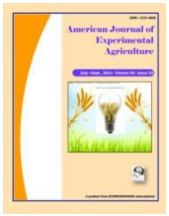

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Effect of Alternative Housing Systems on Blood Profile of Egg-type Chickens in Humid Tropics

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Authors' contributions

This work was carried out in collaboration between all authors. Author OMA designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors OBA and OMA collected on farm data. Author FAA reviewed the experimental design and all drafts of the manuscript. Authors OMA and FAA managed the analyses of the study. Author OMA performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Aims: General well being of animals is of paramount interest in some developed countries and of global importance hence the shift to alternative housing systems for egg-type chickens as replacement for conventional battery cage system. However, there is paucity of information on the effect of this shift on physiological status of the hens and how it affects their health via the blood profile. Therefore, investigation was carried out on two strains of hen kept in three different housing systems in humid tropics to evaluate changes in their blood parameters.
Study Design: A randomized complete block experimental design was used in this investigation.
Place and Duration of Study: Poultry unit of the Teaching and Research Farm, Bowen University, Iwo, Nigeria between June 2007 and April 2008.
Methodology: One hundred and eight, 17-weeks old Super Black (SBL) hens and one hundred and eight, 17-weeks old Super Brown (SBR) hens were randomly allotted to three different intensive systems namely; Partitioned Conventional Cage (PCC), Extended Conventional Cage (ECC) and Deep Litter System (DLS) with 36 hens per housing system each with three replicates. The

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experiment lasted 37 weeks during which blood samples were collected at 18th week of age and every two weeks thereafter for analyses. Parameters measured were packed cell volume (PCV), hemoglobin concentration (Hb), Red blood cell counts (RBC), White blood cell counts (WBC) and serum metabolites such as Total Protein (TP), Albumin (Alb),Globulin (Glb), cholesterol, uric acid, serum cortisol and some serum enzymes such as Aspartate Trans aminase (AST), Alkaline Phosphatase (ALP) and Acid Phosphatase (ACP), while blood indices such as Mean corpuscular hemoglobin (MCH),Mean cell volume (MCV) and Mean corpuscular hemoglobin concentration (MCHC) were calculated.

Results: The hematological values of the hens were not significantly (*P>0.*05*)* affected by the housing system and strain, while among the serum metabolites, serum cortisol was significantly (*P*<0.05*)* affected by the housing system only. Hens housed on PCC had higher values of serum cortisol (20.05 ng/ml for SBL and 20.55 ng/ml for SBR) indicating stress with conventionally caged birds, followed by hens on ECC (18.15 ng/ml for SBL and 18.38 ng/ml for SBL) while hens on DLS had the lowest value (16.50 ng/ml for SBL and 16.00 ng/ml for SBR).

Conclusion: Alternative housing systems can also be adopted for egg-type chickens in the humid tropics from welfare point of view with the results of this work indicate stress among caged hens.

Keywords: Blood; housing; humid-tropics; layers; stress; welfare.

1. INTRODUCTION

Proper housing facilitates maximum productivity from the animals. However, the design, facilities and the capacity of such houses determine the level of welfare of such animals. Egg-type chickens are usually housed conventionally in battery cages which have been found to be the best as far as commercial egg production is concerned [1-4]. Despite very high level of egg production, hen housed inside battery cages are under long term confinement and this poses a lot of welfare challenges hence the ban on usage in many countries of the European community [5]. The need to put the welfare of our animals into consideration as a matter of necessity has been reported to be of global concern now [6-9]. As the use of battery cages for egg-type chickens is being jettisoned in commercial production, alternative housing systems need to be exploited. Frohlich et al. [10], described alternative housing system for poultry as one that is not a barren cage for laying hens or an equally barren deep litter house for meat birds. Any system that will allow the chickens to exhibit their natural behaviors such as dust bathing, scratching, perching and flying; and to move about freely within the flock without limitation is considered to be alternative to battery cages [11].

Therefore, furnished cages [12], get-away cages [13], non-cage systems such as deep litter house with outside runs and pasture [14], fully slated floor system [15], multi-tier or aviary system [16] and extended cages [17] are good examples of alternative housing systems that satisfy the basic requirements for the comfort and general well being of the chickens. However, each system has its own positive and or negative effect on the chickens which may be qualitative and or quantitative. Egg-type chickens must be given maximum space, freedom to move about and be able to exhibit behaviors earlier mentioned including nesting, denial of which can affect them physiologically. Blood parameters have been extensively used in animal experimentations to assess their health status [18]. Blood is an important index of physiological, pathological and nutritional status in the organism. However, normal values must be known for any reasonable inference to be made from it. Meanwhile, these values are prone to change depending on a number of factors such as acute or chronic disease, genetic factors, diet, environmental factors and homeostatic imbalance which can lead to stress within the animal body system [19]. Physiological processes such as cellular transfer of oxygen, detoxification and other liver functions, excretion and immune responses of animals can be accessed through the study of the blood parameters. Consequently, housing system is an environmental factor that needs to be exploited in order to access its effect on the physiological status of egg-type chickens. This research was therefore conducted to investigate the effect of different intensive housing systems on hematological parameters and serum metabolites of laying chickens in humid tropics.

2. MATERIALS AND METHODS

2.1 Location

The experiment was carried out at the poultry unit of the Teaching and Research farm of Bowen University, Iwo, Osun-State of Nigeria which is a typical humid zone of tropical Africa within the latitude and longitude of 3º52^{1}E and 7º23^1 N respectively [20].

2.2 Experimental Birds

A total of 125 Super Black (SBL) and 125 Super Brown day old chicks were purchased from a reputable farm hatchery in Oyo- State of Nigeria. They were initially brooded and reared on deep litter housing system with strict observation of the relevant welfare specifications.

2.3 Experimental Design and Birds' Management

At 15th week of age, 108 pullets were randomly selected from each strain and were divided into three treatment groups of 36 pullets each in a Randomized Complete Block design where the housing system was the treatment that was blocked with strain. Each group of 36 pullets was further divided into three replicates of 12 pullets. The treatment (housing) groups are T1 which was Partitioned Conventional Cage (PCC) which served as the control group being the conventional method of housing egg-type chickens in tropics; T2 which was Extended Conventional Cage (ECC) and T3 which was the Deep Litter System (DLS). ECC shared the same space allowance of 0.1m^2 per bird with PCC but without partitioning to cells to allow birds to move about within the cage. Data collection started at 17th week of age and lasted 37 weeks.

Birds were fed with formulated chicks mash from day old till 8th week of age and thereafter with growers mash till 17th week of age. Layers mash was given to them from 18th till the end of the experiment. Feed ingredients were purchased from a reputable feed mill in Iwo. Feed and water were given *ad libitum* while necessary medications and vaccinations were carried out to keep the birds in good health. The proximate composition of the diets given to the experimental birds was determined by the method described by the Association of Official Analytical Chemists [21].

2.4 Blood Analyses

Blood collection for analyses started at 17th week of age and every other week subsequently. Blood samples were carefully collected with the use of micro syringe from the brachial veins of the wing web. For haematology, blood samples were collected into bottles containing anticoagulant, EDTA (Ethylene diamine tetra acetic acid) while blood samples meant for serum analysis were collected into bottles without anticoagulant. Standard hematological assay procedures as described by Dacie and Lewis [22] were employed in determining packed cell volume (PCV), hemoglobin concentration (Hb), Red blood cell counts (RBC) and white blood cell counts (WBC). Other indices of the haematological parameters such as Mean cell volume (MCV), Mean corpuscular hemoglobin (MCH) and Mean corpuscular hemoglobin concentration (MCHC) were all calculated as described by Jain [23] as follows:

MCV= PCV×RBC
MCH= Hb÷RBC×10
MCHC= Hb÷PCV×100

Serum metabolites such as Total proteins were determined by Biuret method [24], albumin [25], and uric acid by method [26]. Serum enzyme activities were determined according to the methods of spectrophotometric determination of linked reactions [27].

2.5 Statistical Analysis

Data obtained on hematological parameters and serum metabolites were subjected to the fixed effect of housing system and strain with the use of statistical package [28]. Significant differences between the means were separated with the Duncan New Multiple range test procedure of the same software to show the Standard Deviations. The statistical model for the analysis is as stated below:

Yij = u+Bi+ Tj +Eij
Yij= individual observation for the ith treatment
U= general mean
Bi= effect of ith treatment (housing system)
Tj= effect of jth block (strain)
Eij= Experimental error

3. RESULTS AND DISCUSSION

Table 1 shows the gross composition of the diets (growers mash and layers mash) given to the

experimental birds. The metabolizable energy and crude protein contents of the diets were formulated to meet the specifications earlier recommended for growing pullets and layers by [29]. Table 2 shows the proximate compositions of the growers mash and layers mash the crude protein (%CP) content were 11.85 and 15.97 respectively. Table 2 presents the proximate composition of the growers mash and layers mash given to the experimental birds. The rations had adequate nutrients in terms of CP, CF and metabolizable energy (ME) required by the chickens as earlier reported by [30].

Table 3 shows the effect of different intensive housing systems on the haematological parameters of the egg-type chickens. All the parameters investigated such as the PCV, Hb concentration, WBC, RBC and the erythrocytes indices were not significantly affected by the housing system and strain. Their values were also within the normal range earlier reported by [30,31]. However, these results indicate that the health status of the birds was not negatively affected by the different housing systems and strain. The PCV and RBC which are good indicators of the blood volume and oxygen carrying capacity of the birds were normal thereby confirming that the birds were not anemic. Also, the unaltered hemoglobin concentrations across the treatments may suggest that the iron or mineral profile of the blood were not negatively affected by the housing system [32]. Moreover, the immune response of the birds was not altered negatively by the housing system and strain as observed in the values of the WBC which were normal. These results were in agreement with the findings of [33-39] that haematological parameters were not influenced by different housing systems. They however suggested that the parameters were not suitable for assessing the physiological condition of the birds under stress. In addition, since the WBC welfare of the concentrations were not altered negatively, the values cannot be used to assess the birds under stress as a result of the different intensive housing systems. It only showed that there was no infection among the experimental birds as a result of the housing system. However, measurements of the differential leukocytes particularly heterophil-lymphocyte ratios have been reported to be the most reliable measure of stress among chickens [40-42].

Table 1. Gross compositions of grower and layer mash

	Grower mash(%)	Layers mash(%)
Maize	37.00	46.50
Corn Bran	12.00	0.00
Wheat offal	20.00	12.70
Palm kernel meal	21.00	12.00
Groundnut cake	3.50	10.00
Soybean meal	2.00	6.30
Fish meal(72%)	0.00	1.00
Oyster shell	1.00	8.00
Bone meal	3.00	3.00
Salt	0.25	0.25
*Premix	0.25	0.25
Total	100.00	100.00
Lysine	0.10	0.10
Methionine	0.10	0.10
Calculated values		
Crude protein(%)	12.85	16.08
Crude fibre(%)	7.60	4.73
Ether extract(%)	3.92	3.70
Calcium(%)	0.90	3.65
Phosphorus(%)	0.44	0.48
Metabolizable energy(Kcalkg^{-1})	2327.50	2453.60

**Premix to provide the following per kg of feed; Vit A-500 iu, Vit D3- 1200 mg, Vit.E-11 mg, Vit.K-2 mg, Riboflavin- 20 mg, Nicotinic acid- 10 mg, Pantothenic acid- 7 mg, Cobalamin- 0.08 mg, Choline chloride- 900 mg, Folic acid- 1.5 mg, Biotin-1.5 mg, Iron- 25 mg, Manganese-80 mg, Copper-2 mg, Zinc-50 mg, Cobalt-1.25 mg and Selenium-0.1 mg*

Table 4 shows the effect of different intensive housing systems on the serum metabolites of egg-type chickens in humid tropics. All the parameters measured except serum cortisol were not significantly (*P>0.*05) affected by the housing systems and the strain. However, serum cortisol concentration of birds housed in PCC and ECC were higher but both SBL and SBR strains on DLS had lower cortisol concentrations (16.50 and 16.00 ng/ml) significantly (*P*<0.05) than those on PCC and ECC. Meanwhile, no strain effect was observed on serum cortisol concentrations but the interaction of housing system and strain revealed that SBR birds on PCC had highest value of 20.55 ng/ml while SBR birds on DLS had the lowest value of 16.00 ng/ml. These results indicate that only serum cortisol concentrations were significantly affected. Parameters such as serum total protein, albumin and globulin were not significantly affected by the housing system. The implication is that the systemic protein utilization of the chickens was unaltered by the housing system.

This is in agreement with the findings of Ologhobo [43] that serum protein and albumin are likely to be altered by toxins and anti nutritional factors in feed rather than any other thing. The values of serum cortisol ranged from 20.55 ng/ml (SBR on PCC) to 16.00 ng/ml (SBR on DLS), although the values for birds on PBC and EBC were not significantly (*P>0.05*) different. However, higher concentrations of serum cortisol observed in birds housed in PCC and ECC are indication of response of the birds to stress which might be linked to the caging factor. Changes in cortisol concentration have been reported to be one of the reliable means of measuring stress among animals [44].

Table 2. Proximate composition of growers and layers mash

Proximate components	Grower mash(%)	Layers mash(%)
Dry matter	94.20	93.60
Crude protein	11.85	15.97
Crude fibre	7.95	5.35
Ether extract	4.68	4.65
Ash	4.48	6.75
Nitrogen-free extract	65.24	60.88

Table 3. Effect of different intensive housing systems on the haematological parameters of egg-type chickens

		Treatments			
Parameters	**Strains**	**PCC**	**ECC**	**DLS**	**Normal Value(*)**
PCV(%)	SBL	31.45±1.50	31.55±1.50	31.55±1.50	24.90-40.70
	SBR	31.44±1.50	31.50±1.50	31.48±1.60	
Hb(g/dl)	SBL	9.48±0.06	9.45±0.06	9.46±0.05	7.40-12.20
	SBR	9.49±0.06	9.46±0.05	9.45±0.06	
WBC(10^3/ul)	SBL	3.05±0.05	3.09±0.06	3.06±0.06	3.03-21.20
	SBR	3.08±0.06	3.08±0.06	3.08±0.06	
RBC(10^6/ul)	SBL	2.90±0.06	2.92±0.06	2.85±0.05	1.50-3.82
	SBR	2.83±0.06	2.88±0.05	2.82±0.05	
MCV(Fl)	SBL	120.15±5.00	120.00±5.00	120.05±5.00	102-129
	SBR	119.85±5.00	120.55±5.00	120.05±5.00	
MCH(pg)	SBL	39.30±2.05	38.51±2.00	39.30±2.00	31.90-40.70
	SBR	38.95±2.00	39.00±2.00	38.00±2.00	
MCHC(%)	SBL	30.98±2.05	30.85±2.05	30.95±2.00	25.90-33.90
	SBR	31.50±2.05	30.65±2.05	31.05±2.00	

*PCC= Partitioned Conventional Cage; ECC = Extended Conventional Cage; DLS= Deep litter System; SBR = Super Black Strain; SBR= Super Brown Strain. * Normal values= Reference Values (in range) for female chickens(Mitruka and Rawnsley, 1977)*

Table 4. Effect of different intensive housing systems on serum metabolites of egg-type chickens in humid tropics

		Treatments			
Parameters	**Strains**	**PCC**	**ECC**	**DLS**	**Normal Value(*)**
TP (g/dl)	SBL	5.78±0.05	5.72±0.05	5.73±0.05	5.20-6.90
	SBR	5.75±0.05	5.77±0.05	5.77±0.05	
Albumin (g/dl)	SBL	4.56±0.05	4.49±0.05	4.50±0.05	2.10-3.45
	SBR	4.55±0.05	4.51±0.05	4.52±0.06	
Globulin (g/dl)	SBL	1.22±0.02	1.18±0.02	1.21±0.02	1.90-2.30
	SBR	1.20±0.02	1.19±0.02	1.21±0.02	
Uric acid (mg/dl)	SBL	2.54±0.04	2.57±0.05	2.58±0.05	2.47-8.08
	SBR	2.57±0.04	2.59±0.05	2.60±0.05	
Chol. (mg/dl)	SBL	134.05±6.00	135.00±6.00	136.05±6.00	52.00-148.00
	SBR	133.95±6.00	134.55±6.00	134.05±5.50	
AST (mg/dl)	SBL	178.05±6.50	179.00±6.00	178.55±6.00	88.00-208.00
	SBR	179.25±6.00	180.05±6.50	179.65±6.50	
ALP (iu/l)	SBL	30.80±2.05	29.85±2.05	30.00±2.00	24.50-44.40
	SBR	30.00±2.05	30.05±2.05	30.90±2.00	
ACP (iu/l)	SBL	35.00±2.50	35.45±2.50	36.00±2.55	23.00-41.60
	SBR	35.85±2.50	36.00±2.55	35.85±2.50	
Creatinine (mg/dl)	SBL	1.25±0.02	1.23±0.02	1.22±0.02	0.90-1.85
	SBR	1.24±0.02	1.22±0.02	1.20±0.02	
Serum cortisol (ng/ml)	SBL	20.05±2.00[a]	19.00±2.00[a]	16.50±1.85[b]	12.05-18.00
	SBR	20.55±2.00[a]	19.55±2.00[a]	16.00±1.85[b]	

*abc = means with different superscripts along the row are significantly (P< 0.05) different. Means with no superscript indicate no significant (P>0.05) difference;PCC= Partitioned Conventional Cage; ECC = Extended Conventional Cage; DLS= Deep litter System; SBR = Super Black Strain; SBR= Super Brown Strain. * Normal values= Reference Values (in range) for female chickens; (Mitruka and Rawnsley, 1977).*

TP= Total protein; Chol.= Cholesterol; AST= Aspartate transaminase; ALP= Alkaline phosphatase; ACP= Acid phosphatase

4. CONCLUSION

Welfare of animals is very important. Housing, like other management specifications must be well implemented. The results of this research suggest that the health status of birds was not negatively affected by the housing systems and strains. However, with the indications of stress as a result of caging, there is need to adopt alternative housing systems such as deep litter, to ensure the general well being of the birds.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care "(NH publication No. 85-23, revised 1985) were followed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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