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Effect of Housing System (Battery Cages Versus Floor Pen) on Performance of Laying Hens under Tropical Conditions in Congo Brazzaville

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Abstract: The aim of the present study was to evaluate the response of laying hens to battery cages under tropical climate in Congo Brazzaville. A Sample of 3,620 laying hens was split in 2 groups of 1,660 each. Each group was replicated 4 times (415 hens ×4) and separately transferred into battery cages (first group). The second group was raised on the floor in a deep litter. Food and water were supplied *ad libitum*. The 2 groups were compared on data collected during 70 days on egg production, egg and shell quality and food efficiency. The battery cages improved significantly ($p<0.05$) egg number (+55%), as well as egg-laying rate (+ 25.3%), mass egg (+59.6%), egg weight (+2.3%). Also, food consumption (199.2 kg versus 155.7 kg/hen/day) and food efficiency (2.7 versus 3.42) were better ($p<0.05$) in caged laying hens than in hens raised in floor pens. However, the battery cages system produced more broken eggs (+1.08%). There was no difference in egg and shell quality between the 2 groups. Egg production and food efficiency being the major index of performance of commercial layer business, the battery cages may be preferred. However, because of the percentage of broken eggs in cages and the high cost of the battery cages, an economical study is needed to investigate the profitability of each housing system and therefore to validate one of the two housing systems in Congo.

Key words: Battery cages, litter floor, laying hens, eggs, egg quality, Congo

INTRODUCTION

High temperature is detrimental to efficient production and reproduction by poultry. They reported that under elevated temperatures, feed intake and egg production are depressed (Njoya and Picard, 1994; Banga-Mboko *et al*., 2007). In tropical climate, one way to alleviate heat stress on poultry is by improving their habitat. Poultry farmers in developing countries have more housed their poultry in open-sided floor pens than in battery cages (Njoya and Picard, 1994; Badubi and Ravindran, 2004).

Battery cage is a worldwide housing system in modern poultry egg production. This is approximately 90% of all laying hens in commercial production (Awoniyi, 2003; Peterman, 2003). Battery cages and floor pens have been investigated in moderate climate by Al-Rawi and Abu-Ashour (1983), Anderson and Adams (1994), Abrahamsson *et al.* (1996), Van Horne (1996), Azeroul (2005) and Pištiková *et al.* (2006). According to their studies, the main advantages of battery cages are an increased spatial density of birds, an easier control of microclimate, a simplified waste disposal, a reduced labor costs and an easier supervision of individual birds for production level and health status. Results from their works indicate that caged layers had significantly higher production than hens in floor pens and shell thicknesses of the eggs of caged birds were significantly greater than those from hens in floor pens.

On the other hand, Hargreave (1982) and Al-Rawi and Abu-Ashour (1983), in a study in hot climates, showed that floor-housed hens had a higher laying rate and hens consumed more food than hens reared in cages.

In sub-Saharan countries, mostly in Congo Brazzaville, the floor housing with deep litter is the predominant egg production system that is recognized as a low input system. After 3 consecutive civil wars (1993, 1997 and 1999) the national egg production failed down; thus, 86.7% of the demand is imported. Most of the imports are allowed from Central Africa countries and Europe. In order to satisfy the national continuous need of eggs, many private farmers are engaged in the battery cages that are also often imported and used in high ambient tropical climate that is considered as the most harmful effect on egg production.

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Despite the co existence of the two housing systems in egg production in Congo Brazzaville, no evaluation has ever been conducted on these systems. Such an investigation may constitute baseline information on specific aspects of the battery cages and its usefulness in egg production in Congo.

Therefore, the objective of this study was to investigate the battery cage housing and to compare the performance of laying hens housed in floor pens with caged laying hens under the tropical climate in Congo Brazzaville.

MATERIALS AND METHODS

Study areas: The field study was carried out in North Brazzaville at Petronille private farm whereas the laboratory study was set in the Institute for Rural Development at the Marien Ngouabi University. Brazzaville is characterized by a short and a long raining season and also by a short and a long dry season. The experiment was set during the long raining season (March to May 2007) where the average outside temperature ranged between 30 and 35°C.

Birds and experimental conditions: The experimental study included 3,320 Lohmann female day chicks issued. The chicks were first raised on floor pens on litter till the age of 18 weeks. At the age of 18 weeks, the pullets were divided in 2 equal groups consisting of 1,660 pullets each. The first group was divided in 4 flocks of 415 hens each and transferred onto 4 pens covered with a deep litter (control group). The second group of 1660 hens was placed in a room containing battery cages with one level (treated group).

Hens were previously randomly allocated over the experimental units and weighed individually. Based on theses individual weights, one or 2 hens were exchanged between experimental units in order to obtain similar average hen weighted hens and similar variation in all experimental units.

In battery cages, hens were housed in cages measuring 47 ×43 cm with 4 hens/cages in a density of 19 hens m^{-2} as recommended by the manufacturer (Azeroul, 2005), whereas in floor pens, hens were housed at a density of 5 hens m^{-2} as usually required in tropical climate studies (Banga-Mboko *et al*., 2007; Maba, 2008).

The floor pen included nests and an elevated area with a perch. Wood dust was used as a floor substrate in the pens. Each cage and each deep littered floor pen was equipped with an automatic water supply and feeding troughs.

Both groups were subjected to the same natural lighting schedule of 14 h a day during the entire experimental period of 70 days.

Feeding: Food used in the present study was previously tested and contained 2734 Kcal kg^{-1}, 18.1 crude proteins, 151 energy/protein ratio, 3.5% calcium and 0.06% methionine (Banga-Mboko *et al*., 2007). The flocks were vaccinated against Newcastle, Gumboro and Fow Pox diseases.

Measurements: Three classes of variables were measured: variables concerning egg production; those related to egg and shell quality and those concerning feed intake.

Egg production variables: Following the transfer of pullets to cages and on litter floor, egg production was recorded every day from the first laid egg and during 70 days.

These data allowed calculating the age at first egg, the number of eggs laid and the percentage of broken eggs and of shell-less egg.

Egg and shell quality variables: All experiments on egg and shell quality took place in the laboratory of the Institute for Rural Development. From the age of 32 weeks, measurements related to egg quality (yolk weight, albumen height) and shell quality (weight, thickness) were recorded for 30 eggs/pen. In one egg which was weighted and then broken, the yolk was separated from the albumen and weighted. The shell was washed, dried and weighted the following day. The weight of the albumen was estimated as the difference between total egg weight and the sum of the yolk and shell weight. The thickness (mm) of the shell was measured with a caliper on a piece of dried shell.

Food efficiency variables: Over a period of 70 successive days between the ages of 29-33 weeks, food intake was measured. During that period, a total of 300 eggs laid were weighted. The average egg weight was calculated for the 3rd and 4th weeks of the period.

Statistical analysis: Data were processed using Stat view system. Mean values obtained from the floor pen groups and from the battery cage groups were compared using the unpaired t-test. Two means were significantly different when $p<0.05$.

RESULTS AND DISCUSSION

The objective of this research was to study the effect of a housing system on egg production and egg shell quality by using Lhomann laying hens.

Effect of the housing system on the viability of the laying hens: The mortality rate was found to be 0.2% in battery cages versus none in floor pens suggesting that the mortality was affected by housing. This may due to the adaptation of transferred hens in a new environment and also to the high density (19 hens m^{-2} versus 5 hens m^{-2}). Similar findings were reported by Njoya and Picard (1994).

Effect of housing system on age at the first egg: In both group (battery cages and floor pens) the fist egg laid was obtained earlier than 18 weeks. This is in accordance with the reproduction physiology of hens (*Gallus gallus*) in tropical climate (Njoya and Picard, 1994; Banga-Mboko *et al*., 2007).

Effects of housing system on egg production: The results are presented in Table 1. The battery caged improved significantly ($p<0.05$) egg number (+55%), as well as for the egg-laying rate (+25%), egg mass (+59.6%), egg weight (+2.3%). Similar findings were reported by Abrahamsson *et al.* (1996) and Awonyi (2003), suggesting that according to the environment to which layers are exposed, egg production is influenced by the housing system.

However, the battery cages system produced more broken eggs (+2.3%). Such results have been reported by Abrahamsson *et al.* (1996), Al-Awadi *et al.* (1995), Anderson and Adams (1994) and Awoniyi (2003). This difference may be attributed to the behaviour of the hens in floor litter. It is generally accepted that in floor eggs, eggs with a small crack laid on the floor has a greater risk of being broken when hens peck at it. A broken egg will then be eaten very quickly and will not be recorded. In battery cages, all eggs laid in the nests will, instead, roll onto the egg collecting belt, where the hens cannot reach them (Abrahamsson *et al*., 1996).

Effect of the housing system on food intake and food conversion: The corresponding results appear in Table 1. The hens in the battery cages consumed significantly more food than the hens in the floor pens. This was expected in regard with egg production of the laying hens in battery cages. This result contrasts with the report of Al-Awadi *et al.* (1995) who found more food consumption in the hens in the floor pens. According to these authors the higher level of food consumption in their study was attributed to the feed spillage from the floor feeders and also possibly to the extra energy expended by the floor-housed hens in the extra activity.

Table 1: Effect of housing system on egg production and food efficiency in Lhomann laying hens (n = 1,660)

Variables	Battery cages	Floor pens
Age at 1st egg (weeks)	18.000[a]	18.00[a]
Egg number/day	1.176[a]	755.00[b]
Egg weight (g/egg)	62.430[a]	60.97[b]
Egg mass (kg/day)	73.400[a]	46.00[b]
Laying rate (%)	70.800[a]	45.50[b]
Broken eggs (%)	3.000[a]	1.92[b]
Feed intake (kg)	199.200[a]	157.70[b]
Feed conversion	2.700[a]	3.42[b]

Table 2: Effect of the farming system on egg and shell quality in Lhomann laying hens (n = 1,660)

Variables	Battery cages	Floor pen
Egg weight (g)	62.43[a]	60.97[b]
Shell weight (g)	6.80[a]	6.69[a]
Shell-less egg (g)	55.63[a]	54.28[a]
Shell (%)	10.90[a]	11.00[a]
Shell thickness (mm)	0.40[a]	0.47[a]
Albumen weight (g)	35.67[a]	36.38[a]
Yolk weight (g)	18.01[a]	17.68[a]
Yolk/albumen	0.50[a]	0.49[a]

In the same line, 2 means that are not followed by the same superscript number, are significantly different ($p<0.05$)

It was also observed poorer food efficiency in hens in the floor pens. This may be explained by the lower number in egg production in the floor pens as previously found by Awonyi *et al.* (2003). The food efficiency was similar to the value of 2.71 reported by Al-Awadi *et al.* (1995) for caged layers in Kuwait, but lower than the average of 1.70 obtained for similar layer strains under South Africa conditions (Badudi and Ravindran, 2004). These last authors, also, demonstrated a strong and a positive correlation between food intake in a day and eggs produced each day, indicating that hens -day production is strongly influenced by food intake.

Effect of the housing system on egg and shell quality: Results are given in Table 2. The albumen weight, the broken egg weight, the shell weight and the thickness of the shell were more elevated in hens raised in deep litter on the floor; however, the difference was not statistically different. On the contrary the yolk weight was higher in the laying hens in battery cages but once again the difference was not statistically different.

These results are in accordance with those of Abrahamsson *et al.* (1996) who reported no effect on egg quality in their experiments with hens in battery and hens in aviary systems. By contrast Halaj *et al.* (1998), Anderson and Adams (1994) and Pistikova *et al.* (2006) found a lot of differences in egg quality mainly in egg albumen weight and in yolk weight. Theses differences may be due to the different nutrition levels used in their experiments.

CONCLUSION

In this experiment, we thus compared differences in egg production, egg and shell quality and food efficiency in laying hens kept in battery cages versus those raised in floor pens. It is evident from this comparative study that battery cages significantly improve performance when compared with hens raised in floor pens. Parameters in favour of battery cages are related to egg production, food intake and food conversion. Although, shell and egg quality was conserved in both battery cages and floor pens, there was not a clear evidence of difference in both groups concerning these parameters. Therefore, battery cages may be preferred in commercial business. However, economical studies are needed (for example the cost of one kg eggs) to investigate the profitability of each housing system and the usefulness of battery cages under tropical climate in Congo.

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