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Effect Of Qualitative Feed Restriction In The Hot Season (April, May And June) On Broilers' Response

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Abstract:** 135 day- old broiler chicks were used in a study designed to evaluate the effects of different levels of feed restriction at the growing period on the physiological response and performance of broiler chickens under the humid tropical condition of hot season. The experiment consisted of three qualitative feed restriction treatment groups in three replicates of 15 birds per replicate. The treatments reflect the level of restriction imposed on the dietary crude protein (CP) content of feed offered: P1 (0% CP), P2 (20% CP), and P3 (40% CP). The experiment was framed in a Completely Randomized Design and was conducted in the hot season (April, May and June). Feed was restricted during the third, fourth and fifth weeks of age. Blood samples were collected from three birds in each of the replicates after two weeks of brooding just before the commencement of restricted feeding for the determination of baseline haematology and serum biochemical constituent values, and at the end of the fifth and eighth weeks. Results showed that the feed restriction experiments significantly (P < 0.05) reduced feed intake, weight gain, feed conversion ratio and water consumption. The serum biochemical constituents of the birds were also significantly (P < 0.05) reduced by treatments. Feed restriction, however increased the haematological profile of the birds, except for the heterophil: lymphocyte ratio which was increased during the restriction period but contrariwise was reduced during the refeeding period. Economic parameters were significantly (P < 0.05) affected by feed restriction. The highest revenue of production was obtained in the unrestricted treatment groups, while the best score of cost benefit ratio was obtained in the 20 % qualitative feed restriction group. Meteorological elements particularly ambient temperature and relative humidity were negatively correlated with broilers' response during the hot season. It was concluded that by restricting feed up to 20 % of protein content, broiler chickens in the humid tropics would perform optimally during the hot season of rearing without compromising profitability. Recommendations to improve the overall performance of the birds were made.

***Keywords:** qualitative, protein, broilers, feed, response, season*

I. INTRODUCTION

One of the methods of qualitative feed restriction is the use of low protein diets. Broilers require 22 % and 20 % dietary protein during the starting and finishing periods respectively for optimal growth (Dafwang, 2009). When dietary protein is marginally deficient, broilers respond by increasing feed intake (Maynard *et al.*,2019). However, when dietary protein deficiency is severe, broilers respond by eating less (Yu and Robinson, 1992). Chen *et a*l., (2018) reported that chickens were able to recover from reduced feed intake during refeeding period

Donmez and Karsli (2004) studied the effects of protein restriction on the live weight gain and some blood parameters of mature and immature rats and found that glucose and cholesterol levels were lower in rats fed diet containing 3 % protein compared with rats fed diet containing 10 % protein in both mature and immature groups, and that as crude protein concentration of diets increased, both feed intake and live weight gain significantly (P < 0.05) increased in both mature and immature rats.

Tissue culture and metabolism might be impaired during nutrient restriction resulting in reduced weight gain and growth rate (Saxena *et al.*, 2020). In addition to delay in growth, protein restriction has been reported to affect metabolism by changing hormonal status (Karaca *et al.*, 2003). When protein intake is insufficient, protein synthesis in the liver decreases, resulting in significant alteration in cellular protein (Donmez and Karsli, 2004). Rao *et al.* (2005) reported that decreasing dietary calorie- protein ratio caused significant reduction in abdominal fat deposition as a result of depressed hepatic lipogenesis and increased synthesis of uric acid, and Serum cholesterol level is inversely related to dietary protein level due to the cholesterogenesis depressing effect of high protein diet. This experiment was therefore designed to study the effect of qualitative feed (protein) restriction in the hot season (April, May and June) on broilers' response.

OBJECTIVES

- ✓ To determine the effect of qualitative feed restriction in the hot season on the performance of broiler chickens
- ✓ To determine the effects of qualitative feed restriction in the hot season on the hematological responses of broiler chickens
- ✓ To determine the effect of qualitative feed restriction in the hot season on the blood serum biochemistry of broiler chickens
- ✓ To determine the effects of qualitative feed restriction in the hot season on body temperature and respiration rate of broiler chickens
- ✓ To determine the economics of production

II. MATERIALS AND METHODS

LOCATION AND DESCRIPTION OF THE EXPERIMENTAL SITE

This second experiment, as in the previous one was conducted at the Teaching and Research Farm of the Department of Animal Production, Kogi State University, Anyigba located in the Derived Savannah of Nigeria on Latitudes 7^o15^1 and 7^0 29^1N of the equator and Longitudes 7^o11^1 and $7^0 32^1$ E of the Greenwich meridian (Ifatimehin *et al., 2006*).

EXPERIMENTAL LAYOUT AND PROCEDURE

A total of 135 day old broiler chicks were housed and brooded in open sided deep litter pens the floors of which were concrete basement, cleansed, disinfected, and covered with clean, dry wood shavings up to 5 cm thickness. Heat was provided from kerosene stoves placed under metal hoovers as described by Aduku (2004). The birds were vaccinated according to schedule against New Castle and Gumboro diseases (Goni, 1974). Other medications administered included proprietary antibiotics, coccidiostats and mineral-vitamin premix. Feed and water were provided *ad libitum.* At the end of two weeks stabilization period, the birds were randomly assigned to three (3) qualitative feed restriction treatment groups and four quantitative feed restriction treatment groups each in three replicates of 15 birds per replicate. The qualitative treatments reflect the level of restriction imposed on dietary crude protein (CP) content offered: P1 (0% CP), P2 (20% CP) and P3 (40% CP) corresponding to P1 (no reduction in CP), P2 (20 % reduction in CP) and P3 (40 % reduction in CP) of the diet. The experiment was framed in a completely randomized design.

All the birds in the trial were fed and watered between 07:00 and 08:00 hours daily. Feed intake per bird per day was determined by subtracting the quantity left over the following day from the quantity of feed given the previous day which was divided by the number of chicks fed. Feed was restricted during the third, fourth and fifth weeks of age, and thereafter all the chicks were fed a standard finisher ration containing 20% CP and 3000 Kcal ME/kg (Aduku, 2004) till the end of the eighth week. The ingredient composition of both the control and restriction diets is presented in Table 1.

Ingredients	Control	Finisher	P2 (20% CP) (Per cent CP restriction)	P3 (40% CP) (Per cent CP restriction)
Maize	28.90	35.00	31.30	45.30
FFSB	27.00	28.00	27.00	13.80
Blood meal	7.40	4.00	0.82	0.00
Maize offal	32.50	29.70	36.56	35.90
Bone meal	3.00	2.30	3.32	4.00
Methionine	0.70	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25
premix*	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00

Calculated Analysis

	Starter	Finisher	P2 (20 % CP)	P3 (40 % CP)
CP (%)	22.00	20.00	17.60	13.20
ME/Kcal/Kg	2929.00	3000.00	2929.00	2929.00
Ca (%)	1.24	0.98	1.34	1.55
P (%)	0.99	0.87	1.06	1.11
Methionine(%)	1.12	0.89	0.87	0.81
Lysine (%)	1.49	1.28	1.07	0.70

FFSB = Full fat soya beans ME = Metabolizable energy
**Contains the following/Kg of diet for 2.5 kg premix/tonne: Vit A - 13,340 I.U.; Vit. D3 - 2680 I.U. Vit. E - 10 I.U.; Vit K - 2.68 mg; Calcium Pantothenate - 10.68; Vit. B12 - 0.022 mg; Folic acid - 0.668 mg; Chloride - 400mg; Chlorotetracycline - 26.68mg; Manganese - 66.68mg; Zinc - 53.3 mg; Copper-3.20mg; Iodine - 1.86mg; Cobbalt - 0.268mg; Selenium - 0.108mg.*

Table 1: Ingredient Composition of the Control and Restriction Diets (%)

PARAMETERS MEASURED AND ANALYTICAL PROCEDURES

As in the previous experiment, blood samples were collected after two weeks of brooding just before the commencement of restricted feeding for the determination of baseline haematology and serum biochemical constituent values and at the end of the fifth and eighth weeks. The analyses were done at the Biochemistry Laboratory of Kogi State University using the Randox Equipment test kits (Model: BT 29 4QY, UK.) for serum biochemical constituents and the Automated Abascus Junior Analyser for the haematological indices.

Haematological indices measured were:

Total erythrocyte count (RBC), total leucocytes count (WBC), haemoglobin (Hb), mean corpuscular hemoglobin concentration (MCHC), packed cell volume (PCV), heterophils, lymphocytes, eosinophils, basophils and monocytes.

Serum biochemical constituents measured were:

Glucose, total protein, albumin, globulin, urea, aspartate amino transferase (AST), sodium, calcium, potassium, alanine amino transferase (ALT), triglicerides, cholesterol and creatinine..

Body temperature was determined by inserting a clinical thermometer into the vent for a period of one minute using a stop watch.

Respiration rate was taken by counting the flank movement of the birds for an uninterrupted period of one minute using a stop watch

Body weight was determined by weighing the birds at the beginning of the experiment and weekly thereafter.

Feed consumption was determined on daily basis as already indicated in the feeding procedure.

Feed conversion ratio was computed as ratio of mean daily feed consumption to mean daily weight gain.

Water intake: A known quantity of water was supplied to each pen and the quantity left the following morning was determined by difference to obtain the apparent water intake. In order to correct for evaporative loses, another quantity of water of the same volume as the one supplied to each of the pens was kept in the pen. Any difference obtained the following morning was taken as the apparent water loss due to evaporation.

Environmental parameters: Data for the following environmental indices were obtained from the Kogi State University, Anyigba meteorological sub-station: (a) relative humidity (b) wind velocity (c) solar radiation and (d) rainfall. Data on ambient temperature was obtained in the poultry house using an ordinary thermometer.

Economic parameters were determined according to the methods of Orheruata *et al*. (2006) and Cam (2014) as follows:

Revenue: Final body weight × cost / kg live weight

Gross margin: Revenue – total variable cost

Cost benefit ratio: Total cost / Total revenue

STATISTICAL ANALYSIS

Data obtained were subjected to analysis of variance and descriptive statistics using the Statistical Package for Social Sciences (SPSS), Version 16 (2007). Significant differences among treatment means were separated at 5% level by Least Significant Difference (LSD).

III. RESULTS

METEOROLOGICAL DATA

The average meteorological data during the experimental period is presented in Table 2 while the correlation coefficients (r) between the meteorological elements during the experimental period are presented in Table 3. Mean meteorological values during the experimental period in the hot season were 23.57 ± 1.28 °C, 29.10 ± 1.26 °C, 25.23 ± 1.08 °C, 82.87 ± 0.92 %, 5.78 ± 0.25 hours/day and 3.60 ± 1.02 km/hr for ambient temperature, dry- bulb temperature, wet- bulb temperature, relative humidity, solar radiation and wind velocity respectively.. Result of correlation coefficients (r) between meteorological elements showed that ambient temperature was positively correlated with dry- bulb and wet-bulb temperatures but negatively correlated with relative humidity, solar radiation and wind velocity. Wind velocity was positively and significantly correlated (P < 0.05; r = 0.99) with solar radiation.

Season	Environmental Elements					
	AT	DBT	WBT	RH	RAH	WIND
Hot	23.57±1.28	29.10±1.26	25.23±1.08	82.87±0.92	4.06±0.25	3.60±1.02

AT = Ambient temperature (°C)
DBT = Dry bulb temperature (°C)
WBT = Wet bulb temperature (°C)
RH = Relative humidity (%)
RAH = Solar Radiation (hours/day)
WIND = Wind Speed (km/hr)
SEM = Standard error of means

Table 2: Mean values (±SE) of Environmental data during the study period

Environmental Parameters	Parameters					
	AT	DBT	WBT	RH	RAH	WIND
AT	1:00					
DBT	0.70	1.00				
WBT	0.99*	0.79	1.00			
RH	–0.91	–0.34	–0.85	1.00		
RAH	–0.84	–0.98*	–0.90	0.54	1.00	
WIND	–0.81	–0.99*	–0.88	0.50	0.99*	1.00

** = Significant at P < 0.05*
AT = Ambient temperature (°C)
DBT = Dry bulb temperature (°C)
WBT = Wet bulb temperature (°C)
RH = Relative humidity (°C)
RAH = Solar Radiation (hours per day).

Table 3: Correlation coefficients (r) between environmental elements during the experimental period

EFFECTS OF QUALITATIVE FEED (PROTEIN) RESTRICTION IN THE HOT SEASON ON BROILERS

PERFORMANCE PARAMETERS

The results of the effects of protein restriction in the hot season on the birds are presented in Tables 4, 5, 6, 7, 8, 9, 10 and 11. The summary of analyses of variance showed significant differences (P < 0.05) across treatments for all the performance parameters studied during the restriction period, and these differences were still maintained throughout the refeeding period. The results showed that the full fed group had the highest feed intake of 4,290g while the 40 % restriction group had the lowest value of 1,475g. The full fed group also had the highest weight gain of 1,832g while the 40 % restricted group had the lowest value of 759g. Water consumption declined from 2919 ml in the full fed group to 1313ml in the 40 % restricted group.

PHYSIOLOGICAL RESPONSE

The physiological parameters of body temperature and respiration rates were not affected by treatments (P > 0.05). Blood haematology profile showed varying degrees of responses (Table 16) during the restriction period. The result showed that following realimentation, only red blood cells and monocytes did not show significant trend to treatment effects (P > 0.05). H: L ratio was similar for the full fed and 20 % restriction groups (1.01 and 1.03 respectively). The results also showed significant treatment effects for all the serum biochemical constituents studied both during the feed restriction period and also after realimentation, except for alanine amino transferase (ALT).

ECONOMIC PARAMETERS

Analyses of variance also revealed significant effects of treatments on economic indices of performance studied (Table 4). The highest revenue of N1, 658.00 was obtained in the full fed group while the lowest revenue was obtained in the 40 % restricted group. The full fed and 20 % restricted groups had similar (P < 0.05) cost benefit ratios of 0.45 and 0.47 respectively which were significantly lower (P < 0.05) than that of the 40 % restricted group (0.53).

Parameters	Treatments (Levels of restriction)			SEM	LOS
	0%	20%	40%		
Initial body wt (g)	340	342	340	1.28	NS
Final body wt (g)	1148^{a}	933^{b}	638^{c}	73.82	*
Weight gain (g)	808^{a}	591^{b}	298^{c}	73.72	*
Feed intake (g)	1450^{a}	945^{b}	513^{c}	135.27	*
Feed: gain	1.79^{a}	1.60^{c}	1.72^{b}	0.02	*
Feed cost/bird (₦)	135^{a}	80^{b}	38^{c}	14.17	*
Feed cost/kg gain (₦)	174^{a}	136^{b}	129^{b}	7.12	*
Water consumption (ml)	1295^{a}	980^{b}	770^{c}	362.95	*
Body temperature (°C)	41.0	41.0	41.15	0.05	NS
Respiration rate (breaths/min)	34.00	34.67	33.67	0.42	NS

a, b, c = Means with different superscripts on the same row differ significantly (P < 0.05)
NS = Not significant
SEM = Standard error of means
LOS = Level of significance
** = Significant at P < 0.05*

Table 4: Performance of broiler chickens reared on restricted dietary protein regime in the hot season

Parameters	Treatments (Levels of restriction)			SEM	LOS
	0%	20%	40%		
Initial body wt (g)	1148^{a}	934^{b}	639^{c}	73.841	*
Final body wt (g)	2172^{a}	1520^{b}	1100^{c}	156.03	*
Weight gain (g)	1024^{a}	596^{b}	461^{c}	84.84	*
Feed intake (g)	2840^{a}	1465^{b}	962^{c}	280.66	*
Feed: gain	4.19^{a}	4.04^{b}	3.20^{c}	0.09	*
Feed cost/bird (₦)	296^{a}	153^{b}	100^{c}	29.41	*
Feed cost/kg gain (₦)	284^{a}	198^{b}	186^{c}	10.60	*
Water consumption (ml)	1624^{a}	980^{b}	560^{c}	154.73	*
Body temperature (°C)	40.9	40.1	40.95	0.04	NS
Respiration rate (breaths/min)	33.00	33.33	32.67	0.37	NS

a, b, c = Means with different superscripts on the same row differ significantly (P < 0.05)
NS = Not significant
SEM = Standard error of means
LOS = Level of significance
** = Significant at P < 0.05*

Table 5: Performance of broiler finishers reared on recommended dietary protein refeeding regime in the hot season

Parameters	Treatments (Levels of restriction)			SEM	LOS
	0%	20%	40%		
Initial body wt (g)	340^{a}	342^{b}	340^{c}	1.06	NS
Final body wt (g)	2172^{a}	1519^{b}	1099^{c}	155.85	*
Weight gain (g)	1832^{a}	1177^{b}	759^{c}	155.99	*
Feed intake (g)	4290^{a}	2410^{b}	1475^{c}	414.19	*
Feed: gain	2.34^{a}	2.05^{b}	1.94^{c}	0.06	*
Feed cost/bird (₦)	432^{a}	233^{b}	139^{c}	43.26	*
Feed cost/kg gain (₦)	236^{a}	198^{b}	183^{c}	7.97	*
Water consumption (ml)	2924^{a}	1960^{b}	1345^{c}	231.21	*
Body temperature (°C)	40.9	40.1	40.95	0.03	NS
Respiration rate (breaths/min)	30.67	31.33	31.67	0.36	NS

a, b, c = Means with different superscripts on the same row differ significantly (P < 0.05)
NS = Not significant
SEM = Standard error of means
LOS = Level of significance
** = Significant at P < 0.05*

Table 6: Overall performance of broiler chickens reared on restricted dietary protein regime (3–8 weeks) in the hot season

Parameters	Treatments (Levels of restriction)			SEM	LOS
	0%	20%	40%		
PCV (%)	37.81	38.19	38.02	0.44	NS
Hb (g/l)	157	169	164	6.72	NS
RBC ($\times 10^{12}$/l)	6.94^{b}	8.23^{a}	6.19^{b}	0.70	*
WBC ($\times 10^{9}$/l)	7.69^{b}	8.48^{a}	6.69^{c}	0.89	*
MCHC (g/l)	231	232	221	4.93	NS
Heterophils(%)	47.11	49.78	51.67	1.81	NS
Lymphocytes(%)	46.78	45.89	45.89	1.97	NS
H:L	1.04	1.08	1.16	0.08	NS
Eosinophils (%)	1.00^{a}	0.33^{b}	0.44^{b}	0.19	*
Basophils (%)	0.11^{b}	5.60^{a}	5.89	1.03	*
Monocytes (%)	3.33^{a}	2.89^{a}	0.89^{b}	0.39	*

$^{a, b, c}$ = Means with different superscripts on the same row differ significantly (P < 0.05)
NS = Not significant;
LOS = Level of significance;
** = Significant at P < 0.05;*
SEM = Standard error of means;
PCV =Packed cell volume;
Hb = Haemoglobin;
RBC =Red blood cell;
WBC = White blood cell;
MCHC = Mean corpuscular hemoglobin concentration;
H: L = Heterophil/lymphocyte ratio

Table 7: Haematological indices of broiler chickens reared on restricted dietary protein regime in the hot season

Parameters	Treatments (Levels of restriction)			SEM	LOS
	0%	20%	40%		
PCV (%)	39.27^{a}	38.50^{b}	38.09	0.35	*
Hb (g/l)	192.04^{b}	199.52^{b}	203.31^{a}	2.07	*
RBC (× 10^{12}/l)	7.86	8.27	8.48	0.56	NS
WBC (× 10^{9}/l)	6.54^{c}	7.53^{b}	8.85^{a}	0.43	*
MCHC (g/l)	217^{c}	271^{bc}	253^{a}	11.84	*
Heterophils (%)	50.89^{a}	48.78^{a}	45.89^{c}	1.56	*
Lymphocytes(%)	42.33^{b}	48.22^{a}	46.56^{b}	2.05	*
H:L	1.22^{a}	1.01^{b}	1.03^{b}	0.74	*
Eosinophils (%)	0.56^{b}	1.00^{a}	1.11^{a}	0.20	*
Basophils (%)	0.22^{b}	0.22^{b}	0.56^{a}	0.07	*
Monocytes (%)	6.00	6.22	5.67	0.47	NS

$^{a, b, c,}$ = Means with different superscripts on the same row differ significantly (P < 0.05)
NS = Not significant
LOS = Level of significance
** = Significant at P < 0.05*
SEM =Standard error of means
PCV = Packed cell volume
Hb = Hemoglobin
RBC = Red blood cell
WBC = White blood cell
MCHC = Mean corpuscular hemoglobin concentration; H: L=Heterophil/lymphocyte ratio

Table 8: Haematological indices of broiler finishers reared on recommended dietary protein refeeding regime in the hot season

Parameters	Treatments (Levels of restriction)			SEM	LOS
	0%	20%	40%		
Total protein (g/dl)	2.20^{a}	1.80^{a}	1.14^{b}	1.19	*
Albumin (g/dl)	0.92^{a}	0.256^{b}	0.19^{c}	0.11	*
Globulin (g/dl)	1.27^{c}	1.56^{b}	0.96^{a}	0.13	*
Glucose (mg/dl)	117^{a}	106^{b}	91^{c}	3.91	*
AST (mg/l)	49.37^{a}	43.63^{b}	4.04^{c}	1.48	*
ALT (mg/l)	5.85^{a}	3.47^{b}	3.05^{c}	0.66	*
Triglycerides (mg/dl)	693^{a}	614^{b}	460^{c}	42.12	*
Creatinine (mg/dl)	5.11^{a}	1.32^{b}	0.78^{b}	1.12	*
Urea (mg/dl)	3.12^{a}	2.33^{b}	1.78^{c}	0.36	*
Cholesterol (mg/dl)	191^{a}	167^{b}	121^{c}	28.27	*
Sodium (mg/dl)	9.25^{a}	8.92^{b}	8.68^{b}	0.18	*
Potassium (mg/dl)	0.67^{a}	0..62^{a}	0.53^{b}	0.03	*
Calcium (mg/dl)	8.32^{a}	7.94^{a}	5.03^{b}	0.56	*

$^{a, b, c}$ = Means with different superscripts on the same row differ significantly (P < 0.05)
NS = Not significant
LOS = Level of significance
** = Significant at P < 0.05*
SEM = Standard error of means
AST = Aspartate amino transferase;
ALT = Alanine amino transferase

Table 9: Serum biochemical constituents of broiler chickens reared on restricted dietary protein regime in the hot season

Parameters	Treatments (Levels of restriction)			SEM	LOS
	0%	20%	40%		
Total protein (g/dl)	3.83^{a}	3.58^{b}	2.47^{b}	0.24	*
Albumin (g/dl)	0.21^{a}	0.18^{b}	0.18^{b}	0.01	*
Globulin (g/dl)	3.62^{a}	3.39^{a}	2.31^{b}	0.24	*
Glucose (mg/dl)	125^{a}	119^{a}	77^{b}	7.92	*
AST (mg/l)	51.97^{a}	52.20^{a}	44.43^{b}	1.36	*
ALT (mg/l)	6.89	6.13	4.79	0.48	NS
Triglycerides (mg/dl)	730^{a}	700^{a}	566^{b}	34.12	*
Creatinine (mg/dl)	2.06^{a}	1.26^{b}	0.97^{c}	0.31	*
Urea (mg/dl)	3.99^{a}	3.26^{b}	2.25^{c}	0.44	*
Cholesterol (mg/dl)	238^{a}	115^{ab}	94^{b}	28.13	*
Sodium (mg/dl)	10.27^{a}	9.75^{a}	8.42^{b}	0.38	*
Potassium (mg/dl)	0.85^{a}	0.85^{a}	0.72^{b}	0.03	*
Calcium (mg/dl)	9.03^{a}	8.81^{b}	7.20^{c}	0.34	*

$^{a, b, c}$ = Means with different superscripts on the same row differ significantly (P < 0.05)
NS = Not significant
LOS = Level of significance
** = Significant at P < 0.05*
SEM = Standard error of means
AST = Aspartate amino transferase;
ALT = Alanine amino transferase

Table 10: Serum biochemical constituents of broiler finishers reared on recommended dietary protein refeeding regime in the hot season

Parameters	Treatments (Levels of restriction)			SEM	LOS
	0%	20%	40%		
Revenue (₦)	1658^{a}	1146^{b}	825^{c}	121.28	*
Cost of production (₦)	740^{a}	536^{b}	439^{C}	44.33	*
Cost of day old (₦)	185	185	185	-	-
Variable cost (₦)	253	253	253	-	-
Feed cost/bird (₦)	482^{a}	278^{b}	181^{c}	44.33	*
Gross margin (₦)	554^{a}	532^{a}	268^{b}	54.33	*
Cost benefit ratio	0.45^{b}	0.47^{b}	0.53^{a}	0.01	*
Cost saving (₦)	-	204	301	-	-

$^{a, b, c}$ = Means with different superscripts on the same row differ significantly (P < 0.05)

NS = Not significant
SEM = Standard error of means
LOS = Level of significance
** = Significant at P < 0.05*

Table 11: Economic performance of broiler chickens reared on restricted dietary protein regime in the hot season

IV. DISCUSSION

PERFORMANCE PARAMETERS

The reduction in all performance parameters as the severity of feed restriction increases is a direct outcome of feed restriction (Makinde, 2012). Nutrients needed for growth and tissue accretion come from feed; therefore, feed restriction should impede growth. However, compensatory growth usually occurs on re-alimentation due to a complex interplay of hormonal and nutritional factors (Ghazanfari *et al*., 2010). Restricted birds under this study were not able to compensate fully probably due to shortness of the period of the restriction or period of re-alimentation. Ryan (2012) reports that the period of restriction must be long enough to ensure adaptation to the lower plane of nutrition in order for compensatory growth to be realized. Yu and Robinson (1992) also reported that the more severe the restriction, the greater is the initial compensatory growth upon refeeding but the extent to which an animal can recover in the longer term diminishes with increasing severity of restriction, and that the longer the duration of feed restriction, the more difficult it is for the animal to compensate for the loss in body weight upon refeeding.

In the present study, broilers fed low protein diet showed reduced weight gain, feed intake and feed conversion ratio compared with controls. These results are in agreement with those of (Saxera *et al.*, 2020) who found that decreasing the protein content of isocaloric diets resulted in depressed body weight gain. Nguyen and Bunchasak (2005) indicated that lower protein diet (17 % CP) reduced live body weight and daily weight gain at early ages, while Ghazanfari et al. (2010) found that dietary protein levels higher than 17 % CP did not show any significant effect on growth performance and utilization. Ronning *et al.* (2009) and Chen *et al*. (2018) reported that increasing dietary protein levels positively improved growth performance and feed utilization.

PHYSIOLOGICAL RESPONSE

The physiological indices of body temperature and respiration rates were not affected by treatments. The average rectal temperature range of 40.1 - 40.95 and respiration rates range of 30.67-33.33 obtained in this study agrees with values reported in literature for breeds kept in the tropics (Williamson and Payne, 1978 and Wilson and Vohra, 1980) This result could be a reflection of the adaptability of the birds to the tropical environment of Nigeria where this experiment was conducted. Isidahomen *et al.* (2012) reported that rectal temperature, pulse rate and respiratory rates are the most important determinants in the adaptation of poultry to the tropical environment and that they determine to a large extent, the profitability of the poultry enterprise. It is apparent that feed restriction regimes could not alter the stability of the adaptive features of the birds that form the threshold of physiological adaptation to the hot tropical environment.

Feed restriction increased the levels of haematological indices both during the restriction period and refeeding period, except for the Heterophil: Lymphocyte ratio (H:L) which was increased during the restriction period but was reduced during the realimentation period. This result agrees with the works of Jang *et al.* (2009), Ronning *et al.* (2009) and Raghavan *et al.* (2012) that feed restriction improves blood haematology profile. The best Haematological responses were obtained in the 20% protein restriction group. This observation suggests that these restriction levels may have haemapoietic properties for the restricted birds. White blood cells and heterophils are involved in defence and phagocytic activities of the body against invading foreign bodies (Leigh *et al.*, 2010). The findings in this study suggests that restricting feed qualitatively up to 20% could improve immune vigilance and enhance the birds' defenses against infections. The increase in eosinophils during realimentation could also be an indication of increased response against parasitic diseases.

Serum transaminase parameters of alanine amino transferase (ALT) and aspartate amino transferase (AST) were also reduced by treatments. ALT is present in the liver and other cells and is useful in measuring or assessing hepatic necrosis (Cornelius, 1989). An increase in serum AST is associated with cell necrosis of many tissues (Kaneko, 1989). The results of this study may therefore suggest improved liver and kidney function for the birds within the confines of feed restriction levels imposed.

ECONOMIC PARAMETERS

The cost benefit ratio and gross margin for the protein restricted birds were similar for the full fed and 20% restricted groups. This result is in agreement with the report of Yu and Robinson (1992) and Makinde (2012) that economic performance with restricted feeding is always better than with full feeding as a result of improvements in feed conversion rates.

V. CONCLUSION AND RECOMMENDATIONS

CONCLUSION

The final performance expression of the broiler chickens was the result of interactions between the environmental and nutritional factors to which they were exposed. The performance of the restricted birds, though affected during the restriction period leading to significant reduction in feed intake and weight gain improved during realimentation at the finisher stage. Though they could not attain the same body weight with the full fed group at eight weeks of age, they had better feed utilization index of conversion ratio.

Feed restriction improved the physiological disposition of the birds. Consequently, it appeared that the broiler chickens were in their most optimal physiological status at 20 % qualitative feed restriction group.

The immune vigilance of the birds and their defenses against infections appeared to have been improved through feed restriction. Improved liver and kidney functions were also indicated for the broiler chickens.

Feed restriction did not alter the stability of the adaptive features of the birds that form the threshold of physiological adaptation to the hot tropical environment. The broiler chickens used for this study seemed to be adapted to the humid tropical environment of Nigeria where the experiment was conducted.

Early age feed restriction gave an economic advantage over *ad libitum* feeding. This study showed that by restricting feed during the rearing period, cost of production of broiler chickens can be reduced, and it was lowest when feed restriction was 20 % of protein content of the feed.

RECOMMENDATIONS

The result of this study has shown that the present full feeding management procedure whereby broiler chickens are fed *ad libitum* from day old to market age may be less than optimal with respect to broilers performance and productivity. It is hereby recommended that:

- ✓ Feed restriction programmes of sufficient duration and severity should be practiced in the production of broiler chickens for improved overall performance of the birds.
- ✓ The age of the broiler chickens at which the restriction program should commence should not be earlier than two weeks to enable the birds to have stabilized before exposing them to the stress of feed restriction.

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