
EFFECTS OF DIFFERENT PROTEIN LEVELS ON CARCASS CHARACTERISTICS OF BROILER CHICKENS DURING RAINY SEASON IN SEMI-ARID REGION IN SOKOTO, NIGERIA

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Abstract

Carcass characteristics of commercial broiler chickens were studied in semi-arid region of Sokoto state, Nigeria using 80 experimental birds that lasted for 21 days during rainy season. The experiment comprises of 4 treatments and the birds were fed isocaloric (3000 kcal/kg ME) and varying protein levels diets containing 21, 22, 23 and 24% CP denoted as T1, T2, T3 and T4 in a complete randomized design. At the end of the finisher phase analysis of carcass characteristic was conducted. Data obtained were statistically analyzed using SPSS version 21 computer package program. The results showed that characteristics did not differ significantly ($P>0.05$) except live weight, dressed weight and abdominal fat ($P<0.05$). It is concluded that dietary energy (3100kcal/kg ME) and 21% - 22% CP recorded highest live weight, dressed weight and abdominal fat in broiler chickens during rainy season.

Keywords: Broiler chicken, crude protein, carcass yield, semi-arid region, Nigeria

Introduction

Protein from chicken meat and eggs remains one of the most affordable sources of animal protein for human consumption. Broiler production is widely practiced in tropical regions, especially in African countries such as Nigeria, where the poultry sector is expanding (Kpomasse et al., 2021). However, seasonal variations significantly influence broiler productivity. In tropical environments like Nigeria, seasonality is a major non-genetic factor affecting poultry

performance. Broilers achieve optimal feed intake and weight gain when raised within their thermal comfort zone. While growth performance is partly hereditary, environmental conditions exert substantial influence.

In modern broiler production systems, genotype and environment are the two principal determinants of output. Numerous studies have shown that ambient temperature plays a crucial role in broiler production, influencing performance and contributing to economic losses (Bartlett & Smith, 2003; Huang et al., 2012; Attia & Hassan, 2017). Physiological stress induced by unfavorable environmental conditions can impair growth and overall performance in meat-type chickens (Mashsly, 2004), posing persistent challenges to both farmers and researchers. Currently, climatic variability represents a major threat to poultry production, particularly for smallholder farmers who rely on open housing systems (Osti, 2017). In Nigeria, seasonal shifts strongly affect commercial broiler production, with environmental conditions during rearing influencing carcass quality. Against this backdrop, the present study was conducted to examine the effects of the rainy season on the carcass characteristics of broilers.

Literature Review

Poultry as a Source of High-Quality Protein

Chicken meat and eggs are rich in essential amino acids, which are vital for growth, tissue repair, and overall health. According to Gakhar et al. (2012), poultry protein has a higher biological value compared to plant-based protein, making it more efficient in meeting human dietary requirements. Eggs, often termed a “complete food,” contain all essential amino acids in adequate proportions, making them especially valuable in combating protein-energy malnutrition in vulnerable groups such as children and the elderly.

Contribution to Micronutrient Intake

Beyond protein, poultry products contribute significantly to micronutrient intake. Chicken meat provides heme iron, zinc, and B vitamins such as niacin and vitamin B12, which are essential for hemoglobin synthesis and neurological function (Mottet & Tempio, 2017). Similarly, eggs are a source of fat-soluble vitamins A, D, E, and K, as well as minerals like selenium, iodine, and phosphorus. These nutrients play a critical role in immune system support, bone development, and cognitive health.

Poultry Products and Human Health

Regular consumption of poultry meat and eggs has been linked to positive health outcomes. Lean chicken meat, being lower in fat compared to red meat, contributes to cardiovascular health by

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reducing saturated fat intake (Caro et al., 2018). The presence of omega-3 fatty acids in eggs also supports brain function and reduces the risk of chronic diseases. Moreover, poultry protein has been shown to enhance satiety, thereby aiding in weight management (Magalhães et al., 2021).

Role in Food Security and Nutrition in Developing Countries

In developing countries, poultry production is a vital strategy to alleviate malnutrition and hunger. Its relatively short production cycle and low capital investment requirements make it accessible to smallholder farmers and rural households (Tadelle et al., 2013). Eggs and chicken meat are often the first animal-source foods introduced in children's diets, helping to bridge nutrient gaps where diets are predominantly cereal-based. Thus, poultry contributes directly to achieving Sustainable Development Goal 2 (Zero Hunger).

Affordability and Accessibility

Compared to other livestock products, poultry is relatively affordable, making it a crucial protein source for low- and middle-income populations. Poultry meat production has increased steadily due to efficient feed conversion ratios and lower production costs compared to cattle and small ruminants (FAO, 2020). This affordability ensures wider access to high-quality animal protein across socioeconomic classes.

Influence of Environmental Factors on Broiler Productivity

While genetic improvement has enhanced broiler growth rates and feed efficiency, environmental conditions remain critical determinants of productivity. Seasonality, particularly in tropical climates, is considered a major non-genetic factor influencing poultry performance. Broilers achieve their optimal feed intake and weight gain only within a defined thermal comfort zone. Exposure to unfavorable conditions, such as heat stress or excessive cold, results in reduced growth performance and poor carcass yield (Bartlett & Smith, 2003; Huang et al., 2012).

Climatic Variability and Physiological Stress

Environmental stressors, especially ambient temperature fluctuations, have been shown to impair physiological functions in poultry. Heat stress, for example, disrupts metabolic processes, reduces feed intake, and compromises nutrient utilization efficiency, leading to economic losses (Attia & Hassan, 2017). Similarly, Mashly (2004) reported that physiological stress induced by extreme weather conditions negatively affects broiler growth, immunity, and survival rates. These constraints are particularly pronounced in tropical environments where temperature and humidity variations are high.

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Seasonal Variation and Poultry Production in Nigeria

Climatic variability presents one of the most persistent challenges for poultry production in Nigeria. The reliance on open housing systems by smallholder farmers exacerbates the vulnerability of birds to environmental stress (Osti, 2017). Seasonal shifts, especially during the rainy and dry seasons, have been linked to changes in feed intake, growth performance, and carcass characteristics. Studies have shown that broilers raised under favorable seasonal conditions attain better carcass quality and overall performance compared to those reared during periods of climatic stress.

Carcass Characteristics as Indicators of Production Efficiency

Carcass characteristics, including dressing percentage, prime cuts, and fat deposition, serve as important indicators of production efficiency in broilers. Environmental factors such as temperature and humidity influence not only growth rate but also carcass composition and meat quality. Seasonal variation, therefore, does not only determine live weight performance but also affects consumer-preferred carcass traits, which are critical for market competitiveness.

Methodology

Study Area

Sokoto State is located in northwestern Nigeria, near the confluence of the Sokoto and Rima rivers. The state lies within the dry Sahel zone, characterized by sandy savannah and scattered hills (Nigeria Galleria, 2017). Vegetation ranges from short-grass savannah in the south to thorn scrub in the north, covering a total land area of 26,648.48 km². It lies between longitude 5.24°N and latitude 13.06°E at an altitude of 265 meters above sea level (Sokoto Geographical Data, 2019). The state experiences the Harmattan season, a cold, dry, and dusty wind, between November and February, with temperatures dropping to an average of 24.5°C. The Harmattan lasts for about 1.6 months (December–January), during which average daily high temperatures remain below 32.8°C. January is typically the coldest month, with minimum and maximum temperatures averaging 16.7°C and 31.1°C, respectively (Mamman et al., 2000).

Experimental Design

A total of 80 day-old Marshall Strain broiler chicks were used in a feeding trial arranged in a completely randomized design. The chicks were assigned to four dietary treatments, each comprising 20 birds. Each treatment was further divided into four replicates of five chicks per replicate.

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Experimental Birds and Management

The chicks were sourced from Zartech, Ibadan. Before their arrival, brooding pens and equipment (feeding trays and water troughs) were cleaned and disinfected. Wood shavings were spread as litter material, and continuous lighting was provided with 200-watt bulbs. During the first two days, chicks were fed on trays to facilitate acclimatization before being placed on experimental diets. Feed and water troughs were cleaned daily, with leftover feed weighed to assess intake. Apparent nutrient retention was determined at the end of the starter phase. The birds were raised in well-ventilated, sanitized deep-litter pens under standard management, medication, and vaccination practices (Oluyemi & Roberts, 2000). The trial was conducted during the rainy season, from the third week of July to September 2018.

Experimental Diets

Four experimental diets were formulated to contain varying protein levels of 21%, 22%, 23%, and 24% crude protein (CP), each with an energy level of 3000 kcal/kg ME. The gross and calculated nutrient composition of the diets is presented in Table 1.

Table 1: Gross and calculated chemical composition of experimental diets fed to broilers at finisher (4-6wks)

Ingredient (%)	T1 (19%CP)	T2 (20%CP)	T3 (21%CP)	T4 (22%CP)
Maize	63	60	57.5	55
Soya beans meal	4	5	7	8
Groundnut cake	9	11	12	14
Wheat offal	13	13	12.5	12
Blood meal	6	6	6	6
Lime stone	1.5	1.5	1.5	1.5
Bone meal	1.5	1.5	1.5	1.5
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated Chemical Composition				
Metabolizable energy (kcal/kg)	3100	3100	3100	3100
Crude protein (%)	19.0	20.0	21.0	22.0
Crude fibre (%)	4.2	4.6	4.8	5.0
Ether extract (%)	4.4	4.5	4.6	4.5
Calcium (%)	9.0	1.0	1.0	1.0
Phosphorus (%)	4.4	4.3	4.5	5.0
Methionine (%)	0.5	0.5	0.5	0.5

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Lysine (%)	1.0	1.0	1.0	1.0
Premix: Vitamin A 30000000 i.u., Vitamin D3 000000 i.u; VitE 30000 i.u; Vitamin K 2000mg, Vitamin B2 30000mg, Vitamin C30g, Niucin40000mg, panthothemic acid 12000mg, Vitamin B61500mg, Vitamin B12 100000mg , Folic Acid 1000mg, Biotin 400mg, Choline chloride 300000mg, Cobalt 200mg, Copper 1200mg, Iodine 2000mg, Iron 40000mg, Manganese 100000mg, Selenium 150mg, Zinc 30mg, Antioxidant 1250mg.				

Carcass evaluation

Two birds per replicate were used to assess dressed weight, carcass weight, and dressing percentage. Prior to weighing, the birds were starved overnight, and slaughtering was carried out the following morning. Defeathering was performed after immersing the birds in hot water for 2–3 minutes. The prime cuts (thigh, drumstick, wing, back, and breast) and internal organs (intestine, gizzard, crop, heart, liver, and abdominal fat) were carefully removed. Carcass yield was measured using a digital scale. The weights of the internal organs were expressed as a percentage of dressed weight, while the weights of the prime cuts were expressed as a percentage of dressing weight. The procedure followed was as outlined by Akinwumi et al. (2013).

$$\frac{\text{Warm carcass}}{\text{Live weight}} \times 100$$

Statistical Analysis

Data generated were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of the SPSS statistical package. Statistical significance was set at $P < 0.05$. Where significant differences were observed, means were separated using Duncan's Multiple Range Test (DMRT) as described by Steel and Torrie (1980).

Results and Discussions

The carcass characteristics of broiler chickens are presented in Table 2. No significant differences ($P > 0.05$) were observed among the treatments for most of the parameters measured, except for live weight, dressed weight, and abdominal fat weight ($P < 0.05$). Birds fed diets 3 and 4 had comparable live, dressed, and abdominal fat weights, which were significantly higher ($P < 0.05$) than those of birds fed diets 1 and 2.

Table 2: Carcass Characteristics of Broilers fed at varying protein levels during rainy season

Parameter	T ₁ (19%CP)	T ₂ (21%CP)	T ₃ (21%CP)	T ₄ (22%CP)	SEM
Live weight (g)	800.00 ^b	800.00 ^b	1275.00 ^a	1200.00 ^a	98.433
Dressed weight (%)	68.33 ^b	66.25 ^b	1125.00 ^a	1066.75 ^a	112.05
Breast (%)	19.97	20.59	23.73	22.04	25.04
Thigh (%)	4.18	4.13	3.98	3.82	4.787
Back (%)	6.54	5.98	6.99	6.88	6.830
Drum Stick (%)	4.45	4.34	4.05	4.37	4.351
Wing (%)	3.68	3.79	3.05	3.02	3.840
Head (%)	0.25	0.25	0.16	0.54	0.188
Neck (%)	4.05	4.12	3.99	3.81	4.161
Leg (%)	2.25	2.35	1.89	1.86	2.130
Lungs(%)	0.65	0.45	0.58	0.56	0.677
Gizzard (%)	3.44	2.60	2.65	2.54	3.024
Intestine (%)	4.44	4.16	5.04	4.86	0.116
Abdominal fat (%)	0.65 ^b	0.98 ^b	3.63 ^a	1.43 ^{ab}	1.380
Liver (%)	3.21	2.58	2.67	2.25	3.340
Crop (%)	0.79	0.78	0.72	0.69	0.162
Heart (%)	0.78	0.56	0.68	1.20	0.460
Spleen (%)	0.76	0.96	1.39	0.35	0.074

abc means bearing different superscripts along the same row differed (P<0.05)

The results indicated that the pre-slaughter live weight of broilers differed significantly (P≤0.05) among treatments. This finding contradicts the report of Islam et al. (2019), who observed that seasons had no effect on pre-slaughter live weights. Similarly, contrary to the present results, Kamran et al. (2008) suggested that carcass composition of broilers is influenced by dietary crude protein (CP) and amino acid (AA) status, with reduced CP levels leading to increased carcass fat and decreased carcass protein content. In contrast, our results are in agreement with the findings of Hoque (2011), who also reported a higher dressing percentage during the rainy season (P<0.05). However, most cut-up parts such as drumsticks, thighs, back, and neck were not significantly affected by season. Likewise, giblet yields were not influenced by seasonal variation, which is consistent with the findings of Sarma et al. (2020), who reported that the mean percentage yield of giblets among different seasons did not differ significantly (P>0.05).

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Conclusion

Based on the findings of the study, it can be concluded that dietary formulations with 3100 ME/kg and 21–22% crude protein during the rainy season optimize initial weight, dressed weight, and abdominal fat deposition in broilers. This recommendation is particularly applicable to climatic regions with annual temperature ranges between 25.6°C (minimum) and 35.5°C (maximum), and rainfall patterns ranging from 86 mm to 211 mm. However, further research is recommended to validate and strengthen the present findings.

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