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Assessment of Two Female Broiler Rearing Systems (Traditional and Modern) and Their Repercussion on Wellbeing, Corticosterone Concentration, Lesions in Adrenal Glands and Productive Parameters

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Abstract: The effect of two rearing systems on productive performance and level of wellbeing in broilers reared up to day 46 was assessed. The birds were subjected to two treatments: (T1) traditional rearing (open drinkers, population density of 10.7 birds/m^2 and infrared light bulbs as heating source), with 4 repetitions of 6 birds each and (T2) modern rearing (closed drinkers, population density of 13.8 birds/m^2 and infrared gas brooders as heating source) with 10 repetitions of 6 birds each. The birds were lodged in an experimental house with semi controlled environment and reared according to the breed manual. Production variables that were measured weekly were: feed consumption, body weight, feed conversion and mortality; and finally carcass yield and pigmentation. Wellbeing variables that were measured were lesions in their footpad, hock, breast and walking gait; likewise, serum corticosterone levels were measured and adrenal tissue subjected to microscopic inspection. Results showed a favorable significant difference for T2 in feed consumption, body weight, pigmentation, carcass yield and corticosterone levels; but footpad lesions were found and these were statistically different. Histological changes were observed in adrenal glands. The results suggest that the modern rearing systems enhance better productivity; nevertheless, high population densities may be unfavorable for animal wellbeing.

Key words: Broiler, wellbeing, corticosterone, adrenal glands histopathology

INTRODUCTION

Animal wellbeing preservation has acquired more relevance for poultry breeders; especially to satisfy demands by consumer and diverse activist groups that worry about the physical and mental integrity of animals. In European countries animal wellbeing is highly appreciated and there are more institutions dedicated to its protection there (Welfare Quality Project (WQP); Farm Animal Welfare Committee (FAWC); Food and Agriculture Organization of the United Nations (FAO); just to mention a few). In 1997, the European Union gave animals a new legal status of "sentient beings" in a Protocol annexed to the Amsterdam Treaty, manifesting that they are recognized as creatures capable of feeling strife, harm or suffering and they are not merely merchandize or products (Stevenson, 2002). Developing countries must keep in mind safeguarding animal wellbeing since it is being demanded by the world consumer.

Currently, technological innovations implemented in the poultry industry have greatly contributed to promote animal wellbeing and provide a favorable and optimal microclimate for the birds through the appropriate control of temperature, ventilation and humidity; all, through novel drinking systems that at the same time provide a better quality drinking water; quite different from the traditional equipment and handling practices, where a constant supervision of the equipment was needed to ensure an adequate microclimate.

Population densities are a topic that is continuously analyzed in order to be able to safeguard animal wellbeing of broilers. These vary greatly between countries and the different systems that are employed (SCAHAW, 2000). Lodging of a large amount of birds per square meter is perceived by society as an animal wellbeing concern and it is observable in the population densities that are currently being used at commercial farms (Vanhonacker *et al*., 2008). Nevertheless, in a large scale experiment carried out in the 10 main European companies, different population densities were evaluated and the evidence showed that population density is not a determinant factor in productivity or animal wellbeing. In contrast, it was seen that environmental conditions of the lodgings,

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specifically good ventilation and temperature and humidity control have a greater impact on the productivity and wellbeing variables (Dawkins *et al*., 2004).

There are different ways in which animal wellbeing can be measured: low performance of broilers at the end of the cycle may indicate wellbeing is compromised. There are other specific methods such as: evaluation systems for external lesions in birds, the proportion of heterophils: lymphocytes in blood, corticosterone levels in serum and changes in the histological structure of the adrenal gland.

Due to the fact that modern rearing systems for broilers are being currently criticized this study is carried out to evaluate a traditional rearing system and a modern rearing system comparing the production and wellbeing results of female broilers.

MATERIALS AND METHODS

Research was carried out in an experimental house of the Departamento de Medicina y Zootecnia de las Aves de la Facultad de Medicina Veterinaria y Zootecnia de la Universidad Nacional Autónoma de México. Eighty-four, one day old, Ross 308 line, female broilers, with an average weight of 43 g, from a commercial hatchery were used.

Two treatments were evaluated; they consisted of two different rearing systems: T1 or traditional rearing system (birds were provided with open drinkers [jar type], population density of 937.5 cm^2/bird, equivalent to 10.7 birds/m^2 and electric heating using infrared light bulbs), with 4 repetitions of 6 birds each and T2 or modern rearing system (birds were provided with closed drinkers (nipple type), population density of 725 cm^2/bird, equivalent to 13.8 birds/m^2 and heating by gas breeders (infrared), with 10 repetitions of 6 birds each.

Birds were reared during 46 days in a semi-controlled environment house (located at an altitude of 2240 mamsl) with rigid polyurethane insulation on the roof, air injectors and extractors, wood shavings as bedding, natural light program and the birds received warmth by infrared light bulbs or gas breeders (depending on the treatment) during rearing (0-21 d), after that they were maintained at room temperature using only heat sources whenever temperature would fall more than usual.

Food and drinking water were provided *ad libitum* during all the research period; in the initial phase (0-7 d) initiation feeders were provided and then replaced by finishing feeders. Feed was provided in four phases (pre-initiation, initiator, development and finishing) and the diet was formulated based on the nutritional requirements of the breed.

Weight gain (GP), feed consumption (CA), feed conversion index (ICA) and mortality (M) were measured weekly, the sample size equal to the weekly stock. The degree of pigmentation was measured at the right lateral pectoral apteral region using a reflectance colorimeter on a sample size equal to bird stock at day 46 (18 birds from T1 and 50 birds from T2).

To measure wellbeing, footpad, hock and breast lesions were evaluated according to Ekstrand's grading (1998) on a range of 0-3. Gait was evaluated according to Garner *et al*. (2002) on a range of 0-5. The size of the sample was 15 birds for T1 and 31 birds for T2.

Twelve serum samples were collected for T1 and 26 serum samples for T2 in order to establish corticosterone levels using ELISA in a commercial Kit.

Fifteen birds were randomly selected from T1 and 31 birds from T2 in order to assess carcass yield and percentage relationships between weights of breast, leg and thigh (both with bone and without skin) as compared to carcass weight.

Fourteen adrenal glands were collected from T1 and 31 adrenal glands from T2 and fixed in 10% formalin. The glands were cut with one transverse cut and then 5 µm slices were obtained, then stained with Hematoxylin and Eosin (H and E) to identify cell morphology by light microscopy.

Information that was obtained was analyzed using a multivariate analysis of variance for repetitive measurements (MANOVA) for weekly measurements; analysis of variance for one factor (ANOVA) for the final measurements and Mann-Whitney's U test for animal wellbeing (external lesions). No test for comparing means was used to determine the existence of statistical differences since only two treatments were performed. A significance level of ($p<0.05$) was used and the statistical program was IBM SPSS Statistics 20.

RESULTS AND DISCUSSION

Birds reared with the modern system (T2) had better production parameters than birds reared with the traditional system (T1) (Table 1). T2 showed favorable significant difference at the end of the study period in variables GP ($p = 0.018$) and CA ($p = 0.047$). ICA and M parameters showed no significant difference due to treatments ($p>0.05$). Pigmentation results showed favorable significant difference in T2 only in skin luminosity tones ($p = 0.028$) while for reddening and yellowing tones, similar results were obtained ($p>0.05$).

There was significant difference in carcass yield in favor of T2 ($p = 0.05$). Breast, leg and thigh yields in relation to carcass weight did not show significant difference ($p>0.05$).

In wellbeing evaluation, a lower amount of footpad lesions was observed for T1 ($p = 0.044$); while hock lesions, lesions on breast and gait for both treatments did not differ significantly ($p>0.05$) (Fig. 1 and 2).

Corticosterone levels were 0.73 ng/ml for T1 and 0.36 ng/ml for T2; which were statistically different ($p = 0.003$).

Adrenal glands of T1 birds showed in some individuals hyperplasia of cortical tissue cells with hyperchromasia,

Table 1: Production parameters of broiler females evaluated with a traditional rearing system vs. a modern rearing system from 1-46 days of age

Production parameter	T1	T2	Difference	P
Body weight (g)	2476.6[a]	2735.85[b]	259.25	0.018
Feed consumption (g)	4753.74[a]	5265.96[b]	512.22	0.047
Feed conversion index	1.91	1.92	0.01	0.719
Mortality (%)	25	16	9	0.740
Skin pigmentation				
Luminosity	63.36[a]	65.33[b]	1.97	0.028
Reddening	3.09	2.22	0.87	0.195
Yellowing	23.63	24.27	0.64	0.629
Carcass yield (%)	69.41[a]	71.01[b]	1.6	0.050
Breast yield (%)	37.23	36.44	0.79	0.318
Leg and thigh yield (%)	25.93	26.77	0.84	0.227

*Means with different literal per column are statistically different ($p \leq 0.05$)

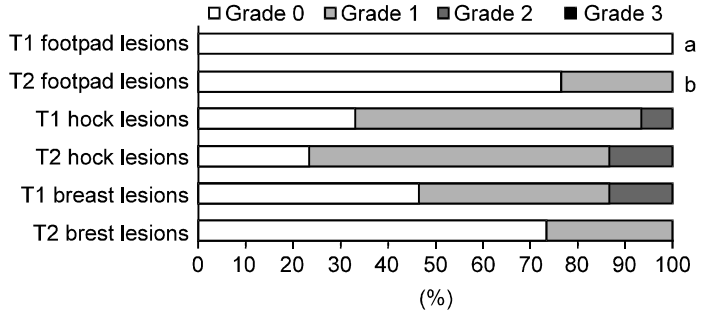

Fig. 1: Comparison of the degree of external lesions in female broilers evaluated with a traditional rearing system vs. a modern system from 1-46 days of age. *Means with different literal per column are statistically different ($p \leq 0.05$)

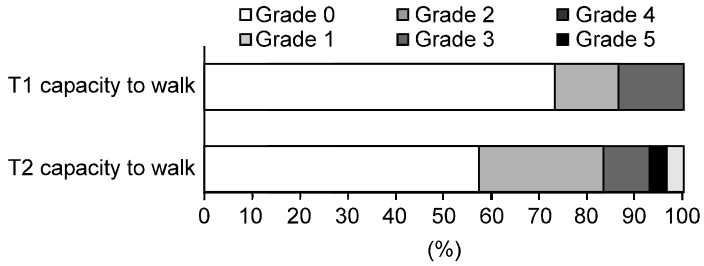

Fig. 2: Comparison of the degree of capacity to walk in female broilers evaluated with a traditional rearing system vs. a modern system from 1-46 days of age

cortical tissue percentage was less when compared to medullar tissue and the percentage of clear nucleus cells was lower than the dark nucleus cells; microscopically in the cortical zone a larger amount of cells with clear nucleus was observed with differing degrees of tumefaction and marked vacuolization (Fig. 1). The degree of tumefaction in adrenal glands of T2 were observed to be less obvious in the clear cell population of cortical tissue and vacuolization was not as manifest with only a few vacuoles corresponding to lipid droplets inside of the cells (Fig. 1); cortical tissue percentage was greater in relation to medullar tissue and the percentage of clear nucleus cells was greater in relation to the percentage of dark nucleus cells. In both treatments variable size accumulations of lymphoid type cells and granulocytes were observed in some glands.

Weight gain and feed consumption differed significantly in regards to the effect of the treatment due to the creation of a different microclimate because of the equipment and population density that was provided which was different to the feed conversion index that derives from the division between feed consumption and weight gain. The infrared light bulbs and gas breeders provided, according to the manual of the breed, an ideal temperature. Nevertheless, the electric heating caused greater variation during cold hours, possibly causing the birds to generate more heat through consumed feed but with a worse productive efficiency.

Mortality was not statistically different when the study period ended although it might be mentioned that

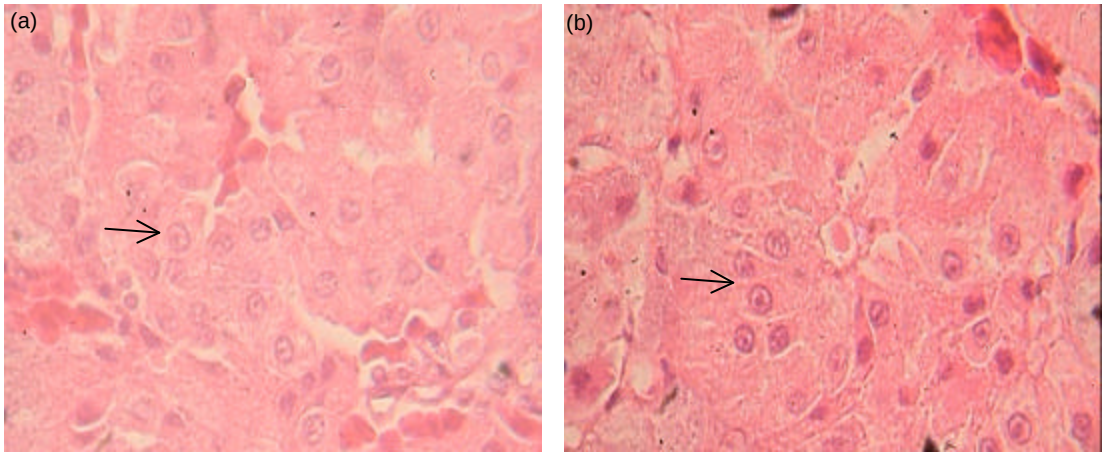

Fig. 3(a-b): Microphotography of the adrenal gland of a 46 day old chicken. (A-T1; B-T2; Arrow-cortical cells) (HE; 100X)

numerically it was higher in T1 (25%) than in T2 (16.66%); with the main cause being the ascites syndrome. Broiler breeding at high altitudes (2240 mamsl) predisposes the birds to cellular hypoxia and in consequence the appearance of ascites syndrome in rapid growth breeds.

Broiler pigmentation is a matter of preference of the consumer in certain countries (mainly in Latin America); this practice has a direct impact on production costs due to low feed consumption, derived from bird discomfort and this directly affects carcass weights that were obtained. The observed information coincides with low feed consumption and therefore less pigmentation and less carcass weight in T1.

Significant difference in production parameters in favor of the higher population density (T2) (even though the birds had less vital space available and in consequence greater contact time with the substrate that excreta propitiated) could be attributed to environmental conditions that were provided by heat sources and open drinkers that established the microclimate; with open drinkers (T1) drinking water comes into contact with the environment and excreta and therefore has a greater amount of contaminants that may influence health of the birds with a reduction of feed and water consumption (water consumption was not measured). Dawkins *et al.* (2004) linked bird health with humid beddings and environmental ammonium perception; in this study, we were able to only associate the presence of humid bedding and lesser vital space (T2 higher amount of birds/m^2) with footpad lesions while lesions of breast, hock and gait showed similar results.

Histological studies of adrenal glands results reveal that T1 had a higher degree of cells with degeneration, possibly caused by stress due to heat source and equipment; likewise, a higher population density was not considered to be a stress factor provided that the environmental conditions are favorable for T2. The degree of histological changes of the adrenal gland under the mentioned stressful conditions may depend on the time of exposure to them. Adrenal gland parenchyma of the T1 birds had a lower amount of cortical tissue than T2; nevertheless, T1 results are quite similar to what was reported by Abdelgader in 2012, with the counting points technique (Weibel, 1963; Aherne and Dunnill, 1982), furthermore, it should be taken into consideration that this research only carried out visual inspection of the relationship of cortical tissue to medullar tissue. Serum corticosterone levels results are in agreement with the degree of histological lesion of the adrenal gland which indicates a stress reaction similar to what was reported by Bedanova *et al.* (2010) and Zikic *et al.* (2011) with exposure to noise as a stressing factor. Corticosterone levels in serum of T2 birds were similar to that which was reported by Rubio *et al.* (2012) in a broiler flock under similar conditions as T2.

Currently, many researches are carried out looking at the prevention of stress factors on birds and thus being able to insure wellbeing in order to comply with society's requests. Lesions may be used to determine the wellbeing of the birds, that when they are evaluated using a grading system, they could indicate the degree of animal wellbeing that is provided by facilities and equipment used for their lodging.

Conclusion: Population density in itself is not a determinant factor for animal wellbeing, this is more closely related with housing environmental conditions. Modern equipment implementation aids in obtaining improved wellbeing in broilers; nevertheless, the use of traditional equipment may also aid in obtaining animal welfare but environmental factors within and outside the house should be taken into consideration.

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