Annals of Warsaw University of Life Sciences – SGGW
Animal Science No 52, 2013: 13–22
(Ann. Warsaw Univ. of Life Sci. – SGGW, Anim. Sci. 52, 2013)

Comparison of the laying and egg weight of laying hens in two types of cages

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Abstract: *Comparison of the laying and egg weight of laying hens in two types of cages.* This study was aimed at comparing production results of laying hens kept in two types of cages: furnished cages and conventional cages. It covered the period from the 36th till the 54th week of hens life that was divided into two experimental stages: stage I – from week 36 till week 44, and stage II – from week 46 to week 54. Till week 44, 190 layers were reared in groups (10 hens each) in furnished cages (F) and 190 layers were kept individually in conventional cages (C). In week 45, the hens from furnished cages (F) were moved to conventional cages (FC), whereas these from conventional cages (C) were randomly merged into groups of 10 hens and transferred to furnished cages (CF). Egg laying (%) and egg weight (g) were controlled as well as percentage contribution of eggs in standard egg weight classes was determined in both experimental stages. The study showed a significant ($P \leq 0.01$) effect of cage type on the laying performance of the hens but only in the second stage of the study, as well as a significant ($P \leq 0.01$) effect of hens moving to different cages. In both cases, higher egg laying was reported for the hens from the conventional cages. Egg weight in the first and the second stage of the experiment was significantly ($P \leq 0.01$) higher in the groups housed in the furnished cage. A higher egg weight ($P \leq 0.01$) was determined in the layers in the second stage of the study. Both in the first ($P \leq 0.01$) and in the second ($P \leq 0.05$) stage, analyses showed a significant effect of cage type on the contribution (%) of eggs in particular egg weight classes. A higher percentage of eggs in the L class was obtained from the hens housed in the furnished cages. Differences in laying performance after hens moving suggest that the layers adapt more easily and faster to conditions of the C type cages. The egg weight was, probably, more dependent on general laying performance and age of the hens than on cage type.

Key words: laying hens, types of cage, laying performance, egg weight

INTRODUCTION

Rearing conditions of laying hens are recently arising much controversies, which is due to the implementation of EC Directive 1999/74/EC that stipulates rearing standards for layers in the EU Member States (European Commission 1999). This Directive obliges egg producers to replace traditional battery cages by new furnished cages with an increased area (750 cm^2 per 1 hen) and possessing additional equipment. With no explicit evidence that hens rearing in furnished cages contributes to their improved welfare (Barnett et al. 2009, Tactacan et al. 2009, Lay et al. 2011), producers had to incur vast expenses to modernize their hen houses according to the Directive and in some cases were forced to eliminate their flocks. Too little time has gone since the final deadline of cages replacement (1.01.2012) to conclude on any consequences of these changes to production farms that had adjusted their production standards to Directive guidelines as well as to the laying hens themselves that were the focus of interest in this fight for "rearing conditions improvement" between producers and animal rights defenders. Problems in reconciling these two sides may result from difficulties in the unequivocal determination of animal welfare (Rodenburg et al. 2008). In the case of laying hens, the level of welfare may be determined based on observations of their behavior (Appleby and Hughes 1991), changes in their plumage (Sherwin et al. 2010), their ability to absorb calcium from feedstuff and its further use in the calcification process (Nasr et al. 2012) as well as the incidence of cannibalism symptoms (Gunnarsson et al. 1999). Also production performance may be indicative of the birds adaptation to rearing conditions. Simultaneously, this performance is of the key significance to producers as it determines poultry production profitability (Sosnówka-Czajka et al. 2010). Another important information may as well be provided by observations of birds ability to adapt to altered rearing conditions.

The aim of this study was to compare two production parameters: laying performance and egg weight, of laying hens reared in conventional cages and furnished cage, as well as to compare the impact of a rapid change in rearing conditions on these two parameters.

MATERIAL AND METHODS

The experiment was conducted with two types of three-store cages. Furnished cages (F), with area for 10 hens, equipped according to guidelines of Directive 1999/74/EC (European Commission 1999) – Figure 1, and individual cages, i.e. conventional cages (C), adjusted for individual housing of hens, with area of 1,196 cm^2, height of 44 cm, and equipped only in one nipple drinker and 26 cm long feeders (Fig. 2).

The study included 380 ISA Brown hens: 190 layers kept in groups in furnished cages and 190 layers kept individually in conventional cages. The housing

FIGURE 1. Furnished cages for laying ISA Brown hens at the RZD Wilanów-Obory experimental farm, SGGW (photo J. Riedel)

FIGURE 2. Conventional individual cages for laying ISA Brown hens at the RZD Wilanów-Obory experimental farm, SGGW (photo J. Riedel)

conditions (light program, temperature and air humidity) were consistent with the ISA Brown Management Guide (www.hendrix-genetics.com 2008). All birds were receiving the same powdered feed mixture in the quantity of 114 g per hen daily. The nutritive value of the feed mixture was provided in Table 1.

TABLE 1. Nutritive value of basal diet applied in ISA Brown laying hens

Nutritive value	Unit	Content in diet
EMN	kcal	2 750.00
EMN	MJ	11.60
Total protein	%	17.00
Crude fiber	%	4.40
Crude fat	%	3.90
Ash	%	12.10

In week 45 of hens life, their housing conditions were changed as follows: the laying hens from furnished cages (F) were moved to conventional cages (FC) and housed individually, and the laying hens from conventional cages (C) were randomly merged into groups of 10 birds and transferred to furnished cages (CF). The other housing conditions and feed mixture remained unchanged.

Observations were continued in two stages (9 weeks each). The first stage (from week 36 to week 44) covered the period when the hens were staying in the same cage as at the beginning of production, whereas the second stage (from week 46 to week 54) covered the period since hens transfer to different cages till the end of experiment. The week when the cages were changed (45^{th} week) was not included into any of the stages in order to eliminate the impact of direct stress induced by hens transfer.

Since week 44 to week 54 of hens life, laying performance and egg weight were controlled in hens from both types of cages. The percentage of egg laying was calculated on an everyday and weekly basis. Eggs were weighed 3 times a week, next day after laying. Data achieved enabled calculating: the mean laying performance (%), the mean egg weight (g), and the percentage contribution of eggs in particular egg weight classes (F, C, FC, CF).

The statistical analysis of results was carried out using the statistical package SPSS 21.0 (SPSS 2010). Normality of parameters distribution was verified with the Kołmogorow-Smirnow test (of all parameters examined only egg laying had normal distribution). The effect of cage type, hens age and the effect of cage change on laying performance was examined with one-way analysis of variance. Differences in egg laying between groups in particular weeks were determined with the T-test. The impact of cage type on egg weight was estimated with the Mann-Whitney test, and the impact of cage change – with the Kruskal-Wallis test. The contribution of eggs in particular egg weight classes was compared with the Chi-square test. The differences were considered significant at $P \leq 0.01$ and $P \leq 0.05$. The variability of the investigated traits was expressed by the standard error of the mean (±SE).

RESULTS AND DISCUSSION

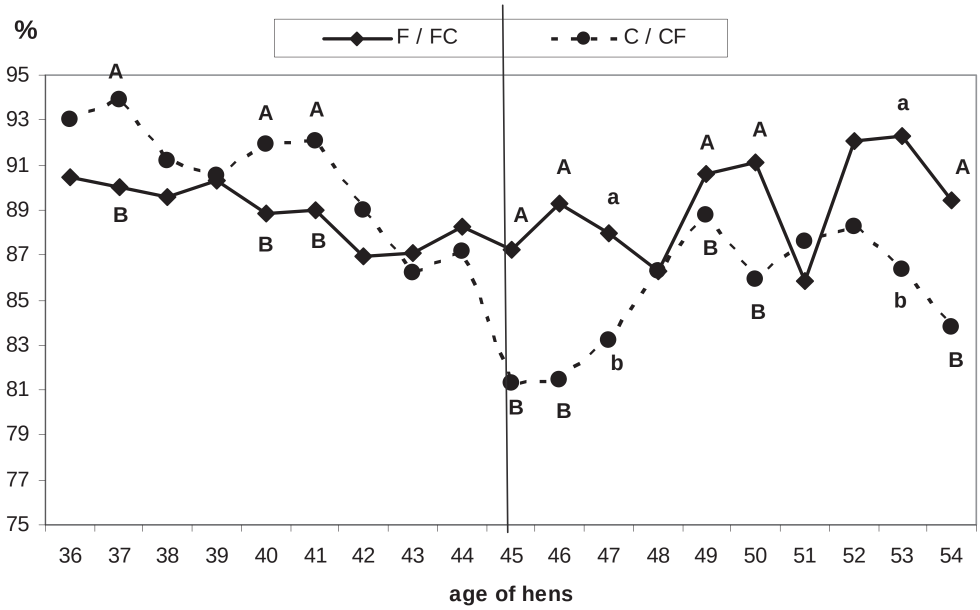
Laying performance

The laying performance of ISA Brown hens kept in both types of cages before the change of the housing system (36–44 week of life) was at a similar level of ca. 89% (Table 2) and slightly lower than the standard values of 91–94% (www.hendrix-genetics.com 2008). A significantly higher ($P \leq 0.01$) laying performance in group C was determined only in week 2, 5 and 6 of observations (Fig. 3), which was however insignificant to the total result from this period. The higher laying performance of hens kept in conventional cages compared to furnished cages was confirmed by Glatz and Barnett (1996), whereas Appleby et al. (2002) as well as Guesdon and Faure (2004) achieved a similar laying percentage in both types of cages. Egg laying was found to depend to the greatest extent on the rapid transfer to a different type of cage. In both groups analyses demonstrated a decrease in laying performance between week 44 and 46 of hens life: by 8.0% in hens moved from group C to group CF, and by 1.0%

TABLE 2. Least squares means (LSM) and SE of the ISA Brown laying hens production (%) depending on cage type

Hens age (weeks)	Laying production (%)				Effect of cage type
36–44	Conventional cage (C)		Furnished cage (F)		NS
	LSM	±SE	LSM	±SE	
	89.5	0.4	88.9	0.3	
46–54	Furnished cage (CF)		Conventional cage (FC)		**
	LSM	±SE	LSM	±SE	
	85.7	0.4	90.4	0.5	
Effect of cage type conversion	**		**		×

**difference significant at $P \leq 0.01$.



a, b – difference significant at P ≤ 0.05; A, B – difference significant at P ≤ 0.01.

FIGURE 3. Weekly laying production (%) of ISA Brown hens during experimental period. F/FC – hens kept in furnished cage and transferred to conventional ones; C/CF – hens kept in furnished conventional cage and transferred to furnished ones

in hens moved from group F to group FC (Fig. 3). The statistical analysis of the entire period after cage shifting demonstrated significantly higher (P ≤ 0.01) laying performance in FC group compared to CF group. Also in the successive weeks of the experiment the higher laying performance was observed in the hens from conventional cages – except for the 4th and 7th week after the change of cages (Fig. 1).

The laying performance of hens moved from group C to group CF decreased significantly (P ≤ 0.01) reaching the maximum value of barely 88.8% in week 50 of hens life and the minimal value of 81.3% in week 46 of hens life (Fig. 3). Undoubtedly the significant difference in the laying performance of hens after movement to a different type of cage was due to the number of birds having both direct and visual contact. Hens kept individually in groups C and FC had only visual contact with two neighboring hens, whereas layers kept in group cages (F and FC) had a direct contact with 9 hens housed in the same cage and visual contact with 20 hens from neighboring cages. It may be speculated that the rapid decrease in laying performance directly after hens transfer from C to CF resulted from a hierarchy being established in a group of hens that have so far been kept individually (Fig. 3). Already after 4 weeks the performance returned to the level determined before cage change. The mean egg production in this period was lower by 3.8% (P ≤ 0.01) compared to the first stage of the study (Table 2). In contrast, hens moved to cages with a significantly lesser area adapted to new housing conditions as early as after a week. It may be speculated that the diminished egg production was caused rather by hens taking out of the cages and their transfer than by the change of rearing conditions. As reported by Lay et al. (2011), the DEFRE (Department for Environment, Food and Rural Affairs 2006) study shows that the method of birds catching and taking out of cages affects their blood level of corticosterone. In addition, in the successive weeks of the experiment analyses showed in this group higher laying performance compared to the period when these birds were housed in the group furnished cages. The laying performance of hens moved from group F to group FC was higher after cage shifting by 1.5% ($P \leq 0.01$; Table 2), reaching the maximum value of 92.3% in week 52 (Fig. 3). It suggests that the direct contact with other hens may be a more stressful factor than the reduction of living space. Investigations by Douglis (1948) demonstrate that hens are capable of recognizing up to 27 other hens and treating them as members of their flock. A higher number of hens in a group induces stress and predisposes to continuous fights for dominance. It seems, therefore, that in our experiment the number of hens and behavioral interactions between them had a greater impact on changes in their laying performance than the size and equipment of cages they were kept in.

Egg weight and egg weight classes

Egg weight in the first and second stage of the experiment was significantly higher ($P \leq 0.01$) in the groups kept in furnished cages (by 0.3 g and 0.4 g, respectively, Table 3). The egg weight was also found to be significantly ($P \leq 0.01$) affected by the change of cage type. In both variants of the change, higher egg weight was determined in hens from the second stage of the study (Table 3). When comparing laying performance of the investigated hens (Fig. 3) and

TABLE 3. Least squares means (LSM) and SE of the ISA Brown hens' eggs weight (g) depending on cage type

Hens age (weeks)	Eggs weight (g)				Effect of cage type
36–44	Conventional cage (C) (*n* = 4 738)		Furnished cage (F) (*n* = 4 608)		**
	LSM	±SE	LSM	±SE	
	61.0	0.07	61.3	0.07	
46–54	Furnished cage (CF) (*n* = 4 109)		Conventional cage (FC) (*n* = 4 669)		**
	LSM	±SE	LSM	±SE	
	62.5	0.08	62.1	0.07	
Effect of cage type conversion	**		**		×
Effect of hens age	** (F = 37.86)		** (F = 15.76)		

**difference significant at $P \leq 0.01$; F – Fischer test.

egg weight it may be concluded that the higher level of laying performance corresponded to lower weight of eggs, and that lower egg production corresponded to higher egg weight. A similar tendency was observed in the contribution of eggs in particular weight classes (Table 4). Both in the first ($P \leq 0.01$) and in the second ($P \leq 0.05$) stage of the experiment a significant effect of cage type was demonstrated on this parameter. Better results were achieved in the case of hens kept in furnished cages: in the first stage (F) they were characterized by a higher number of large eggs (L) and a fewer number of small eggs (S), whereas in the second stage (CF) – also by a higher number of large eggs (L) but also of extra large eggs (XL). In turn, the effect of cage change turned out to be significant only in groups C–CF ($P \leq 0.01$), where a higher number of large eggs (L, XL) and a lower number of small eggs (S, M) were determined after cage change.

The tendency for a lesser egg weight along with a higher egg production has been known for years. Even the study of Jully (1930) demonstrates that hens laying eggs with the weight higher than the average for the flock were characterized by lower laying performance than the hens laying lighter eggs than the average for the flock. It is difficult to conclude explicitly whether the decline of laying performance induced by stress after hens transfer to a different type of cage was due to disorders in the ovulation process or to simply elongation of egg formation period, which normally spans for ca. 24 h (Hiramoto et al. 1990). The longer period of egg formation is usually linked with its longer retention in the shell gland and formation of a thicker shell that may affect its weight (Berg 1945).

TABLE 4. Share (%) of ISA Brown hens' eggs in different weight classes (S, M, L, XL)

Hens age (weeks)	Share of eggs in egg weight classes								Effect of cage type
36–44	Conventional cage (C) (*n* = 4 738)				Furnished cage (F) (*n* = 4 608)				**
	S	M	L	XL	S	M	L	XL	
	3.4%	64.5%	31.0%	1.1%	2.0%	63.3%	33.6%	1.1%	
46–54	Furnished cage (CF) (*n* = 4 109)				Conventional cage (FC) (*n* = 4 669)				*
	S	M	L	XL	S	M	L	XL	
	1.6%	59.7%	37.1%	1.6%	1.5%	63.3%	34.0%	1.2%	
Effect of cage type conversion	**				NS				×

*****difference significant at $P \leq 0.05$; ******difference significant at $P \leq 0.01$; NS **–** difference not significant.
Egg weight classes: S (48–53 g); M (54–63 g); L (64–73 g); XL (>74 g).

The second factor that could contribute to differences in egg weight in the first and second stage of the study was the age of laying hens (Table 3). Baumgartner et al. (2007) and Zita et al. (2009) demonstrated a significant impact of layers age on the weight of laid eggs. According to the ISA Brown Management Guide, the mean egg weight in weeks 36–44 of hen life reaches 64.6 g, whereas in weeks 46–54 it accounts for 65.1 g (www.hendrix-genetics.com 2008). Though the weight of eggs determined in our experiment was lower than the standard values, the differences in egg weight between the subsequent stages of the study could therefore result from various age of the laying hens.

CONCLUSIONS

In summary, the type of cage the laying hens were kept in (conventional cages and furnished cages) had no significant effect on their laying performance in the first stage of the experiment. Differences in egg production after birds transfer suggest that the layers were more easily and faster adapting to conditions of the conventional cages, despite a smaller living space. The weight of laid eggs was, probably, more dependent on the laying performance and age of hens than on cage type. No sound evidence was achieved from results of the analysis of two experimental factors (laying performance and egg weight) to declare the furnished cages as better from the viewpoint of hens laying performance and thus cost-effectiveness of egg production.

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Streszczenie: *Porównanie nieśności i masy jaj kur nieśnych utrzymywanych w dwóch typach klatek*. W badaniach porównywano wyniki produkcyjne kur niosek utrzymywanych w dwóch typach klatek: klatkach wzbogaconych i klatkach konwencjonalnych. Badaniami objęto okres od 36. do 54. tygodnia życia kur podzielony na dwa etapy: I – od 36. do 44. tygodnia, II – od 46. do 54. tygodnia. Do 44. tygodnia 190 niosek utrzymywano grupowo (po 10 kur) w klatkach wzbogaconych (F) i 190 niosek utrzymywano pojedynczo w klatkach konwencjonalnych (C). W 45. tygodniu nioski z klatek wzbogaconych (F) przeniesiono do klatek konwencjonalnych (FC), a ptaki z klatek konwencjonalnych (C) połączono losowo po 10 i wprowadzono do klatek wzbogaconych (CF). W obu etapach badań kontrolowano nieśność (%) i masę jaj (g), określono też procentowy udział jaj w standardowych klasach wagowych. Wykazano istotny wpływ ($P \leq 0{,}01$) typu klatki na nieśność kur, ale tylko w drugim etapie badań, oraz istotny wpływ ($P \leq 0{,}01$) przeniesienia kur. W obu przypadkach większą nieśność wykazywały kury w klatkach konwencjonalnych. Masa jaj w pierwszym i drugim etapie doświadczenia była istotnie większa ($P \leq 0,01$) w grupach utrzymywanych w klatkach wzbogaconych. Większą masę jaja ($P \leq 0,01$) stwierdzono u kur w drugim etapie badań. Zarówno w pierwszym ($P \leq 0,01$), jak i w drugim ($P \leq 0,05$) etapie badań wykazano istotny wpływ typu klatek na udział (%) jaj w poszczególnych klasach wagowych. Więcej jaj w klasie L uzyskano u kur utrzymywanych w klatkach wzbogaconych. Różnice w nieśności kur po przeniesieniu sugerują, że nioski o wiele łatwiej i szybciej adaptują się do warunków klatek C. Masa uzyskanych jaj była bardziej zależna od poziomu nieśności i wieku kur niż rodzaju klatki.

MS. received in November 2013

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