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STRAIN AND PLACEMENT DENSITY EFFECTS ON WELFARE, HAEMATOLOGICAL AND SERUM BIOCHEMICAL INDICES OF BROILERS IN NORTH CENTRAL NIGERIA

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Strain and placement density effects on welfare, haematological and serum biochemical indices of broilers in north central Nigeria

This study aimed at evaluating the influence of strain and stocking density on welfare, haematological and serum biochemical indices of broilers in a 28-day trial. Two hundred and seven 4-week old birds each of Anak Titan and Arbor Acre genetic provenience were randomly allocated to three housing densities of 8.3, 11.1 and 14.3 birds/m^2.These corresponded to 17, 22 and 30 birds per pen (2.01 × 1.00 m) in a 2x3 factorial experiment. Each treatment group was replicated three times. The welfare parameters estimated were gait score, feather score, foot and hock burns, pecking, pushes, chases, fights and mortality. Blood samples were tested for packed cell volume (PCV), red blood cells (RBC), white blood cells (WBC), haemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC). Similarly, sera were utilized for the determination of total protein, albumin, globulin, glucose, cholesterol, and creatinine contents. There were no genotype-associated differences ($P > 0.05$) in the welfare indicators examined. However, placement density significantly ($P < 0.05$) influenced incidence of pushes, chases and fights, with higher values in most cases recorded for birds housed at the highest density. The strains and population densities were similar ($P > 0.05$) in haematological profile. Strain and stocking density also exerted no influence ($P > 0.05$) on serum biochemical components. Strain × stocking density interaction effects were not observed in all the parameters. Consequently, the two strains could be reared at a density of 14.3 birds/m^2 since density did not lead to a great degree of stress.

Key words: poultry / broilers / genotype / stocking density / blood parameters / animal welfare

Vpliv genotipa in gostote naselitve na počutje, serumske in biokemijske parametre pri brojlerjih v severni in osrednji Nigeriji

V raziskavi smo skušali oceniti vpliv genotipa in gostote naselitve na počutje živali, hematološke in biokemijske parametre seruma brojlerjev v 28 dnevnem poskusu. Dvesto sedem štiri tedne starih brojlerjev provinienc Anak Titan in Arbor Acre smo naključno porazdelili v tri oddelke z gostoto naselitve 8,3, 11,1 in 14,3 ptic/m^2, kar je ustrezalo 17, 22 in 30 pticam na oddelek (2,01 × 1,00 m) v faktorskem poskusu 2x3. Za vsako obravnavo smo imeli po tri ponovitve. Počutje živali smo ocenjevali z ocenami za držo telesa, perje, žulje na nogah, kljuvanje, odrivanje, preganjanje, spopade in smrtnost. V vzorcih krvi smo določili hematokrit (PCV), število rdečih krvniček (RBC), belih krvniček (WBC), hemoglobin (Hb), srednji volumen eritrocitov (MCV), srednjo maso hemoglobina na eritrocit (MCH) in srednjo koncentracijo hemoglobina v hematokritu (MCHC). Krvni serum smo uporabili za določitev vsebnosti skupnih beljakovin, albumina, globulina, glukoze, holesterola in kreatinina. V poskusu nismo opazili z genotipom povzročenih razlik v indikatorjih počutja ($P > 0,05$). Gostota naselitve je značilno ($P < 0,05$) vplivala na pogostnost odrivanja, lovljenja in bojev, ki smo jih najpogosteje opazovali pri najgosteje naseljenih živalih. Med različnimi genotipi in naselitvenimi različicami nismo opazili razlik v hematološkem profilu ($P > 0,05$). Genotip in gostota naselitve ravno tako nista vplivala na biokemijske parametre v krvnem serumu ($P > 0,05$). Pri nobenem od proučevanih parametrov nismo opazili interakcij med genotipom in gostoto naselitve. Zaključujemo, da tudi najvišja gostota naselitve,14,3 živali /m^2 ni povzročala značilnega stresa.

Ključne besede: perutnina / pitovni piščanci / genotip / gostota naselitve / krvni parametri / dobro počutje živali

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1 INTRODUCTION

Animal welfare has generated concerns from the domestic and global market sectors. According to English Federation for Humane Treatment of Animals (Jensens and Toates, 1997), animal welfare is accomplished if there are lack of hunger and thirst; lack of discomfort; lack of pain, injury or sickness; freedom for normal behavior; and lack of fear, anxiety and depression. Welfare of birds is to a large extent regulated by various intrinsic and extrinsic factors, among which stocking density plays a pivotal role. In the broiler industry, the major welfare concern is the effect of high stocking densities on the welfare of birds, especially during the final weeks of the growing period when body weight per unit area is high (Ravindran *et al.*,2006).

There are conflicting reports on the effects of high placement density on the welfare, performance and immune status of birds. Dozier *et al.* (2005) reported that body weight gain and feed consumption were adversely affected by increasing the housing density from 30 to 45kg of BW/m^2 of floor space. High rearing densities in broilers are associated with an increased incidence of leg problems (Sorensen *et al.*, 2000). However, Ravindran *et al.* (2006) reported that weight gain, feed intake, livability and carcass characteristics of broilers grown at densities of 16, 20 and 24 birds/m^2 were similar over the whole 35-day trial. Thaxton *et al.* (2006) reported that stocking density did not cause adaptive changes indicative of stress in birds.

The European Union is currently adopting standards for broilers aimed at a chief welfare concern, namely overcrowding by limiting maximum stocking density (Dawkins *et al.*, 2004). Focusing research on adequate space requirements may lead to management changes that could help diminish stress and subsequently lead to improved growth and survivability. In North Central Nigeria, there appeared to be virtually no documented evidence on the appropriate placement density for broilers. The current practice involves the indiscriminate allocation of birds to floor space based on the imagination (subjective evaluation) of the farmers. This tends to undermine animal welfare and hence, profitability of the enterprise.

Therefore, the present investigation set out to determine the effects of genotype and stocking density on welfare indicators, haematological and serum biochemical parameters of broilers. The result so obtained could contribute to the knowledge on optimal floor space of broilers in the semi-humid tropics characterized by high environmental temperature and relative humidity.

2 MATERIALS AND METHODS

2.1 STUDY LOCATION

The research was conducted in the Poultry Unit of the Teaching and Research Farm, Faculty of Agriculture, Nasarawa State University, Keffi, Shabu-Lafia Campus, located in the guinea savanna agro-ecological zone of northern Nigeria.The mean monthly environmental temperature during the study which lasted four weeks was 32.75^{0}C, while the monthly relative humidity, rainfall and evaporation were 79.00%, 207.45mm and 2.5ml respectively.

2.2 EXPERIMENTAL DESIGN

Four hundred and fourteen broiler chickens consisting of equal number of Anak Titan and Abor Acre strains were utilized for the investigation. Birds were raised on conventional starter ration (22.00% crude protein and 2800kcal/kgME) from day old to 4-week of age. Birds were randomly allocated to three stocking density treatments vis: 8.3, 11.1 and 14.3 birds /m^2. These corresponded to 17, 22 and 30 birds per pen in a 2 × 3 factorial arrangement. Each treatment group was replicated three times. The dimension of each pen made of wooden plank and wire netting was 2.01m^2 (2.01m × 1.00m), and was constructed in such a way as to permit straight-through ventilation. From week five to week eight, the birds were fed commercial broiler finisher ration (2900kcal/kg ME and 20.00% crude protein). Feed and fresh clean water were supplied *ad libitum*. The feeders and waterers were allotted proportionately depending on the number of birds in each pen. Vaccination schedule and other management practices were strictly adhered to.

2.3 DATA COLLECTION

Birds were assessed on a weekly basis for gait score, feather score and foot and hock burn as described by Ravindran *et al.* (2006). Number of pecking, pushes, fights and chases were recorded per pen per replicate during feeding and at 3-day interval, following the procedure adopted by Olukosi *et al.* (2001). Gait score was assessed for six randomly selected birds per pen. Birds were watched by two observers walking in the run within the poultry house, and their walking ability was scored on a three-point scale (0, normal gait, bird walks freely and has regular and even strides and is well balanced; 1, bird walks with irregular and uneven strides and appears unbalanced; 2, bird is reluctant to move and is unable to

walk many strides before sitting down). A score was ascribed only when there was consensus between the two observers.

Feather score or the degree of feather coverage over the breast was recorded for six birds per pen. Each bird was stroked over the keel with the palm of the hand in an anterior or posterior direction, and the amount of flesh showing was scored on a three -point scale (1, no visible skin, complete feather cover; 2, relatively small amount of skin showing; 3, relatively large amount of skin showing). Foot and hock burn was recorded for all the birds in a pen using a three -point scale (1, no burns; 2, mild burns; 3, severe burns).

2.4 HAEMATOLOGICAL AND BIOCHEMICAL ANALYSES

At the end of the experimental period, blood samples were collected from four randomly selected birds per treatment combination. Five-ml of blood was collected through the jugular veins in immobilized animals. Half of the sample was expelled gradually into vacutainer glass tubes containing ethylene diamine tetra acetic acid (EDTA) for the determination of haematological components following standard procedures described by Davice and Lewis (1991). The rest of the sample was collected in a second set of vacutainer glass tubes without EDTA for serum biochemical parameters. The haematological indices investigated were packed cell volume (PCV), red blood cells (RBC), white blood cells (WBC), haemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC).Similarly, sera were used for the determination of total protein, albumin, globulin, glucose, cholesterol and creatinine contents.

2.5 STATISTICAL ANALYSIS

Data collected were subjected to multivariate analysis of variance using SPSS (2001) statistical package. The separation of means was effected using least significant difference (LSD) method and tested at probability level of 5%.

3 RESULTS

The influence of genotype and stocking density on the welfare parameters of broilers is shown in Table 1. Genotype did not significantly ($P > 0.05$) affect the welfare parameters investigated.

Stocking density had no effect ($P > 0.05$) on gait score, foot and hock burns, feather score and pecking. However, housing density significantly ($P < 0.05$) influenced number of pushes, chases and fights, with higher mean values recorded for birds stocked at 14.3 birds/m^2.

Effect of genotype and population density on the haematological parameters of broilers is shown in Table 2. Strain and density effects on PCV, RBC, WBC, Hb, MCV, MCH and MCHC were not observed ($P > 0.05$).

Effect of strain and placement density on serum biochemical parameters of broilers is presented in Table 3. Genotype exerted no significant influence ($P > 0.05$) on the parameters estimated. There was also no placement density influence ($P > 0.05$) on total protein, albumin, globulin, glucose, cholesterol and creatinine contents. Strain × stocking density interaction effects were not observed in all the parameters investigated.

Table 1: *Effect of genotype and stocking density on welfare indices of broilers*
Preglednica 1: *Vpliv genotipa in gostote naselitve na počutje brojlerjev*

	Genotype				Stocking density (bird/m^2)				
Parameters	Anak Titan	Abor Acre	Prob.	S.E.M	8.3	11.1	14.3	Prob.	S.E.M
Gait score	1.19	1.17	0.85	0.14	1.21	1.04	1.29	0.36	0.13
Food and hock burns	1.47	1.39	0.59	0.15	1.33	1.33	1.63	0.28	0.13
Feather score	1.86	1.84	0.90	0.13	1.88	1.71	1.97	0.13	0.11
Pecking	1.77	1.52	0.32	0.24	1.72	1.53	1.71	0.56	0.30
Pushes	2.36	2.34	0.88	0.15	1.99	2.31	2.25	0.01	0.13
Chases	1.78	1.83	0.72	0.14	1.48	1.83	2.11	0.01	0.12
Fights	1.94	1.83	0.37	0.12	1.53	1.79	2.34	0.05	0.10
Mortality	0.01	0.01	0.85	0.006	0.01	0.01	0.008	0.65	0.007

S.E.M: Standard error of means

Table 2: *Effect of genotype and stocking density on haematological indices of broilers*
Preglednica 2: *Vpliv genotipa in gostote naselitve na hematološke parametre pri brojlerjih*

	Genotype				Stocking density (bird/m^2)				
Parameters	Anak Titan	Abor Acre	Prob.	S.E.M	8.3	11.1	14.3	Prob.	S.E.M
PCV (%)	31.25	31.17	0.92	0.85	31.50	31.13	31.00	0.64	1.03
RBC (x 106/µL)	2.46	2.47	0.84	0.05	2.48	2.47	2.45	0.76	0.07
WCB (x 103/µL)	24.61	24.48	0.64	2.76	24.64	24.61	24.37	0.45	3.38
Hb (g/dl)	9.42	9.89	0.23	0.38	9.73	9.64	9.59	0.85	0.47
MCV (fl)	128.87	130.06	0.45	1.52	129.95	130.50	127.93	0.18	1.86
MCH (pg)	38.86	39.58	0.25	0.62	39.38	39.40	38.87	0.50	0.76
MCHC (g/dl)	30.30	30.60	0.36	0.33	30.63	30.13	30.61	0.23	0.41

S.E.M: Standard error of means

4 DISCUSSION

Genotype-associated significant differences did not manifest in the welfare parameters investigated. This is an indication of similarity in the ranking of the two strains under consideration, although better numerical mean values were recorded for Abor Acres. The present result is in consonance with that of Albentosa *et al.* (2003), where strain of birds did not influence fearfulness and exploratory behaviour. Similarly, Anderson *et al.* (2004) reported that appetitive behaviours and feather pecking were not affected by strain, and that the patterns and number of aggressive acts did not increase to compromise the welfare status of the birds. In contrast to the present findings, Kjaer and Sorensen (2002) and Aerni *et al.* (2005) reported effect of genotype on feather pecking, mortality and cannibalism respectively. Gait score represents subjective method of evaluation of the walking ability of birds. Genetic differentials in gait score, foot and hock burns, feather pecking and cannibalism in Ross 208 and Labresse cross had been documented (Nielsen *et al.,* 2003). The performance of the birds in gait score, feather score, foot and hock burns and pecking was independent of placement density. The present findings are consistent with that of Ravindran *et al.* (2006) where placement density did not exert any influence on leg and feather scores. In contrast to the current observations, Sorensen *et al.* (2000) reported poorer walking ability in birds reared at higher densities and attributed this to constrained mobility and reduced opportunity for activity, especially as birds approach the end of the grow out phase.

Dozier *et al.* (2005) reported that foot pad lesson score increased progressively as placement density increased from 30 to 45kg of BW/m^2. The submission of Muniz *et al.* (2008) confirms this, as percentage foot-pad dermatitis in broilers increased linearly with increasing stocking density. The negative effect of high housing density on hock burns had also been reported (Thomas *et al.*, 2004), reflecting poorer litter quality and the increased time that the birds spend sitting, in contact with the litter.

The differential effects of stocking rate on gait score and foot and hock burn of the present investigation and others might be partly attributed to the length of rearing, environment and management practices. Under the con-

Table 3: *Effect of genotype and stocking density on serum biochemical indices of broilers*
Preglednica 3: *Vpliv genotipa in gostote naselitve na biokemijske parametre pri brojlerjih*

	Genotype				Stocking density (bird/m^2)				
Parameters	Anak Titan	Abor Acre	Prob.	S.E.M	8.3	11.1	14.3	Prob.	S.E.M
Total protein (g/dl)	5.76	5.91	0.54	0.26	5.98	5.89	5.63	0.29	0.32
Albumin (g/dl)	2.48	2.77	0.18	0.33	2.54	2.98	2.35	0.13	0.40
Globulin (gdl)	3.28	3.14	0.67	0.30	3.44	2.92	3.28	0.18	0.37
Glucose (mmol/L)	12.72	13.43	0.32	0.70	13.86	12.45	12.91	0.12	0.87
Cholesterol (mmol/L)	4.91	5.60	0 19	0.51	5.45	5.08	5.24	0.55	0.63
Creatinine (µmol/L)	71.83	71.33	0.90	4.02	70.25	75.00	69.50	0.28	4.92

S.E.M: Standard error of means

ditions of the current study, more of mild feather pecking and less of aggressive pecking which was mainly directed at the head was observed. The other agonistic behaviours such as pushes, chases and fights were not similar in the three stocking density treatments, as they were more associated with the highest housing density. The competition for feed could partly be responsible for the observed responses. Similar findings have been reported in broilers where increasing the feeder space reduced agonistic acts during the feeding period from 7.8 (at 2.4cm feeder space to 4.5 (at 3.6cm/bird) (Olukosi *et al.* 2001). According to Spinu *et al.* (2003), stereotyped pecking increased with an increase in density. Mortality is one of the most obvious measures of bird welfare. However, population density was not a significant explanatory factor in it in the current investigation. This concurs with the report of Thomas *et al.* (2004). In contrast, Imaeda (2000) found that mortality was markedly increased at higher animal densities.

Measurement of haematological indices provides valuable information on the immune status of animals. The literature provides varying evidence concerning the effect of stocking density on birds' physiological response and stress. The present findings are comparable to the report of Talebi *et al.* (2005) which revealed that the haematological values of four main broiler strains (Ross, Cobb, Abor Acres and Arian) showed slight but non-significant differences, indicating that the broiler strains are nearly similar to each other in haematological indices. Conversely, Manzoor *et al.,* (2003) reported genotype-associated differences in the haematological parameters of broiler lines. Placement density did not exert any influence on the haematological characteristics, as very similar values were recorded for the three stocking rates investigated.

The two strains under consideration appeared to be similar in their serum biochemical values. However, Abor Acres seemed to have better numerical mean values for total protein, albumin, glucose and creatinine. Serum biochemical parameters were also not density dependent. This is an indication that the body homeostasis, and hence health of the birds were not adversely disturbed as a result of housing the birds up to 14.3 birds/m^2. Using linear trend analysis, Thaxton *et al.* (2006) reported that stocking density did not cause physiological adaptive changes indicative of stress. Skomorucha and Muchacka (2007) submitted that the level of biochemical indicators was affected by animal density, although this manifested greatly in birds placed under housing density of 17 birds/m^2, which is quite higher than the 14.3 birds/m^2 reported in the present study.

5 CONCLUSIONS

The study has shown that genotype had no significant effect on gait score, foot and hock burns feather score, pecking, pushes, chases, fights and mortality of broilers. Conversely, stocking density significantly influenced incidence of pushes, chases and fights with higher mean values recorded for birds reared at 14.3 birds/m^2. There was no genotype and stocking density effects on the haemotological parameters. Serum biochemical indices were also not significantly affected by placement density. Genotype × stocking interaction effects were not observed in all the parameters investigated. It is concluded that the two strains could be reared at a stocking density of 14.3 birds/m^2, since density did not negatively affect the physiological adaptive responses of birds. This will eventually guarantee high yield per unit area, which could assist livestock farmers and the entire populace in poverty alleviation under the climatic and production conditions of this study.

6 REFERENCES

Aerni V., Brinkhof M.W.G., Wechsler B., Oester H., Frohlich E. 2005. Productivity and mortality of laying hens in aviaries: a systematic approach.World's Poult. Sci. J., 61: 130–142

Albentosa M.J., Kjaer J.B., Nicol C.J. 2003. Strain and age differences in behaviour, fear response and pecking tendency in laying hens. Br. Poult. Sci., 44: 333–344

Anderson K.E., Davis G.S., Jenkins P.K., Carrol A.S. 2004. Effects of bird age, density and molt on behavioural profiles of two commercial layer strains in cages. Poult. Sci., 83: 15–23

Davice J.U., Lewis S.M. 1991. Practical haematology. 8th Edition. London, Longman Ltd.: 22–68

Dawkins C., Donnelly A., Jones T.A. 2004. Chicken welfare is influenced more by housing conditions than by stocking density. Nature, 27: 342–344

Dozier III W.A., Thaxton J.P., Branton S.L., Morgan G.W., Miles D.M., Roush W.B., Lott B.D., Vizzier-Thaxton Y. 2005. Stocking density effects on growth performance and processing yields of heavy broilers. Poult. Sci., 84: 1332–1338

Imaeda N. 2000. Influence of the stocking density and rearing season on incidence of sudden death syndrome in broiler chickens. Poult. Sci., 79: 201–204

Jensens P., Toates F.M. 1997. Stress as a state of motivational system. Appl. Anim. Behav. Sci., 53: 145–146

Kjaer J.B., Sorensen P. 2002. Feather pecking and cannibalism in free-range laying hens as affected by genotype, dietary level of methionine + cystine, light intensity during rearing and age at first access to the free range. Appl. Anim. Behav. Sci., 76: 21–39

Manzoor A., Cheema M.A., Qureshi A., Havenstein G.B. 2003. A comparison of the immune profile of commercial broiler strains when raised on marginal and high protein diets. Int. J. Poult. Sci., 2: 300–312

Nielsen B.L., Thomsen M.G., Sorensen P., Young J.F. 2003. Feed and strain effects on the use of outdoor areas by broilers. Br. Poult. Sci., 44: 161–169

NIMET. 2008. Nigerian Meteorological Agency, Lafia, Nasarawa State

Olukosi O.A., Daniyan O.C., Matanmi O. 2001. Effects of feeder space allowance on agonistic behaviour and growth performance of broilers. Livestock Research for Rural Development, 13. http://www.cipav.org.co/lrrd/lrrd13/1/oluk131.htm

Ravindran V., Thomas D.V., Thomas D.G., Morel P.C.H. 2006. Performance and welfare of broilers as affected by stocking density and zinc bacitracin supplementation. Anim. Sci. J., 77: 110–116

Skomorucha I., Muchacka R. 2007. Effect of stocking density and management on the physiological response of broiler chickens. Annals Anim. Sci., 7: 321–328

Sorensen P., Su G., Kestin S.C. 2000. Effects of age and stocking density on leg weakness in broiler chickens. Poult. Sci., 79: 864–870

Spinu M., Benveneste S., Degen A.A. 2003. Effect of density and season on stress and behaviour in broiler breeder hens. Br. Poult. Sci., 44: 170–174

SPSS. 2001. Statistical Package for the Social Sciences. New York, SPSS Inc.

Talebi A., Asri-Rezaei S., Rozeh-Chai, Sahraei R. 2005. Comparatative studies on haematological values of broiler strains (Ross, Cobb, Arbor-acres and Arian). Int. J. Poult. Sci., 4: 573–579

Thaxton J.P., Dozier III W.A ., Branton S.L., Morgan G.W., Miles D.M., Roush W.B., Lott B.D., Vizzier-Thaxton Y. 2006, Stocking density and physiological adaptive responses of broilers. Poult. Sci., 85: 819–824

Thomas D.G., Ravindran V., Thomas D.V., Camden B.J., Cottam Y.H., Morel P.C.H., Cook C.J. 2004. Influence of stocking density on the performance, carcass characteristics and selected welfare indicators of broiler chickens. N. Z. Vet. J., 52: 76–81