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Evaluating Two Systems of Poultry Production: Conventional and Free-Range

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ABSTRACT

The improvement in production technology was the major factor that lead Brazil to become the third largest poultry producer. The improvement was world´s based on the careful control of several aspects, including which nutrition and management (environment, health and rearing systems). Nowadays, the search for good welfare conditions is a global tendency in animal production. Concomitantly, an extensive production system of free-range broilers has been increasing in Brazil. This study evaluated *in situ* production indexes of two different commercial broiler productions, an intensive and conventional (farm A) and a semi-extensive free-range production (farm B), in order to assess the relationship between productivity and management. It was observed that the physical environment in farm A presented higher temperatures and relative humidity. Based on the results, the production index was better in farm A than in farm B. It was not clear that the production index was related to inadequate welfare of broilers under the conventional rearing system.

INTRODUCTION

Free-range broiler production has increased substantially as a result of the greater demand for the so-called natural products (Silva *et al.*, 2001; Dawkins *et al.*, 2003). This rural activity may represent a profitable alternative for small producers and may offer better broiler welfare as well (Bastianelli, 2001; Heier *et al.*, 2002; McInerney, 2004).

Naked-neck broilers with red feathers (Label Rouge®) have been used in free-range production in Brazil. These birds are more resistant to heat stress when compared to fully-feathered breeds (Silva *et al.*, 2001) as they dissipate sensible heat more efficiently through the naked areas of the body (Singh *et al.*, 2001; Hellmeister Filho *et al.*, 2003).

Bird density in conventional broiler rearing systems directly affects productive indexes as well as bird welfare (Bolis, 2001; Maddocks *et al.*, 2001; Garcia *et al.*, 2002).

There is no clear definition of the best rearing conditions for free-range production in Brazil. Besides, the productive indexes are rather conflicting when compared to conventional production.

The objective of this research was to evaluate productive indexes in two systems of broiler rearing: conventional (totally confined) and free-range (partially confined).

Methodology

The research was carried out in two broiler production farms in the region of Anhembi, SP, latitude 22°45' South, longitude 48°10' West and altitude of 500m. The weather in the region shows predominantly hot and humid summer and moderate cold and dry winter, with average annual temperature of 20.9^{o} C and rain index of 1,230 mm. The data of regional temperature, relative humidity and rain index were collected at the meteorological station Posto Agrometeorológico da Área de Física e Meteorologia – LCE, at Escola Superior de Agricultura – ESALQ (USP), located in Piracicaba County, SP, Brazil, at a latitude 22^{o}42'30'' South, longitude 47^{o}38'00'' West and altitude of 546 m.

The water content of the bedding material (litter humidity) was analyzed at Faculdade de Engenharia Agrícola da Unicamp (FEAGRI). The assessment of the general management of both farms was done in a descriptive way through visual observation. The total period of studying and observation was from November 5th, 2004 to March 15th, 2005.

Both farms were integrated to the same company and the birds were slaughtered in an abattoir with Federal Inspection (SIF) located 74 km from the farms in Pereiras County, SP.

In the conventional housing system (farm A), Cobb®/ Hybro® birds were used. The birds were slaughtered at 45 days of age with an average weight of 2.5 kg. A sex-mixed flock of 14,000 one-day-old chicks was reared in a concrete-floored poultry house measuring 100m x 10m and height of 2.8m, East-West oriented and naturally ventilated with side and roof openings. The roof was covered with white-coated fiber cement tiles. Side walls height measured 0.6m, and wire mesh side openings were covered with yellow plastic curtains. Nipple-type drinkers and tray feeders were initially used; tray feeders were replaced by automatic feeders after three weeks. Initial density was 65-80 chicks/m^2 and was decreased until 14 broilers/m^2 by the end of the growing period. During the initial growing period the chicks were placed inside cardboard brooding circles and heating was provided by gas heaters. The house was equipped with twenty 0.5HP fans placed at every 10m and 2.0m above the floor, and the fogging system along the house had two lines of nozzles at every 10m. Wood shavings were used as bedding material. The diet was based on maize (60.7%), soybean meal (35.3%), dicalcium phosphate (2.2), limestone (0.9%), sodium chloride (0.4%), mineral/vitamin supplement (0.5%)[1], crude protein (20.5%), metabolized energy (2880kcal/kg), calcium (0.97%), and available phosphorus (0.49%), according to the nutritional requirements suggested by the integrator. A growth promoter (12,500mg) and a coccidiostat (15,000mg) were added to the growing diet. The nutritional program was divided into four phases as follows: pre-initial (1-7 days old); initial (8-21 d), growing (22-38 d); and final (39-45 d).

Label Rouge® birds were reared in the free-range system (farm B) and were slaughtered at 80 days of age with mean body weight of 2.0 kg. A sex-mixed flock of 7,150 one-day-old chicks was reared in a house measuring 51m x 12m, and height of 2.0m. The house was East-West oriented, with compacted soil floor and naturally ventilated with side and roof openings. Clay tiles covered the roof and wood shavings were used as bedding material. Side walls measured 0.5m and wire mesh side openings were covered with blue plastic curtains. In the first three weeks, heating was provided by three wood burning stoves. The cardboard brooding circles were gradually opened to provide more floor space and bird density was decreased from 65-80 birds/m^2 to 11birds/m^2 after two weeks. The birds had access to an open area (pasture) of approximately 3,200 m^2 (100m X 32m) after 30 days of age. The area was naturally shaded by *Caruru* bushes during most of the day. Free access to pasture was provided 10-12h/day and the birds were placed inside the house at dusk, where they were kept until the next morning. Bell-type drinkers and initial tray feeders were used; feeders were changed at three weeks of age to larger manual feeders. The paddocks had no drinkers or feeders. Diets were similar to those fed to conventionally-reared broilers, except that there was no addition of antibiotics or other chemical additives or components. The nutritional program was divided into four phases according to the bird age as follows: pre-initial (1-7 d); initial (8-31 d), growing (32-50 d); and final (51-80 d).

Harvesting and transportation procedures from the farm to the abattoir were similar for both flocks.

Environmental data (regional ambient temperature in degrees centigrade and relative humidity in percentage) were collected using four HOBO® H8 data loggers. Readings were recorded at every 90min at the geometric center of the building during the growth period.

The equations described by Dawkins *et al*. (2003) were used to calculate the habitat/ambient use of the area in farm B, and the birds were filmed for 15min at 15, 45, and 75 days of age, both inside the house (close to the door) and in the pasture (under a tree shade),

[1] Provided per kg: Vit. A, 2,500,000 IU; Vit. D3, 500,000 IU; Vit. E, 3,500mg; Vit. K, 600mg; Vit. B1, 150mg; Vit. B2, 1,200mg; calcium pantothenate, 3,000mg; niacin, 8,500mg; Vit. B12, 3,000mcg; biotin, 10mg; choline chloride 50%, 150,000mg; folic acid, 100mg; Co, 40mg; Cu, 3,000mg; Fe, 25,000mg; Mg, 26,000mg; Se, 100mg; Zn, 18,000mg; DL-methionine, 200,000mg; antioxidant, 2,000mg.

focusing on the birds moving out of the house. The recording started only after a 15-min adaptation period, so that the birds would be adapted to the presence of the researcher.

Equation 1 was used to calculate the variation in the use of the habitat and to estimate bird density in relation to the different use of the areas (inside the house and under the shade of bushes and trees).

$$v = \frac{\sum_i (w_i * b_i^2) - [\sum_i (w_i * b_i)^2 / \sum_i (w_i)}{\sum_i (w_i)} \qquad \textbf{Equation 1}$$

where v is the average variation (use of distinct types of habitats) described by the coefficient of variation of expected values (w); i is the number of birds in the pasture; w_i is the number of birds observed in a certain area; b is the reference density (b_i=1); and $\sum_i$ is the total number of considered habitats. The values of w were calculated using Equation 2.

$$w_i = \sum_n [\ \frac{a_i * F}{A}\ ] \qquad \textbf{Equation 2}$$

where a_i is the area occupied by the bird i in the pasture area; A is the total pasture area; and F is the total number of birds in the pasture area. The value $\sum_n$ is the total area occupied by the birds. In this research, the total occupancy area (house + pasture) was considered 100%.

The water content in the bedding material (litter humidity) was assessed using three samples taken from each farm in the last week of rearing. The samples were put into plastic bags and, after removing the air, the bags were hermetically closed and taken to the Faculdade de Engenharia Agrícola da UNICAMP (FEAGRI) under refrigeration. The analysis was performed according to BRASIL (1992). Means of the three samples were calculated and expressed as percentages.

The following productivity indexes were assessed: mortality (M, Equation 3); daily weight gain (DWG, Equation 4); feed consumption; and feed conversion (FC, Equation 5); feasibility (F) and production index (PI, Equation 6), as defined by Araújo *et al.* (2002), Stringhini *et al.* (2003) and Hellmeister Filho *et al.* (2003).

M (%) = (number of dead birds/number of one-day-old chiks) x 100 **Equation 3**

DWG(kg/day) = mean weight at slaughter (kg)/days at slaughter **Equation 4**

FC = total feed intake (kg)/ total body weight (kg) **Equation 5**

P I= (DWG. F)/FC x 100 **Equation 6**

Mortality percentage was calculated taking into account the dead birds from the first day of rearing. Average weight gain was obtained dividing total live weight by the number of harvested birds. Mean feed intake was calculated dividing the total feed intake by the number of harvested birds.

Feasibility was calculated dividing the number of harvested broilers by the number of live birds arriving at the abattoir, multiplied by 100 and expressed as percentage.

Mean feed intake was calculated dividing the total feed intake during production by the total number of birds. A sample of 20 birds was randomly chosen in both farms and the average weight at slaughter was calculated one day before the slaughter.

Flock uniformity in both farms was assessed both directly and indirectly. Direct assessment was performed using the video image of 375 carcasses that were filmed for three periods of 1min (speed of slaughter 7,500 bird/h). Indirect evaluation was performed using equipment records and machinery logbooks in regard to the necessity of adjustments during slaughter.

The general management history of six flocks from the conventional farm and four flocks from the free-range broiler system were used for comparison and in order to help to understand the statistical analysis. A descriptive analysis of the data was done. On the slaughter day, the total weight of birds was recorded. Data were statistically analyzed using Student's t test, and boxplot graphs were built using Minitab®.

RESULTS AND DISCUSSION

Table 1 presents the summarized mean data of ambient temperature, relative humidity and litter humidity.

Ambient temperature inside the houses was significantly different between farms A (conventional) and B (free-range) ($p < 0.0001$). Figure 1 shows the ambient temperature pattern. Average values were 25.15°C in farm A and 26.25°C in farm B. Farm A had an effective high temperature control and the occurrence of large amplitudes during the day was limited, as recommended by Tinôco (1995), Nääs *et al.* (1998) and Moura (2001).

Table 1 - Environmental variables in two systems of broiler rearing: conventional (farm A) and free-range (farm B).

Environmental variables	Farm	
	A (conventional)	B (free-range)
Mean temperature (°C)	25.15[a] (n=781)	26.25[b] (n=1216)
Mean relative humidity (%)	66.80[a] (n=781)	64.90[a] (n=1216)
Litter humidity (%)	64.00[a] (n=3)	28.80[b] (n=3)

Means followed by different letters in the row are different (p<0.05).

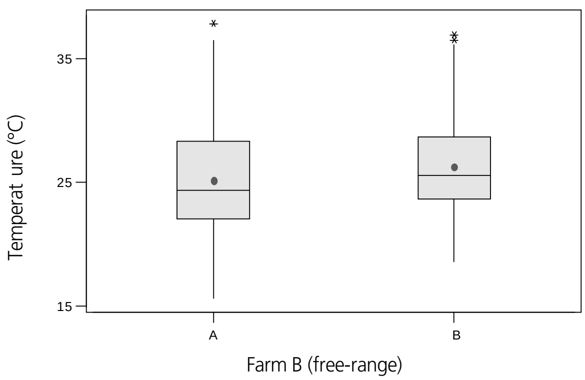

Figure 1 - Environmental temperature inside the houses in two different systems of broiler production: conventional (farm A) and free-range (farm B).

The high mean temperature observed in farm B was expected, since neither fan nor evaporative cooling systems were used. The mean temperature could have been even higher if the broilers had been kept inside the house rather than outside in the pasture. The difference between inside and outside temperature was also statistically significant ($p < 0.001$). Since the outside temperature (22.89°C) was lower than inside temperature (25.85°C), the birds spent most of the day in the pasture (Figure 2). House temperatures in farm A (conventional) and farm B (free-range) were similar in numbers, but were statistically different ($p<0.001$).

Mean litter humidity was 64%. Such value is considered high (Paganini, 2004) and may have influenced the productive indexes as proposed by McFerran (1993). According to Mendes (2001), the structure of the bedding material may cause lesions and losses in broiler production. Litter humidity was 29.8% in farm B, probably due to the low bird density during the daytime (<11 birds/m^2). Figure 3 shows the mean litter humidity in both farms ($p<0.05$)

The broilers barely moved in farm A (conventional), whereas the density in farm B (free-range) was 11 birds/m^2 until 30 days of age. The habitat/environment use (Dawkins *et al.*, 2003) was assessed and it was estimated that 80% of broilers preferred to stay in the pasture even during the winter, while the remaining 20% stayed inside the house.

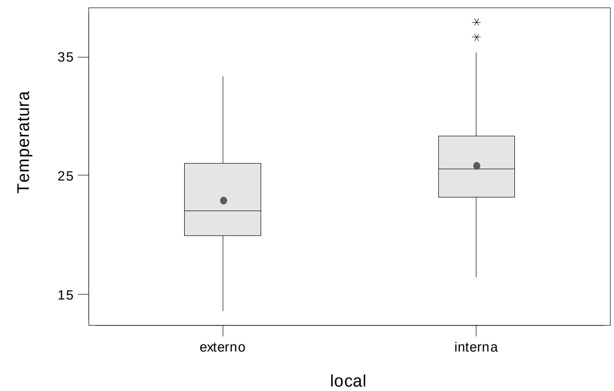

Figure 2 - Mean temperature inside and outside the house in farm B (free-range).

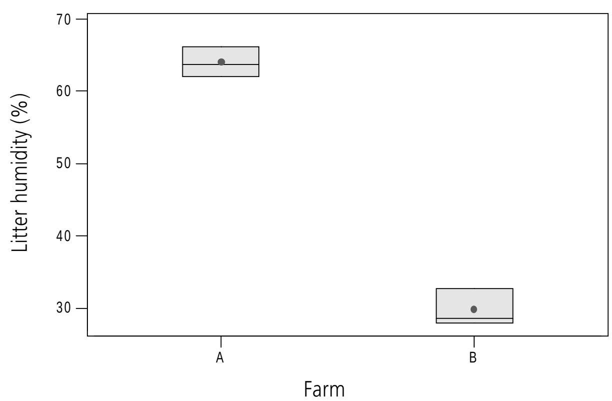

Figure 3 - Litter humidity (%) in rearing systems A (conventional) and B (free-range).

Means of the production parameters are shown in Table 2 (mortality, average weight at slaughter and feed conversion, etc).

Table 2 - Mean productive indexes in farms A and B (conventional and free-range rearing).

Productive index	Farm	
	A (conventional)	B (free-range)
Mortality (%)	5.32[a]	1.34[b]
Final body weight (kg)	2.58[a]	2.10[b]
Feed conversion	1.97[a]	2.98[b]
Age at slaughter (days)	45	80

Means followed by different letters in the row are different (p<0.05) Farm A (n=6 flocks); Farm B (n=4 flocks).

Table 3 presents the results of productive index (PI), daily weight gain (DWG) and feed conversion (FC).

Conventional rearing showed higher mortality (5.32%) than free-range rearing (1.43%) ($p<0.001$), agreeing with findings reported by Hellmeister Filho *et al.* (2003). It is well documented that mortality is influenced by several factors such as exposition to cold weather during the first three weeks, heat stress in the end of the growing period, problems in water distribution, as well as inappropriate housing and bird density (Wang & Edens, 1998; Sorensen *et al.*, 2000; Martrenchar *et al.*, 2000; Heier *et al.*, 2002; Zulkifli *et al.*, 2003).

Table 3 - Mean production indexes in farms A (conventional) and B (free-range).

Production indexes	Farm	
	A (conventional)	B (free-range)
Feed intake*	4.730	6.020
Production index (PI)**	2.702	0.833
Daily weight gain (DWG, kg)	0.056	0.025

Farm A (n=6 flocks); Farm B (n=4 flocks)
* FC= total feed intake (kg)/ total body weight (kg) (Equation 5)
**PI= (DWG. F)/FC. 100 (Equation 6)

Feed conversion (FC) was 1.97 and 2.98 in farms A and B, respectively. Conventionally-reared broilers had better feed conversion than broilers in farm B (free-range) ($p = 0.001$) as shown in Figure 4. Hellmeister Filho *et al*. (2003) reported similar results in free-range Label Rouge®.

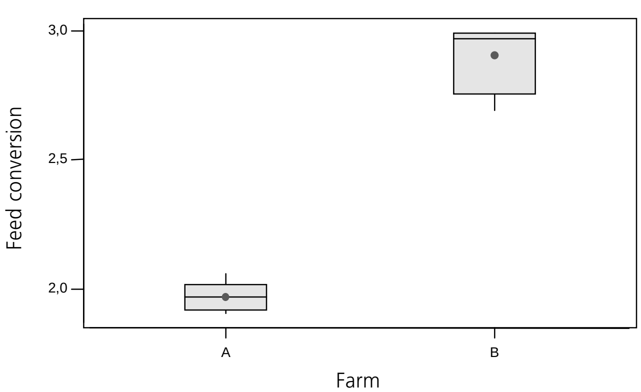

Figure 4 - Feed conversion of broilers reared in farms A (conventional) and B (free-range).

Daily weight gain (DWG) was 0.056 kg/day for the birds from farm A, whereas broilers reared in the free-range system (farm B) gained 0.0252 kg/day. The productive index (PI) was 2.7022 in farm A and 0.833 in farm B. Mean feed intake was 4.74 kg/day in farm A and 6.02kg/day in farm B, and similar results were found by Hellmeister Filho *et al.* (2003).

No differences were found in carcass uniformity using the direct descriptive analysis. Besides, no modifications were needed in the machinery during slaughter, which indicates that carcasses were uniform between the farms (Mendes, 2001).

CONCLUSION

Conventional rearing in farm A presented higher broiler mortality when compared to free-range rearing in farm B. Feed conversion in the free-range system was poorer than in farm A, and both strains followed the expected genetic pattern when exposed to the housing environment. Based on the results, the production index was better in farm A than in farm B. Nevertheless, it was not clear if the production index was related to inadequate welfare of broilers under the conventional rearing system.

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