Effects of housing systems on behavioural assessment, bone morphometry and faecal egg counts of broiler chickens

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Abstract

Animals that are well-managed thrive and produce better than those kept under conditions which do not take full consideration of their behavioural and welfare needs. This experiment was conducted with one hundred and eighty unsexed one day-old Marshall and Arbor Acre breeds of broiler chickens to investigate the effects of housing systems on behavioural assessment, bone morphometry and faecal egg counts. The birds were brooded for three weeks and acclimatized for one week in their respective housing systems. Each of the housing systems (deep litter and outdoor run) was allotted 90 birds with 45 chicks per breed in three replicates of 15 birds each after balancing for body weights. The birds were fed same quality and quantity of feed and water ad libitum throughout the period of the experiment which lasted for four weeks. Data were collected on behavioural observations, bone morphometry and faecal samples were analyzed to determine the helminthes egg per gram. The experiment was arranged in a 2 x 2 factorial layout in a completely randomized design. The results of behavioural assessment showed that the two breeds of broiler chickens expressed more ($p<0.05$) of their natural instincts in the outdoor run compared with their counterparts on deep litter housing system. Irrespective of breeds, birds reared on outdoor run had higher ($p<0.05$) bone strength ($14.61 N/mm^2$) compared with those on deep litter ($10.68 N/mm^2$). Also, the result of faecal egg counts showed that broiler chickens reared on deep litter had a higher incidence of intestinal helminthes compared with those managed on outdoor run. It was concluded that outdoor run could be adopted to enhance more expression of natural behaviours, better bone strength and reduced incidence of intestinal helminthes in Marshall and Arbor Acre breeds of broiler chickens.

Keywords: Behavioural assessment, bone morphometry, faecal egg counts, housing systems and broiler chickens

Introduction

Behavioural changes are often the first signs of disease and the main signs of distress in animals. Thus, behavioural measurements are often used to assess animal welfare (Ayo *et al*., 2002; Broom, 2003) as it provides information about the well-being of the animals. Behaviour is a reflection of animal's welfare status at a particular moment or its response to stimuli sensed either from the environment or from within the body of the animal (Grandin, 2000). Natural behaviour of modern domestic birds (such as foraging, dust bathing, sun bathing and scratching, to mention just a few) is defined as the behaviour an animal normally presents when provided with adequate space and access to diverse resources similar to its natural habitat (Bracke and Hopster, 2006).

Welfare of broiler chickens can be challenged by multiple factors such as genetic potential for growth, decline of environmental quality, poor management, or excessive density (Dawkins *et al*., 2004; Estevez, 2007), which may result in dermatitis, metabolic, skeletal and muscle disorders, emotional distress or emergence of harmful variants of abnormal behaviours such as feather pecking and hysteria, or both (Dawkins *et al*., 2004; Estevez, 2007;). The study of behaviour of an animal in its environment produces a broad ecological behaviour picture by which the husbandry system adopted by the stockman could be judged whether or not it is found desirable (Albright and Arave, 1997; Ayo *et al*., 2002). Hence, when the management conditions are stable, the behaviour of an animal is relatively stable. This therefore calls for redesigning, modification and clearing of noxious factors that may compromise welfare of animals.

Broilers bred for fast growth have a high incidence of leg deformities because the large breast muscles cause distortions of the developing legs and pelvis, and birds cannot support their increased body weight (Barreiro *et al*., 2011, Shim *et al*., 2012). Therefore, they may develop skeletal disorders or suffer from broken legs, and as well become very inactive, poor foragers, prone to predation, and are generally not suited to small free-range flocks. Hence, innovative management techniques in the area of housing system of poultry had been brought about by the economic stress and effort to strike balance between the scientific recommendations and profitable farming. As a result, this has led to the development of poultry production on different housing systems with adoptable recommendations for resource-poor poultry farmers (Sogunle *et al*., 2013). However, it has been reported that broiler chickens are exposed to risk of parasitic infections regardless of the management systems. Faecal egg count is often regarded as an indication of the severity of parasitic infections and size of the adult worm (Amarante, 2000). The detection of the number of eggs in can be a warning sign of the magnitude of a parasite infection. This study therefore investigated the effects of housing systems on behavioural assessment, bone morphometry and faecal egg counts of broiler chickens.

Materials and Methods

Experimental site

The experiment was conducted at the Poultry Unit of the Directorate of University Farms, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The location falls within the rainforest zone of South-Western Nigeria at longitude 7° 10', 37'N, latitude 3° 26' 58'E and altitude 173m above sea level. The climate is humid with a mean annual rainfall of 1,037mm. The mean annual temperature and humidity are 34.7°C and 82%, respectively (Google Earth, 2014).

Experimental animals, housing and management

A total of one hundred and eighty unsexed one day-old Marshall and Arbor Acre breeds of broiler chicks (ninety birds per breed) were sourced from a reputable commercial hatchery in Abeokuta, Ogun State. The chicks were floor brooded for three weeks in a standard brooding pen, and thereafter acclimatized for one week in their respective housing systems. The deep litter housing system was constructed as an open-sided house and the length of the building was an east-west orientation to minimize exposure to direct sunlight. The roof was made of iron sheet, and the floor was covered with wood shavings as the litter material. It was fully enclosed to protect birds from predators with a dimension of 3m x 3m. Broiler chickens reared on outdoor run were kept in an enclosure with a dimension of 5m x 5m and provided with an area that covered about 25% of the enclosure as mini-shelter.

Each of the housing systems (deep litter and outdoor run) was allotted 90 birds with 45 chicks per breed in three replicates of 15 birds each after balancing for body weights. The experiment lasted for 4 weeks (finishing phase), during which same quality and quantity of feed and clean fresh water were offered *ad libitum.* All medications and vaccination schedules were strictly adhered to.

Data collection

Behavioural study

Ten birds per replicate were marked with non-toxic dyes as focal animals, and their activities in each housing systems were monitored with digital camera. Behavioural observation was conducted between the hours of 10.00 am - 12.00 noon and 02.00 - 03.00 pm twice on weekly basis. Specific behaviours such as dust bathing, sun bathing, scratching, stretching, perching and pecking were recorded from each focal animal and expressed as percentages of frequency of occurrence.

Bone breaking strength determination

At the end of the trial (finishing phase), shanks from fresh carcasses of two birds per replicate were excised and de-fleshed. The bones were individually sealed in sample bags to minimize moisture loss. Thereafter, sample bags were placed in a plastic container and stored at 4°C for one day and later dried at 105°C for a period of 24 hours. The dried bones samples were thereafter placed in dessicators and analyzed for breaking strengths using a shear force measurement as outlined by Wilson (1991). Bone morphometry parameters measured include shank weight, length, width, robusticity index, density and bone breaking strength. The robusticity index and bone breaking strength were calculated as follows:

i. Robusticity index = Bone length/ (bone weight)⅓

ii. Bone breaking strength (N/mm^2) = Force/Area

Procedure for faecal analysis

Total faecal egg count was carried out at the end of the experiment using floatation method at the Parasitology Laboratory, College of Veterinary Medicine, Federal University of Agriculture, Abeokuta, Ogun State. Fresh faecal samples (5g) collected from birds in the housing systems on replicate basis were measured into test tubes containing 1.5ml of floatation fluid. The content was mixed thoroughly with a tongue blade faecal fork to break the faecal ball. The resultant faecal suspension was then poured through a strainer into another test tube and left for 10 minutes. Test tube with faecal suspension was then filled and placed in a test tube stand. The test tube was covered by a cover slip and this was mounted on micro slide for microscopic examination of egg identification using a low power microscope. This simple technique was used in conjunction with the McMaster technique to detect numbers of eggs per gram.

Statistical analysis

Data collected were subjected to one-way analysis of variance in a 2 x 2 factorial experimental layout. Significant ($p<0.05$) differences among treatment means were separated using Duncan's Multiple Range Test as contained in SAS (2003). Descriptive statistics was used to analyze the faecal egg counts.

Results and Discussion

Table 1 showed the main effects of breed and housing system on behavioural assessment of broiler chickens. Breed had significant ($p<0.05$) effect only on aggressive behaviours of broiler chickens with Marshall expressing more of pecking while Arbor Acre expressed fighting behaviour. Housing system on the other hand, significantly ($p<0.05$) influenced all the behavioural indices tested. Broiler chickens reared on deep litter housing system were more aggressive than those on outdoor run which expressed more of their natural behaviours. The aggressive behaviour of birds kept on deep litter is a response to extraneous or stressful stimuli which could arise from lack of freedom to indulge in their normal behaviour patterns or frustration for behavioural needs as cited by Ayo *et al*. (2002). The interaction effects of breed and housing system on the behavioural assessment of broiler chickens (Table 2) showed that both breeds of broiler chickens performed more of their natural instincts in the outdoor run due to access to comfort movements (Guo *et al*., 2012) which are pleasurable, and promote biological functions, thus birds were less susceptible to stress (Miao *et al*., 2004). This also confirmed the report of Leone and Estevez (2008) that even distribution of birds in adequate space and access to diverse resources allows more activity and locomotion thus, reduces disturbances, aggression as well as fear and stress. However, the aggressiveness of their counterparts reared on deep litter resulted in some aspect of threat or attack, directed to other individual of the same species- with the purpose of establishing and maintaining hierarchy within a small group (Loiselet, 2004).

The main effects of bone morphometry of broiler chickens as affected by breed and housing system are shown in Table 3. Breed and housing system had no significant ($p>0.05$) effect on all the parameters measured with the exception of bone breaking strength. There was a significant ($p<0.05$) increase in bone breaking strength from $10.45 N/mm^2$ in Marshall breed to $10.68 N/mm^2$ in Arbor Acre breed. Also, birds reared on outdoor run had greater bone strength ($14.61 N/mm^2$) compared with those kept on deep litter housing system ($10.68 N/mm^2$). This was due to free movement and bumping of shank in the outdoor run as a result of availability of more space for exercises thereby making the leg muscles stronger (Shields *et al*., 2004). Dynamic loading occurs during normal movement and causes stresses and strains to bone and muscle that keep the skeletal system healthy. The interaction effects between breed and housing system on bone morphometry of broiler chickens (Table 4) showed that the value of bone breaking strength required for the shank of birds reared on outdoor run was greater than those reared on deep litter. That is, 20.65N and 20.41N was required to break (Bone Breaking Strength) the shank of Marshall and Arbor Acre breeds of broiler chickens reared on outdoor run, respectively. Lack of exercise or reduced locomotion activities in confinement leads to bone fragility and impaired bone strength, which could affect the profitability of poultry production (Rath *et al*., 2000).

The results of breed and housing system on faecal egg counts of broiler chickens are shown in Figure 1. Marshall breed reared on deep litter and outdoor run housing systems

Table 1: Main effects of breed and housing system on behavioural assessment of broiler chickens

	Breed			*Housing system*		
Parameter	Marshall	Arbor Acre	SEM	Deep litter	Outdoor run	SEM
Dust bathing	33.74	32.22	7.12	27.30^{b}	38.66^{a}	6.60
Sun bathing	25.70	28.52	4.62	0.00^{b}	54.22^{a}	5.83
Scratching	55.97	52.96	5.58	42.65^{b}	66.29^{a}	2.06
Stretching	54.14	54.44	5.31	53.34^{b}	55.24^{a}	4.83
Perching	18.71	19.63	8.38	0.00^{b}	38.34^{a}	1.55
Pecking	27.04^{a}	16.30^{b}	5.27	32.65^{a}	10.69^{b}	2.41
Fighting	5.95^{b}	12.96^{a}	2.73	16.32^{a}	2.59^{b}	1.21

^{a,b}: Means on the same row with different superscripts are significantly ($p<0.05$) different
SEM: Standard Error of Mean

Table 2: Interaction effects of breed and housing system on behavioural assessment of broiler chickens

Breed	*Marshall*		*Arbor Acre*		
Housing system	Deep litter	Outdoor run	Deep litter	Outdoor run	SEM
Parameter					
Dust bathing	37.57^{ab}	29.91^{ab}	17.04^{b}	47.41^{a}	2.96
Sun bathing	0.00^{b}	51.40^{a}	0.00^{b}	57.04^{a}	5.19
Scratching	44.55^{b}	67.40^{a}	40.74^{b}	65.19^{a}	3.92
Stretching	42.98^{b}	65.29^{a}	45.19^{b}	63.70^{a}	1.48
Perching	0.00^{b}	37.42^{a}	0.00^{b}	39.26^{a}	3.23
Pecking	38.62^{a}	15.45^{c}	26.67^{b}	5.93^{d}	1.48
Fighting	11.90^{b}	0.00^{d}	20.74^{a}	5.19^{c}	0.74

^{a,b,c,d}: Means on the same row with different superscripts are significantly ($p<0.05$) different
SEM: Standard Error of Mean

had 433.33 eggs per gram of *Heterakis gallinarum* and 100 eggs per gram of *Ascaridia galli,* respectively. However, Arbor Acre breed reared on deep litter had higher number of *Heterakis gallinarum* (497.16) while those on outdoor run recorded lower number of *Heterakis gallinarum* (83.67). The observation of more eggs per gram in broiler chickens reared on deep litter is synonymous with the findings of Etuk *et al.* (2004) who reported that birds managed on deep litter had a greater incidence of intestinal helminthes as a result of direct contact of birds with litter.

Conclusion

Table 3: Main effects of breed and housing system on bone morphometry of broiler chickens

	Breed			*Housing system*		
Parameter	Marshall	Arbor Acre	SEM	Deep litter	Outdoor run	SEM
Shank weight (g)	2.63	2.94	0.15	2.94	3.03	0.26
Shank length (mm)	3.17	2.52	0.32	2.52	2.57	0.39
Shank width (mm)	0.44	0.56	0.10	0.56	0.43	0.11
Robusticity index	2.31	1.84	0.21	1.84	1.87	0.30
BBS (N/mm^2)	10.45^{b}	10.68^{a}	1.08	10.68^{b}	14.61^{a}	1.01
Bone density (g/mm^3)	0.57	0.57	0.03	0.57	0.61	0.03

^{a,b}: Means on the same row with different superscripts are significantly ($p<0.05$) different
SEM: Standard Error of Mean
BBS: Bone breaking strength

Table 4: Interaction effects between breed and housing system on bone morphometry of broiler chickens

Breed	*Marshall*		*Arbor Acre*		
Housing system	Deep litter	Outdoor run	Deep litter	Outdoor run	SEM
Parameter					
Shank weight (g)	2.43^{b}	2.83^{ab}	3.45^{a}	3.23^{a}	0.20
Shank length (mm)	3.26^{a}	3.09^{a}	1.78^{b}	2.05^{ab}	0.54
Shank width (mm)	0.33^{b}	0.55^{ab}	0.79^{a}	0.31^{b}	0.20
Robusticity index	2.41^{a}	2.21^{b}	1.72^{c}	1.53^{c}	0.31
BBS (N/mm^2)	12.09^{b}	20.65^{a}	9.27^{b}	20.41^{a}	1.42
Bone density (g/mm^3)	0.56	0.59	0.59	0.64	0.01

a, b, c: Means on the same row with different superscripts are significantly ($p<0.05$) different
SEM: Standard Error of Mean
BBS: Bone breaking strength

The study concluded that the rearing of Marshall and Arbor Acre breeds of broiler chickens on outdoor run is advantageous as it allows for a greater expression of their natural behaviours, enhanced bone strength and reduced the incidence of intestinal helminthes.

References

Albright, J.L. and Arave, C.W. 1997. *The Behaviour of Cattle*, CAB International. Edition 7.

Amarante, A.F.T. 2000. Relationship between faecal egg counts and total worm counts in sheep infected with gastrointestinal nematodes. *Revista Brasileira De Parasitol. Veterinaria* 9: 45-50.

Ayo, J.O., Oladele, S.B. and Fayomi, A. 2002. Behavioural reactions of cattle to stress situation; a review. *Journal of Agricultural Technology* 8(2): 15-20.

Bairrero, F.R., Baraldi-Artoni, S.M., DoAmara, L.A., Barbosa, J.C., Girardi, A.M., Pacheco, M.R. and Amoroso, L. 2011. Determination of broiler femur parameters at different growth phases. *International Journal of Poultry Science* 10: 849-853.

Bracke, M.B.M. and Hopster, H. 2006. Assessing the importance of natural behaviour for animal welfare. *Journal of Agriculture and Environmental Ethics* 19: 77-89.

Broom, D.M. 2003. Causes of poor welfare in large animal during transport. *Veterinary Research Communications* 27: 515-518.

Dawkins, M. S., Donnelly, C. and Jones T. 2004. Chicken welfare is influenced more by housing conditions than by stocking density. *Nature* 427: 342-344. Pmid: 14737165

Estevez, I. 2007. Density allowances for broilers: Where to set the limits? *Poultry Science* 86: 1265-1272.

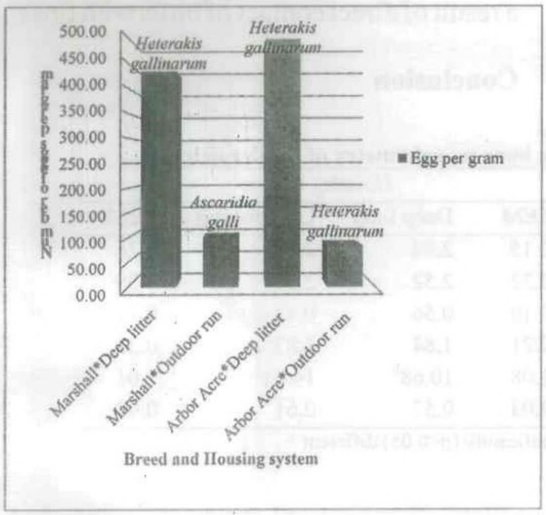

Figure 1: Effects of breed and housing system on faecal egg counts of broiler chickens

Pmid: 17495104

Etuk, E.B., Okoli, I.C. and Uko, M. U. 2004. Prevalence and management issues associated with poultry *Coccidiosis* in Abak agricultural zone of Akwa Ibom state, Nigeria. *International Journal of Poultry Science* 3(2): 135-139.

Google Earth. 2014. Google location map; Google earth imagery date; December 3rd, 2014.

Grandin, T. 2000. Behavioural principles of livestock handling. *American Registry of Professional Animal Scientist*. Colorado.

Guo, Y.Y., Song, Z.G., Jiano, H.C., Song, Q.Q. and Lin, H. 2012. Effect of group sizes and stocking density on the welfare and performance of hens housed in furnished cages. *Animal welfare* 21: 41-49.

Leone, E.H. and Estevez, I. 2008. Use of space in the domestic fowl: Separating the effects enclosure size, group size and density. *Animal Behaviour* 76: 1673-1682.

Loiselet, J. 2004. Behaviour and feather pecking are priority areas for selection. *World Poultry* 7(20): 22-23.

Miao, Z.H., Glatz, P.C. and Ru, Y.J. 2004. Free-range Poultry Production: *A review of livestock systems*, South Australian Research and Development Institute, Roseworthy Campus Roseworthy, South Australia, Australia. 5371, pp 1-20.

Meluzzi, A., Sirri, F., Castellini, C., Roncarati, A., Melotti, P. and Franchini, A. 2009. Influence of genotype and feeding on chemical composition of organic chicken meat. *Italy Journal of Animal Science* 8: 766-768.

Rath, N.C., Huff, W.E. and Balog, J.M. 2000. Factors regulating bone maturity and strength in poultry. *Poultry Science* 79: 1024-1032.

SAS. 2003. Statistical Analysis System. Version 9.3, SAS, Institute Inc. Carry N.C. USA.

Shields, S.J., Remena, R.A., Gainer, J.P. and Mench, J.A. 2004. A dust bathing by broiler chickens; a comparison of preference for four different substrates. *Applied Animal Behaviour Science* 87: 69-82.

Shim, M.Y., Karnuah, A.B., Mitchell, A.D., Anthony, N.B., Pesti, G.M. and Aggrey, S.E. 2012. The effects of growth rate on leg morphology and tibia breaking strength, mineral density, mineral content, and bone ash in broiler chickens. *Poultry Science* 91: 1790-1795.

Sogunle, O.M., Olaniyi, O.A., Egbeyale, L.T., Akinola, O.S., Shittu, T.A., Abiola, S.S., Ladokun, A.O. and Sobayo, R.A. 2013. Free-range and deep-litter poultry production systems: Effect on performance, carcass yield and meat composition of cockerel chickens. *Tropical Journal of Animal Health and Production* 45(1): 281-288.

Wilson, J.H. 1991. Bone strength of caged layers as affected by dietary calcium and phosphorus concentrations, reconditioning and ash content. *British Poultry Science* 32: 501-508.

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