Comparison of production and egg quality parameters of laying hens housed in conventional and enriched cages

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Production and egg quality parameters between two groups of Isa-Brown hens housed in conventional and enriched cages were evaluated in this experiment. Production parameters (hen-day egg production, hen-day feed consumption, feed consumption per egg) and mortality were recorded daily. Egg quality parameters, as well as number of downgraded eggs, were evaluated monthly during whole laying period. Concerning production parameters no statistical differences among the groups were found. Hen-day egg production in both types of cages has reached similar values (87.57% in conventional and 88.72% in enriched cages). Percentage of downgraded eggs (cracked, soiled) tended to be slightly higher in conventional cages (6.32%) compared with enriched ones (5.99%). Cage enrichment caused an increase in number of broken and cracked eggs compared to the conventional cage housing, however more soiled eggs was recorded in latter cage system. Type of caging significantly affects only egg weight - hens housed in enriched cages lay in average heavier eggs (P<0.05) comparing with hens housed in conventional cages. Other egg quality parameters as egg white height, Haugh units, egg yolk height, egg yolk index, egg shell breaking strength and egg shell thickness are no significantly affected by type of caging. Hen-day egg performance curve at the end of laying period declines more rapidly in conventional cages, the reason should be earlier exhaustion of hens linked with different degree of welfare between observed cage designs.

Keywords: hen performance; egg quality; conventional cage; enriched cage; directive 1999/74EC

Introduction

In 1999 the European Union passed EU Directive 1999/74 EC laying down minimum standards for the protection of laying hens, requiring that battery cages be phased out by 2012 (Appleby, 2003). These should be replaced for enriched cages, which must provide a minimum of 750 cm^2 for each hen, a nest box, a litter area and a claw shortening device (CEC,1999). Obligatory substitution of cages will lead to production costs increase by 13% (van Horne, 2003).

In this way close attention of researchers started to give a production parameters which can hens generate in newly introduced models of cages. More complicated structural arrangement of enriched cages compared to barren conventional cages predict problems with increased number of downgraded eggs. Appleby et al. (2002) observed that hens housed in enriched cages laid in some cases eggs from perches and into litter area and concluded, that such eggs are often downgraded. Similarly Glatz and Barnett (1996) concluded, that presence of the perch in the cage causes broken and soiled eggs increase.

Concerning production quantity Fiks - van Niekerk (2002) concluded that in present models of enriched cages can be the production on the same level as in traditional cages. Some authors refer about slightly lower egg production in furnished cages, but the differences are minimal according to their results. Tauson et al. (2002) compared the egg performance of hens housed in various models of

enriched cages (namely Victorsson, Triotec, Hellmann and Big Dutchman). They refer that in all from observed cages hens reached economically acceptable level of production (19 kg of egg mass per hen for laying period).

The many comparisons of the egg quality in observed cage types are focused to egg weight and egg shell quality.

Appleby et al. (2002) and Jendral et al. (2004) refer about slightly heavier eggs laid from hens housed in conventional cages compared to hens housed in enriched cages. On the other hand Lichovníková et al. (2003) observed higher weight of eggs laid in enriched cages.

Concerning egg shell quality Pokludová et al. (2003) found no statistical differences in egg shell breaking strenght and shell thickness between observed cage types. However Chmelničná (2004) report significantly stronger shells ($P<0.001$), when more space area to hens was given. So we can´t excluding some interrelationship between different stocking densities of housed hens and egg shell quality.

To white and yolk quality relatively less results are related. This area still more observations are needed.

Materials and methods

Experiment was carried out in commercial farm conditions. Production parameters of Isa Brown hens housed in conventional and enriched cage system during the whole 303 day long laying period (10 months) were observed. Hens in both cage types were in the same age and received similar commercial layer diet.

Cage designs:

1.Conventional cages: In each cage of company Kovobel (Czech Republic) were 5 hens housed. The stocking density was 550 cm^2 per hen. Rearing system meet the Directive 1999/74EC criteria. Together 14 789 hens was in this cage type housed. Cage batteries in poultry house were localised into 4 rows. Each row of cage batteries has 3 etages.

2.Enriched cages: Model Eurovent - EU 625 from Big Dutchmann were used. In each cage 22 hens was housed. Cages were fitted with perches, nest box and litter area. Cages similarly meet the Directive 1999/74 EC criteria. Total number of hens housed in enriched cages was 13 431. Cage localisation was similar than conventional cages.

Hen-day production and feed intake were recorded on a daily basis. Number of dowgraded eggs were recorded monthly. These eggs were observed from production of hens housed in two rows of cages (approximately 50% of all hens housed in the poultry house) in both cage systems. Downgraded eggs were divided into three main categories:

- eggs with damaged egg shells (broken, cracked)
- eggs soiled with droppings
- other categories (eggs soiled with egg contents, dust and blood, doubleyolked eggs, eggs with deformations, small sized eggs).

At the beginning of the laying period was selected one stable group of hens in each of observed cage type. From both groups (both cage types respectively) were 30 pieces of table eggs taken away for egg quality analysis on the monthly basis. During entirely laying period 10 analyses were made.

In each egg quality analysis were followed quality parameters observed:

- egg weight (g)
- egg white height (mm)
- Haugh units
- egg yolk height (mm)
- egg yolk index according to the formula :

$$Yolk_{index} = (\text{yolk height in mm} \div \text{yolk width in mm}) \cdot 100$$

- egg shell breaking strenght (N)
- egg shell thickness (mm)

Results were compared and statistically evaluated in Statgraphics 5.0 (ANOVA).

Results and discussion

The hen-day production was recorded daily during the 303 days laying period. Daily feed consumption per hen was calculated according to the feed quantity supplied into storage tank and also according to the number of days when the feed was consumed by hens actually housed at that time.

Table 1 Production parameters of hens (Average results for laying period)

	Conventional cages	Enriched cages	Significance
Hen -day egg production %	87.57	88.72	-
Daily feed consumption per hen g	115.35	115.55	-
Feed consumption per egg g	132.45	130.70	-

No significant results from observed parameters between systems of keeping were found. Hen - day feed consumption was on the same level in both cage types. Slightly higher feed consumption per egg produced in conventional cages were caused by lower egg production of hens housed in conventional cages.

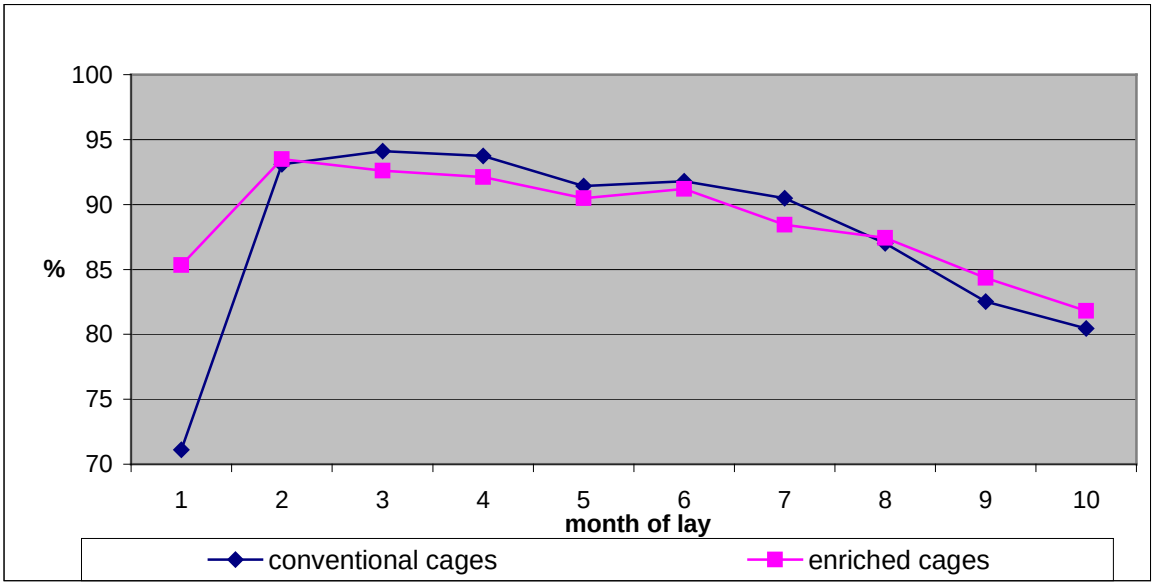

Figure 1 Average hen - day production during the laying period

Very appreciative result of hen - day production (88.72%) was reached by hens in enriched cages, what was in average little bit more compared to hens housed in conventional cages (87.57%). This confirms Fiks - van Kiekerk (2002) conclusion about comparable results in production quantity in both types of cages.

From the Figure 1 (hen-day production development) are visible several interests:

1. The beginning of the laying period: Hens housed in conventional cages laid lower count of eggs at the beginning of the laying period compared to hens in enriched cages (see differences in hen-day production during the first month of laying period), but the differences were erased in the next month. This development in conventional cages signalizes that hens reached sexual maturity a bit later compared to hens in enriched cages.

2. The middle of the laying period: More than 180 days of laying period hens in conventional cages produced in average more eggs than these in enriched cages. Except this the production peak was similarly on the higher level in this cage type. Also hens housed in conventional cages used their production potencial more effectively.

3. The finish of the laying period: From the 9th month of the laying period the hen-day production in conventional cages decreased faster compared to enriched cages. This development is probably

caused by hens earlier exhaustion and partly can be linked with poorer welfare of hens housed in this cage type.
Results concerning quantity of downgraded eggs are shown in Table 2.

Table 2 Percentage of downgraded eggs

Category	Conventional cages	Enriched cages	Significance
Percentage of downgraded eggs (from evaluated)	**6.32**	**5.99**	-
% of eggs with damaged shells (% from downgraded)	0.58 (9.18%)	0.80 (13.36%)	not evaluated
% of eggs soiled with droppings (% from downgraded)	1.15 (18.20%)	0.86 (14.36%)	not evaluated
other categories (otherwise soiled, doubleyolked etc.)	4.59 (72.62%)	4.33 (72.28%)	not evaluated
Total number of eggs evaluated pcs.	55 636	52 774	not evaluated

No significant differences in percentage of downgraded eggs among the cage systems were found. Results refer about slightly lower count in enriched cages. In general low amount of downgraded eggs in enriched cages were reached thanks to plastic curtain fixed round the nest. This can effectively reduce the rolling out speed of egg from the nest and so is the risk of it´s breakage lower. Our observations suggest the appropriate lenght of nest curtain can reduce the speed of 65 g heavy egg at about 20%.

Webster and Hurnik (1990), Duncan et al. (1992), Appleby (2002) and Lichovníková et al. (2003) similarly concluded that cage enrichment leads to increase of number of broken and soiled eggs. Our experiment confirmed still remaining problem with higher amount of broken and cracked eggs in enriched cages. On the other hand the incidence of soiled eggs was less frequent in enriched cages compared to conventional. Similar results observed Abrahamsson and Tauson (1997) in their trial.

In conclusion the observed results reached in enriched cages are indicating on the successful effort the companies and researchers towards to gradual lowering of number of downgraded eggs.

Table 3 Egg quality parameters

Parameter	Conventional cages	Enriched cages	Significance
egg weight g	62.77	63.70	*
egg white height in mm	8.46	8.38	-
Haugh units	90.89	90.13	-
egg yolk height in mm	19.39	19.34	-
egg yolk index	50.10	50.00	-
egg shell breaking strenght N	30.19	29.36	-
egg shell thickness mm	0.404	0.401	-

* $P<0.05$

Hens housed in enriched cages laid significantly heavier eggs ($P<0.05$) compared to hens housed in conventional cages. In other quality parameters were no significant differences found among the cage systems. Egg white and yolk quality was almost unaffected by cage type. Even Pokludová et al. (2003) did not found any significant differences in egg white height, also in parameter which mostly defines egg white quality.

Greater differences, but still not significant, were in egg shell quality achieved. Results signalize some negative correlation between egg weight and its shell strenght. As the egg is larger, its shell strenght declines. This is probably due to larger need of Calcium, which is responsible for shell development. Bain (2005) concluded that egg shell quality is influenced by its structural (thickness, egg size and curvature) and material properties (ultrastructural organisation of calcite minerals). Egg size also can affects the shell strenght. Still isn´t recognized, if the system of keeping hens can directly affect the egg shell ultrastructural organisation.

Conclusions

It can be concluded that no statistical significant differences in hen - day production and feed consumption between hens housed in conventional and enriched cage systems were found. Similarly

percentage of downgraded eggs weren´t affected by system of keeping. Amount of eggs with damaged egg shells (eggs broken and cracked) tended to be higher in enriched cages, but on the other hand more soiled eggs were in conventional cages observed. No statistical significant differences in egg quality except egg weight were found. From hen-day egg performance curve development is visible, that hens in conventional cages can exploit their production potencial more effectively, but simultaneously they exhaust theyself earlier compared to hens in enriched cages. This can be linked with different degree of welfare between observed cage types.

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