PERFORMANCE INDICATORS, HAEMATOLOGY AND BIOCHEMICAL INDICES OF GROWING PULLETS UNDER TWO REARING MANAGEMENT SYSTEMS

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Abstract
Performance indicators, haematological profiles, and serum biochemical indices of growing Bovan nera pullets (n=576) at week 12 weighing 1.06 ± 0.01-1.08 ± 0.03kg/pullet. Pullets were reared under two housing management systems: deep litter system (DLS) and battery cage system (BCS). The pullets were divided into two groups each having 288 birds per rearing management in a completely randomised design. A grower diet containing metaboliseable energy; 2,781.38 Kcal/kg and crude protein; 16.18% was formulated and fed offered *ad libitum* to the pullets. Data were subjected to t-test analysis at $\alpha_{0.05}$ using the General Linear Model Procedure and significant means separated by Duncan Multiple Range option of General Linear Model procedure of SAS. Feed intake, weight gain, and feed conversion ratio showed no significant ($p>0.05$) differences between rearing management systems. Haemoglobin (Hb), Packed Cell Volume (PCV), and Red Blood Cell (RBC) counts remained within physiological norms across treatments indicating no adverse health effects. However, there were significant ($p<0.05$) differences in Albumin (AL), Albumin/Globulin (AL:GL) ratio, and Phosphorus (P) levels with birds in DLS showing higher values ($p<0.05$). The results showed enhanced protein metabolism and mineral utilization due to increased physical activity of pullets in DLS. There were no significant differences in lipid profiles or liver enzyme activities, indicating metabolic stability of birds in both rearing management. In conclusion, growth performance and haematological indices were not affected but serum albumin, albumin/globulin ratio, and phosphorus levels vary with rearing management. The deep litter system supported enhanced immune function and energy metabolism, due to increased bird activity

Key words: Housing systems, pullets, haematology, serum biochemistry, poultry performance

Description of the Problem

Poultry products especially eggs offer affordable, high-quality protein and micronutrients vital for human nutrition [1]. However, in Nigeria and many other developing countries, achieving efficient and sustainable poultry production remains a major challenge due to limitations in rearing management, feed quality, climate stress, and general husbandry practices [2]. Commercial egg production in Nigeria is largely reliant on exotic chicken strains bred and optimized for performance under temperate environmental conditions, often within controlled battery cage systems. These systems allow for high spatial efficiency, improved disease monitoring, and better environmental control, which collectively enhance productivity [3]. Nevertheless, in practice, many Nigerian poultry farmers still utilize deep litter systems (DLS) due to lower capital investment and accessibility [4]. Despite their economic appeal, deep litter systems are more susceptible to environmental stressors such as heat, poor ventilation, and waste accumulation, all of which can compromise poultry health and productivity. Empirical findings show that housing type significantly influences feed intake, body weight gain, egg production, and survivability of birds [5]. In particular, high ambient temperatures—common in tropical regions can induce thermal stress, reduce feed intake and impair metabolic functions in birds [6]. Heat stress not only affects performance indicators but also distorts haematological and biochemical profiles, which are key indicators of physiological status and immune competence in poultry [7]. Blood parameters such as red blood cell count, haemoglobin concentration, and serum enzymes provide vital insights into nutrient metabolism, immune response, and overall health of poultry [8]. These indicators are influenced by diet, housing environment, and exposure to stressors [9].

Inadequate housing conditions may lead to oxidative stress, inflammation, and impaired organ function, which ultimately hinder performance. Given these challenges, there is a compelling need to evaluate how different rearing systems, specifically battery cage and deep litter housing, affect the growth performance, haematological indices, and serum biochemistry of growing pullets in Nigerian conditions. This study therefore seeks to provide evidence-based insights that can guide optimal housing strategies for enhanced poultry production under tropical conditions.

Materials and Methods

The experiment was carried out at the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. A total of 576 Bovan nera pullets were randomly allotted to two housing systems with 288 birds in each housing system. Each housing system had a triplicate of eight birds per replicate. Birds (n=288) were each raised on conventional BCS and a partitioned DLS house respectively. Each cage measured 50 x 45 x 40cm^3 and accommodated 4 pullets. The DLS was partitioned into 36 smaller pens with an average floor area of 3.32 m^2 to accommodate 8 pullets per pen. The composition of the experimental growers' diet is shown in Table 1.

The design of the experiment was a completely randomized design. At week 14, 6 pullets per housing system were randomly selected to determine the performance parameters included initial body weight/bird (kg), final body weight/bird (kg), live weight gain (kg)/bird/day, feed intake (kg)/bird/day, feed conversion ratio, and mortality (%). The haematological parameters were Haemoglobin (g/100ml), Red blood cells (10^{6}IU), White blood cells (10^{3}IU), Pack Cell Volume (%), Mean Corpuscular Volume (fl), Mean Corpuscular Haemoglobin (pg), Mean Corpuscular Haemoglobin Concentration (g/dL), Lymphocytes (%), Heterocyst (%), Monocytes (%); Eosinophil (%), Basophil (%), and Platelets x 10^5. Also, the serum biochemical parameters were Total protein (g/dL); Albumin (g/dL), Globulin (g/dL), AL: GL ratio, Total Cholesterol (g/dL), Triglycerides(g/dL), Low Density Lipoprotein (mg/dL), Very Low-Density Lipoprotein (mg/dL), High Density Lipoprotein (mg/dL), Urea (mg/dL), Uric Acid (mg/dL), Aspartate amino Transferase (IU/L), Alkaline amino Transferase(IU/L), Alkaline Phosphatase (IU/L), Calcium (mg/dL) and Phosphorous (mg/dL) of growing pullets. Data on performance indicators, haematology and serum biochemical indices were subjected to t-test analysis at $\alpha_{0.05}$ using the General Linear Model procedure of SAS [10] and significant means separated using Duncan Multiple Range option of the same software.

Table 1: Gross composition of experimental growers' diet

Ingredients	Level of inclusion (%)
Maize	54.89
Soybean meal	7.98
Groundnut cake	7.98
Palm kernel cake	13.97
Wheat bran	9.98
Bone meal	2.00
Oyster shell	2.00
Salt	0.30
Methionine	0.15
Lysine	0.10
Grower premix	0.15
Biotronic	0.30
Mycofix	0.10
Ronozyme G2G	0.02
Ronozyme P	0.02
Avatec	0.06
Total	100.00
Calculated nutrient values	
ME (kcal/kg)	2,781.38
Crude protein (%)	16.18
Crude fibre (%)	4.84
Fat (%)	4.70
Calcium (%)	1.58
Phosphorus (%)	0.82
Lysine	0.77
Methionine + cysteine	0.69

Results and Discussion

Performance indicators of growing pullets under two rearing management is shown in Table 2.

The impact of two housing systems, DLS and BCS on the performance indicators of pullets revealed no significant ($p>0.05$) differences in feed intake, weight gain, feed conversion ratio, or mortality. Feed intake was slightly higher in DLS (0.10 ± 0.06 kg/bird/day) than in BCS (0.08 ± 0.08 kg/bird/day), while both rearing management systems showed similar results in weight gain (0.01 kg/bird/day). These findings suggest that housing system did not adversely affect nutrient bioavailability or utilization. This aligns with findings by [11], who reported that housing type may not significantly influence performance indicators when feed quality and environmental management are standardized. Contrary to earlier studies by [12], this study shows that performance is resilient across housing systems when birds are maintained under controlled management. Heat stress, a major determinant in tropical climates, was likely mitigated in both systems, resulting in uniform growth rates [7].

Table 2: Growth performance of pullets under two rearing management systems

Parameters	DLS	BCS
Initial body weight/bird (kg) at week 13	1.06 ± 0.01	1.08 ± 0.03
Final body weight/bird (kg) at week 16	1.34 ± 0.01	1.32 ± 0.04
Live weight gain (kg)/bird/day	0.01±0.07	0.01 ± 0.03
Feed intake (kg)/bird/day	0.10 ± 0.06	0.08 ± 0.08
Feed conversion ratio	10.00± 0.02	8.00± 0.03
Mortality (%)	0.00	0.00

DLS-Deep Litter System, BCS-Battery Cage System

Haematology of pullets under two rearing management systems

The result of haematology of growing pullets under two rearing management is presented in Table 3. Haemoglobin (Hb), Packed Cell Volume (PCV), Red and White Blood Cell counts, and differential counts were not significantly influenced by rearing management. All values fell within physiological norms for poultry health [8]. The slightly higher Hb (7.17±0.82 g/dL) and PCV (21.50±2.43%) observed pullets in DLS suggesting improved oxygen carrying capacity possibly due to greater physical activity [13]. However, the PCV values for both groups were lower than optimal (i.e., <24%), indicating subclinical anaemia. This may reflect mild nutrient deficiencies, particularly of folic acid and iron which are essential for erythropoiesis [14]. Nevertheless, no clinical symptoms were observed, and zero mortality supports the assertion of good physiological health status.

Table 3: Haematology of pullets in two housing systems

Haematological indices	DLS±SD	BCS±SD
Hb (g/100ml)	7.17±0.82	7.15±0.59
PCV (%)	21.50±2.43	21.50±1.76
RBC (10^6IU)	3.66±0.31	3.56±0.43
MCV (fl)	58.74±0.95	60.39±0.28
MCH (pg)	19.59±014	20.08±0.25
MCHC (g/dL)	33.35±0.82	33.26±0.59
WBC (10^3IU)	21.28±2.44	19.03±4.31
Lymphocytes (%)	68.83±4.36	66.00±5.62
Heterocyst (%)	24.83±5.12	28.33±6.12
Monocytes (%)	3.00±0.63	3.00±0.63
Eosinophil (%)	3.17±1.60	3.17±1.60
Basophil (%)	0.17±041	0.33±0.52
Platelets x 10^5	2.42±7.81	2.12±8.50

DLS-Deep Litter System, BCS-Battery Cage System, Hb-Haemoglobin, RBC-Red blood cells, WBC-White blood cells, PCV-Pack Cell Volume, MCV-Mean Corpuscular Volume, MCH-Mean Corpuscular Haemoglobin, MCHC-Mean Corpuscular Haemoglobin Concentration

Serum biochemical parameters of growing pullets under two rearing management systems

The result of serum biochemical parameters is presented in Table 4

Serum biochemical parameters were largely unaffected by housing system, with the exception of serum albumin (AL), albumin-to-globulin (AL:GL) ratio, and serum phosphorus (P), which were significantly higher ($p<0.05$) in DLS pullets. These elevations indicate stronger immune status and improved protein metabolism due to more physical activity [15]. Low globulin levels observed across both groups may indicate a marginal compromise in immune responsiveness. Globulins, particularly gamma globulins (immunoglobulins) play crucial roles in immune defence, and reduced levels can reflect suboptimal humoral immunity [16]. Such reduction is associated with secondary immune deficiency and reduced antibody production in animals under physiological or environmental stress, or those with dietary protein imbalances [17]. Serum lipid profiles (total cholesterol, HDL, LDL, VLDL, triglycerides) were comparable between groups, though numerically higher in DLS, reflecting enhanced lipid mobilization likely triggered by higher physical activity [18]. This is physiologically beneficial, as cholesterol plays a crucial role in cell membrane integrity, fat-soluble vitamin absorption, and steroid hormone synthesis [19]. Serum phosphorus was significantly higher in DLS (1.61 ± 0.28 mg/dL) than in BCS (1.20 ± 0.11 mg/dL), indicating increased energy metabolism and bone mineralization, crucial during growth phase [20]. These variations could reflect differences in energy expenditure between more mobile pullets in DLS and more sedentary birds in BCS.

Table 4: Serum biochemical parameters of growing pullets under two rearing management

Serum biochemical indices	DLS±SD	BCS±SD
TP (g/dL)	4.24±0.35	4.08±0.60
AL (g/dL)	3.38±0.36^{a}	2.70±0.21^{b}
GL (g/dL)	1.11±0.29	1.55±0.74
AL: GL ratio	3.05±0.32^{a}	1.74±0.47^{b}
TC (g/dL)	114.63±21.08	97.48±15.23
TG (g/dL)	111.30±76.77	68.01±34.84
LDL (mg/dL)	62.60±9.25	53.87±15.35
VLDL (mg/dL)	22.26±15.35	13.60±6.97
HDL (mg/dL)	101.54±12.75	92.05±12.31
UN_2 (mg/dL)	3.62±2.45	4.20±0.51
UA (mg/dL)	3.92±2.04	2.79±1.57
AST (IU/L)	81.64±16.26	86.54±24.51
ALT (IU/L)	3.41±4.25	1.76±0.40
ALP (IU/L)	459.77±31.98	452.18±21.78
Ca (mg/dL)	8.97±3.07	9.68±2.38
P (mg/dL)	1.61±0.28^{a}	1.20±0.11^{b}

[ab]Means with different superscripts within the same row are significantly different (P<0.05), DLS-Deep Litter System, BCS-Battery Cage System, TP-Total protein; Al-Albumin; GL-Globulin; TC-Total Cholesterol; TG-Triglycerides; LDL-Low Density Lipoprotein, VLDL-Very Low-Density Lipoprotein, HDL-High Density Lipoprotein, UN_2-Urea N_2, UA-Uric Acid, AST-Aspartate amino Transferase, ALT-Alkaline amino Transferase, ALP-Alkaline Phosphatase; Ca-Calcium; P-Phosphorous; SD-Standard Deviation.

Conclusion and Application

The growth performance and haematological indices of growing pullets were not impacted by rearing management systems. Serum albumin, albumin/globulin ratio, and phosphorus levels vary with rearing management. The deep litter system supported enhanced immune function and energy metabolism, due to increased bird activity. Some of the application of this study include poultry health monitoring, housing design and management, and policy implications.

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