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Broilers Welfare and Economics under Two Management Alternatives on Commercial Scale

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Abstract: An experiment was conducted to clarify the effect of two management systems (cages Vs floor system) on welfare status and economics of broiler chicks. Two commercial flocks each of about 12375 day old Hubbard broiler chicks of mixed sex were housed in two fully environmentally controlled pens (cage and floor pens) from 0-6 weeks of age. Welfare was assessed through bird's performance, behavior, fearfulness and Heterophil: lymphocyte ratio (HLR). Compared to cage reared group, floor reared broilers recorded significantly heavier final body weight, body weight gain, better feed conversion and lower mortalities throughout the whole rearing period (0-6 weeks). Behavioral data showed that, caged birds were more often standing and stereotyped drinking, however floor reared group showed more walking, feeding and pecking. Total prevalence of gait problems and (HLR) were significantly higher in cage than floor group. Economic analysis revealed that, rearing broilers on floor was more profitable than cage rearing system. Data obtained in this experiment suggested that the welfare status of broilers was compromised under cage conditions as indicated by impaired performance, increased mortalities, higher prevalence of leg problems, stereotyped behavior and higher (HLR). In conclusion, cages are not recommended as a management system for rearing broilers from both the economic and welfare points of view.

Key words: Broiler management, performance, behaviour, H/L ratio, economics, broiler housing system

INTRODUCTION

Broiler rearing system is a crucial factor affecting birds comfort, welfare, health and production efficiency. Broiler chickens throughout the world are reared in a variety of production systems, which varies according to so many factors, among which; the dominating environmental conditions, the target size of production and the availability of the financial aspect. There are two basic systems for rearing broilers; floor litter system and cages.

Generally, deep litter system requires more floor space, but, it is very important for satisfaction of the bird's motivation for dust bathing and performing important behavioral activities.

On the other hand, cage constitutes the most economic use of land and labour (Awoniyi, 2003), at the same time social stress is negligible (Swain *et al*., 2002), however, lack of physical space, behavioral restrictions and environmental deficiencies are some disadvantages of cage rearing system (Duncan, 2001).

Several studies have been conducted to elucidate the effect of both systems on broiler performance and economicity. Wang *et al.* (1997) and Thanga *et al.* (2001) favored cage rearing system for better performance, higher survival rate and finally more profits per bird than floor rearing system. However, Turkylmaz *et al.* (2002) concluded that, broilers reared on floor were more profitable than those reared on cages.

On the other hand, Swain *et al.* (2002) found no effect or insignificant effect for either rearing system (Cage Vs Floor) on live weight gain, feed intake and carcass traits. Most of these studies have been conducted on small scales and concerned mainly with profitability of the operation system, regardless of the bird's welfare status in these systems.

Welfare of a bird, is a difficult concept to define and even more difficult to assess. Nevertheless, a variety of indicators, including health, productivity, behavioral and physiological characteristics commonly used to reveal this situation (Cunningham and Mauldin, 1996).

Health problems especially leg disorders in broilers are important welfare and economic issue in poultry industry. Mortality, number of culls and condemnations due to leg abnormalities have been estimated to cause 0.1-0.3 of the total loss (Julian, 1995). Management, genetics and environment are among the factors that influence the occurrence of these problems (Sanotra *et al*., 2001).

Behavioural data also is a good index for birds' welfare evaluation and contributes to explain the more traditional data of production, health and economy (Wegner, 1992).

Freedom from fear has been identified by the UK Farm Animal Welfare Council as one of the five freedoms being important for safe guarding animal welfare. (Webster and Nicol, 1988).

Another approach for the study of birds' welfare in different housing environments is to monitor

physiological parameters associated with reaction to a stressor. Physiological manifestations of stress in poultry include changes in the number of circulating leukocytes in particular a pronounced Heterophilia and Lymphocytopenia (HLR) which is a reliable indicator of stress (Maxwell, 1993; Hester *et al*., 1996; Al-Murani *et al*., 1997).

Therefore, this study was conducted to assess broiler welfare in the 2 housing systems with their different management practices under commercial farm conditions, through examination of birds' performance, behaviour, fearfulness and physiology with special reference to leg condition walking ability and evaluation of the economic aspect of each system.

MATERIALS AND METHODS

Birds and Housing: Two commercial flocks, each of about 12375 day-old Hubbard broiler chicks of mixed sex were used in this experiment. The chicks were supplied to the farm by the same commercial hatchery. On arrival, the 2 flocks were allotted into 2 fully environmentally controlled housing systems, cage and floor litter pens:

Cage housing system: Broiler type cage house of 3 vertical tiers was used in the present study. Six birds were housed in each cage to allow 500 cm^2 floor area/ bird. Each cage was fitted with a front feeding trough allowing 7.5 cm feeder space/bird, 2 fast flow nipples and there was a movable belt underneath each tier for manure collection.

Floor litter house "floor pen": A built-up litter house of 775 m^2 floor area was used for the housing of the second flock. Fine wood shaving was used as litter material and was uniformly distributed to cover the floor area to a depth of 10 cm. The flock was housed at a stocking density of 16 bird/m^2. The house was equipped with automatic pan-feeder system providing one pan-feeder/50 birds and fast-flow nipple system sufficient to provide one nipple/8 birds.

Birds in both houses were allowed free access to fresh water and feed of starter, grower and finisher rations which were formulated to satisfy the strain requirements stated in the broiler management guide.

The 2 flocks received 24 h, continuous photoperiod at light intensity of 10 lux/m^2. House temperature was set through the automatic control system. To be 32°C at the first day which was reduced 0.4°C daily till reaching a temperature of 22°C (±2).

Relative Humidity (RH%) was maintained at 70% during the first week then 50% till the end of the rearing period.

Measured parameters

Performance data: Body weight development, average weight gain, average feed intake/bird (g), efficiency of feed conversion and mortality rate were calculated and recorded weekly up to 6 weeks.

Behavioral measurements: The behavioral states of birds were recorded using scan sampling. Behavioral observation was started at 9 am, where the birds were scanned at 1 min. intervals for a period of 10 min a total of 120 min per pen/day, twice per week.

The number of birds performs each of the following activities; feeding, drinking, object pecking, walking, standing, lying and comfort behavior, was recorded and calculated as percent of the total number.

In floor pen, behavioral observation was conducted on 100 birds in a framed area inside the pen as representative for the whole pen including feeding troughs, drinkers, litter and stocking density. However in cage pen, a number of 12 cages were identified where the cage act as a unit scanned twice per week.

Gait performance test: At the age of 37 days, 50 chicks from each house were randomly chosen to be tested for their gait score. Gait performance was evaluated on a scale ranging from 0-5 according to the gait scoring method described by Kestin *et al*. (1992) as follows: score 0 represented no detectable impairment of walking normal bird, scores 1-4 indicated increased lameness and score 5 meant total inability of the bird to walk. Birds with score 5 were excluded from the test in both groups. The proportions of normal birds and total prevalence of gait problems (gait score >0) were calculated.

Fearfulness measurements: At the age of 39 days, Novel object test was done according to Oden *et al*. (2002) for floor birds and with some modifications for cage birds as follows:

A novel object (a red coloured ball) unknown to the birds of about 7 cm diameter was placed by the observer in the middle of the litter area and inside the cage itself. The reaction of the birds was scored on a scale ranging from 0-4: Zero indicated no noticeable reaction and 4 meant panic among birds. Also, latency of the first bird up to 10 min to peck the novel object. If the bird didn't peck at all, it was given the maximum time for measuring (10 min).

Physiological measurements: At the age of 39 days, twenty birds were randomly selected form each treatment and blood samples were collected via wing vein in tubes containing EDTA as anticoagulant for heterophil to lymphocyte counts. Blood smears were prepared using may-Grunwald- Giemsa stain. One hundred leukocytes including granular (Heterophils Oesinophils and basophils) and non granular (lymphlocytes and monocytes) were counted on one slide for each bird and the Heterophil to Lymphocyte Ratio (HLR) was calculated.

Statistical analysis: SPSS system (statistical package of social science) version 12 for windows 2003 was used. Proportions of normal birds and those with gait problems in both groups were analyzed by a Chi-square test (SAS Institute, 1996). Results of performance, behavior, fearfulness and physiological indices were analyzed between both groups by using t-test (Petric and Watson, 1999). Values were presented as mean±SD. A level of significance as minimal acceptable level was assessed at ($p<0.05$).

RESULTS AND DISCUSSION

Performance data: Performance describing data is important for analysis of bird welfare, where productivity is a good index of well-being and economic success and even slight changes are of major financial importance (Jukes, 1992).

Data obtained in this experiment revealed that, at the age of 6 weeks, floor reared broilers showed significantly ($p<0.05$) better weekly growth rate and heavier final body weight (1862.5±209.11g) than cage reared group which recorded (1616.27±187g) (Table 1). It was clear that, both floor and cage groups showed nearly similar growth pattern (body weight and body weight gain) during the early brooding period (0-3 weeks), however, the difference between both groups tended to increase with age, with the greatest numerical difference during the late growing period 4-6 weeks (Table 1).

Hypes *et al.* (1994) recorded better feed efficiency for cage brooded broilers during the grow out phase Vs floor reared group, however, when feed conversions were adjusted for 21 day weights, there was no treatment effect.

It was noticed that, the total feed consumption (g/bird) was nearly similar between both groups, however, floor reared broilers showed significantly ($p<0.05$) higher average total gain (1822.82±206g) and better feed conversion (1.72) throughout the entire rearing period (0-6W) than cage group which recorded (1566.04±180 g and 1.97) for both parameters respectively (Table 1).

The difference in productive performance is most likely attributed to feed wastage in caged broilers (Hypes *et al.*, 1994).

Data obtained in this study denotes that system of housing had also a marked effect on mortality rate where the total mortality was 7.8 Vs 5.8% in both cage and floor groups, respectively (Table 1).

The higher mortality among caged broilers could be attributed to lack of exercise and limited floor space (Koelkbeck and Cain, 1984).

Results of better growth and productive performance under floor rearing conditions are agreeable with that of Rodriguez *et al.* (2005) and Santoso (2002) who recorded a marked decline in live weight and gain at 42 days also poor feed conversions for birds reared on cages than floor reared ones. Contrarily Wang *et al.* (1997) and Thanga *et al.* (2001) inferred that, cage reared chicks showed improved growth, better feed efficiency and higher survival rate. However, Swain *et al.* (2002) found no or insignificant influence for system of rearing on live weight gain, feed intake and carcass traits of broilers.

Economics: Economic analysis revealed that, rearing broilers in floor system was more profitable than cages. As noticed in (Table 4) floor reared birds recorded lower No. of culled and dead birds (968), while higher No. of sold birds (11407) and total average live body weight (21245.77 kg) than caged group (which recorded 1340, 11035 and 17835.54 kg for the same parameters respectively), together with better feed conversion, where the individual bird consumed 1.72 kg feed to produce 1 kg live body weight (0.250 kg less feed/kg live body weight than caged group). This reflected in higher total net profit for the whole floor pen than cage pen.

These results are parallel to that obtained by Turkylmaz *et al.* (2002) who recorded that, broilers in floor management were more profitable than cage system. However, Wang *et al.* (1997) and Thanga *et al.* (2001), favored cages for more profits per bird than floor rearing system.

Behavioral measurement: Behavioral measurements of broilers under both housing conditions are shown in Table 2. Compared to caged broilers, floor reared birds were more often feeding, walking, lying and object pecking which is a consequence of litter and space availability (Hansen, 1994). However, caged broilers stood and drank significantly ($p<0.05$) more often (Table 2), where standing replaced walking activity, as birds responded to restricted space by increased standing not lying activity due to limited floor space and lack of free locomotive opportunity, a result which is agreeable with that of Tanaka and Hurnik (1992) who recorded that birds in cages show more frequently stereotypies, drinking and food pecking behavior.

It was suggested that, the release of opioids during stereotyped behavior is dearousing and that such behavior may represent a successful coping strategy for alleviating stress (Kostal *et al.*, 1992; Savory *et al.*, 1992).

In contrast to Tanaka and Hurnik (1992), comfort behavior was higher in caged birds than floor reared birds (Table 2) which could be an indication of displacement activity in cages that might be expressed if the performance of a highly motivated behavior is restricted (Hansen, 1994) or if there is competition between motivations.

The difference in behavior patterns between birds in both housing alternatives could reflect different ways of adaptation to the various environments. The adverse

Table 1: Performance data of Hubbard broilers reared on cages and floor litter houses (Mean±SD)

	Age (week)			
Parameter	H. weight	0-1	1-2	2-3
Average body weight (g)				
Floor	39.70±2.5	149.02±9.86	360.13±34.19	656.63±120.17
Cages	40.00±3.29	150.65±10.66	352.19±45.31	636.48±110.5
Average weight gain (g)				
Floor	-	109.32±31.22	211.11±45.41	296.50±66.21
Cages	-	110.65±34.78	201.54±51.25	284.22±70.54
Average feed intake/bird (g)				
Floor	-	125.72	276.55	447.72
Cages	-	134.99	268.19	426.15
Feed conversion (g food/g gain)				
Floor	-	1.15	1.31	1.51
Cages	-	1.22	1.33	1.50
Mortalityrate (%)				
Floor	-	1.70	0.75	0.55
Cages	-	1.80	1.00	0.06

Table 1 Cont.

	Age (week)			
Parameter	3-4	4-5	5-6	Total
Average body weight (g)				
Floor	1032.09±160^{a}	1430.52±198^{a}	1862.52±209^{a}	-
Cages	948.0±136^{b}	1272.08±185.6^{b}	1616.27±187^{b}	-
Average weight gain (g)				
Floor	375.46±81.84^{a}	398.43±89.32^{a}	432.00±92.09^{a}	1822.82±206^{a}
Cages	312.09±75.03^{b}	323.71±84.5^{b}	344.09±88.51^{b}	1566.04±180^{b}
Average feed intake/bird (g)				
Floor	698.36	753.03	838.08	3096.48
Cages	714.69	747.12	805.34	3139.46
Feed conversion (g feed/g gain)				
Floor	1.86	1.89	1.94	1.72
Cages	2.29	2.31	2.32	1.97
Mortalityrate (%)				
Floor	0.30	1.20	1.30	5.80
Cages	0.04	2.40	2.50	7.80

H. weight: Weight at hatching, Means carrying different superscripts indicate significant difference between groups

Table 2: Proportions (%) of birds performing different behavioral activities, Gait performance (%) and Fearfulness indicators (Mean±SD) of Hubbard broilers reared on cages and floor litter houses

	Housing system	
	Floor	Cage
Behavioral activities		
Feeding	14.71±4.5	11.67±3.47
Drinking	4.56±1.31^{b}	8.03±2.53^{a}
Walking	9.29±2.50^{a}	2.85±0.60^{b}
Standing	4.02±1.62^{b}	16.59±3.05^{a}
Lying	60.64±19.87	54.68±17.2
Comfort	3.50±0.84	5.68±1.56
Object pecking	3.29±0.95^{a}	0.50±0.15^{b}
Gait performance		
Normal birds (Gs = 0)	72%^{a}	28%^{b}
Total prevalence of gait problems (Gs>0)	48%^{b}	52%^{a}
Fearfulness indicators		
Reaction	1.50±0.53^{b}	21.30±7.97^{b}
Latency for 1st peck (Sec.).	3.10±0.74^{a}	370.60±217.141^{a}

Gs: gait score. Means carrying different superscripts indicate significant difference between groups

Table 3: Physiological indices of Hubbard broilers reared on cages and floor litter houses

	Measured parameters			
Housing system	Heterophil	Lymphocyte	Heterophil: lymphocyte	Basophil
Floor	23.56±5.36[b]	73.00±4.47[a]	0.33±0.09[a]	2.00±1.94[b]
Cage	34.90±2.85[a]	55.60±4.81[b]	0.63±0.07[b]	5.30±1.64[a]

Means carrying different superscripts indicate significant difference between groups

Table 4: Profit potentials of Hubbard broilers reared on cages and floor litter houses

	Measured parameters				
Housing system	No. of total birds	No. of culled and dead birds	No. of sold birds	Average total live body weight (kg)	Feed conversion
Floor	12375	968	11407	21245.77	1.72
Cage	12375	1340	11035	17835.54	1.97

behavior patterns shown by birds in cages (mostly frequent standing and stereotypy drinking) may indicate that this environment is less appropriate or has a stressful effect for this type of broiler strain which adversely affect their welfare status.

Appleby and Hughes (1991) concluded that, layer welfare was compromised more in battery cages than in well run alternatives due to behavioral restrictions and environmental deficiencies in cages.

Gait performance and walking ability: Leg disorders are serious welfare and economic issues. Seriously lame birds may lose weight and could be culled from the flock. Lame birds are also more likely to be down graded at slaughter.

Results of this experiment indicate that system of housing (Cage Vs floor) had a significant ($p<0.05$) effect on the prevalence of gait problems and impaired walking ability.

It was noticed that, the proportion of birds with score 0 "normal birds" was higher in floor (72%) than cage reared broilers (48%), however, the proportion of those with gait problems (gait score >0) was higher in caged than floor reared group, with total prevalence of gait problems 52 Vs 28% in both groups, respectively (Table 2), the result which is comparable to those recorded by Haye and Simons (1978).

However, Wang *et al.* (1997) recorded similar proportions of leg problems between broilers of both housing systems.

The higher prevalence of gait problems in caged birds may indicate poor welfare status and could be attributed to lack of exercise under confined cage conditions which is one of the causal factors responsible for failure of structure of long bones to strengthen thus resulting in a high incidence of leg problems in commercial meat type chickens (Reiter and Bessei, 1998a, b).

Fearfulness: Fearfulness can be described as a propensity to be easily frightened by a variety of potentially alarming situations (Jones, 1996) and the degree to which a test stimulus is avoided reflects the bird's fear of it (Keer-Keer *et al.*, 1996).

As noticed in Table 2, birds from cages showed significantly higher fearfulness and greater avoidance stress response in the novel object test than floor reared group as indicated by higher reaction to the novel object (3.1±0.23) and longer duration for its approaching and pecking (370.6±68.67 sec) than floor reared birds which recorded lower reaction (1.5±0.16) and shorter duration for object pecking (21.30±2.52 sec) (Table 2).

Hughes and Black (1974) recorded that laying birds from cages exhibited greater fear response than birds housed in pens when exposed to novel object test where birds in pens appeared to lack completely fear responses to the stimulus used.

The higher fearfulness of caged birds could be explained on the basis that caging of hens causes considerable frustration through preventing normal behavior patterns behavioral restrictions including flying and flight response avoidance response. This reflected in greater fear response and compromised welfare status of birds.

Physiological indices: Regarding the physiological responses of birds, in both housing systems, cage reared broilers had a marked heterophilia (34.9±0.9) and basophilia (5.3±0.52) while corresponding lymphocytopenia (55.6±1.52) consequently higher (HLR) (0.63±0.02) than floor reared group which recorded 23.56±1.79, 2±0.64, 73±1.4 and 0.33±0.02, respectively (Table 3).

As H:L ratio has been found to be a successful indicator of stress (Maxwell, 1993; Al-Murani *et al.*, 1997), the increased heterophil: lymphocyte ratio in caged group revealed that cage housing system act as a stressor for broiler chicks . Moreover the increased basophil number indicates a prolonged stress response (Maxwell *et al.*, 1990) especially during the late growing period.

Pop (1990) recorded that; prolonged periods of stress and reduced feed intake are recognized as major causes of reductions in lymphocyte numbers and atrophy of lymphoid organs.

In his experiment, Mench *et al.* (1986) found no difference in heterophil: lymphocyte ratios between floor

and cage housing systems for laying birds, however, they recorded that high density cages might be a stressor for layers.

Conclusion: Data obtained in this experiment suggested that the welfare status of broilers was compromised under cage conditions as indicated by impaired growth performance, increased mortalities, higher prevalence of leg problems, stereotyped behavior, higher fearfulness and H:L ratio. Moreover, it is economically, feasible to use deep litter system for raising broilers instead of cages. In conclusion, cages are not recommended as a management system for rearing broilers from both the economic and welfare point of view.

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