among the experimental groups. The results obtained were lower than the range (4-7.5 mmol/l) obtained by (10).

Alkaline phosphate values for T1, T2, T3 and T4 were 76.67, 76.00, 103.00 and 72.00 respectively. The result showed there were no significant (P>0.05) differences among the experimental groups. Values obtained in this study were lower than the range (226-260) reported by (10).

### Cost Benefit Analysis

The cost benefit analysis is presented in Table 6. The highest cost per kilogram feed (₦330/kg) was in T<sub>3</sub> (soya bean meal-based concentrate) compared to ₦329.04, ₦325.85, ₦315.15/kg, respectively for T<sub>1</sub>, T<sub>4</sub>, and T<sub>2</sub>. The lowest cost (₦315.15/kg) was obtained in T<sub>2</sub> (groundnut cake-based concentrate).

Feed cost per weight gain (₦801.91/kg) was lowest in T<sub>4</sub> (groundnut cake 50% + soya bean meal 50% based protein concentrate) and highest (₦1083.68/kg) in T<sub>1</sub> (commercial protein concentrate). (17) who fed broiler chickens universal protein concentrate

blended with milled cassava obtained a similar result. T<sub>4</sub> (groundnut cake 50% + soya bean meal 50% based protein concentrate) is better because of its low cost/ kg gain (₦801.91/kg) followed by T<sub>3</sub> (Soya bean-based protein concentrate) (₦814.03/kg).

Therefore, considering the weight gain and cost/kg gain, diets compounded with on-farm formulated protein concentrate can be fed to broiler chickens without adverse effects on growth and development, while reducing the costs of feeding the broiler chickens to market weight.

**Table 6: Cost benefit analysis of broiler chickens fed diets compounded with commercial and on-farm formulated protein concentrate**

Parameters	Treatments/Diets			
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
Initial body weight (g)	611.67	621.67	603.33	628.33
Final body weight (g)	1528.33	1823.00	1980.00	1890.00
Total feed intake (g)	3029.00	3178.34	3395.50	3123.33
Total feed intake (kg)	3.03	3.18	3.40	3.12
Total weight gain (g)	916.67	1201.33	1376.66	1261.67
Total weight gain (kg)	0.92	1.20	1.38	1.26
Cost/kg feed ( ? )	329.04	315.15	330.40	325.85
Total feed cost ( ? )	996.99	1002.18	1123.36	1010.41
Cost/kg gain ( ? /kg)	1083.68	835.15	814.03	801.91

Cost per kilogram of various feed ingredient used in compounding the experimental diets. Maize ? 220.00, Wheat offal ? 180.00, Groundnut cake ? 380.00, Soya bean meal ? 450.00, Fish meal ? 550.00, Bone meal ? 400.00, Lysine ? 1500.00, Methionine ? 2200.00, Salt ? 200.00 and Premix ? 2200.00.

T<sub>1</sub>= Commercial protein concentrate + Maize

T<sub>2</sub>= On- farm formulated groundnut cake-based protein concentrate + Maize

T<sub>3</sub>= On-farm formulated soya bean meal-based protein concentrate + Maize

T<sub>4</sub>= On-farm formulated groundnut cake 50% + soya bean meal 50% based protein concentrate + Maize

## Conclusion

1. Based on the results of this study, it can be concluded that diets compounded with commercial concentrates and on-farm formulated concentrates are suitable for feeding broiler chickens without detrimental effects on performance, haematology and serum biochemical indices.
2. Also, **there were differences between the diets formulated with commercial protein concentrate and on-farm formulated protein concentrates in terms of cost. The birds that fed on diets compounded with on-farm formulated protein concentrates had better feed cost/kg gain.**

## Recommendation

Based on the results of this study, it is recommended that the use of on-farm formulated concentrates to formulate broiler chickens' diets should be considered as an alternative to commercial concentrates or commercial diets in order to curtail the costs of broiler feeding.

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