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The effects of free range keeping and cage system on the plumage status of Prelux-G laying hens

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ABSTRACT

Plumage damage was measured on hens of Slovenian provenance Prelux-G in two housing systems. Hens were grown from one-day old as a single group on deep litter. At 18 weeks of age, they were randomly assigned to group of 113 hens in a conventional cage system (group I) and to a group of 50 hens and one cock in a free range system (group II). Plumage observations were performed individually at the age of 36 and 72 weeks. The body of a layer was divided into six parts that were measured for denuded areas. Two parts (wings-primary feathers and tail) were examined for damaged and broken feathers. Significantly worse plumage status was found on the head and neck above, head and neck below, breast and wings-coverts at both recordings (36 and 72 weeks) in the group I compared to group II. In contrast, group I had a significantly better feather status on the back compared to group II that is ascribed to the presence of a cock in group II. Denuded areas significantly increased with age for head and neck above in group I, for head and neck below in both groups and for back also in both groups. At the age of 72 weeks more damage for wing primaries was recorded in group I, while more damage for tail feathers was noticed in group II.
(Keywords: hens, plumage status, free range, battery cages)

INTRODUCTION

Consumers are increasingly interested in the safety and origin of their food and the ethical issues within the production chain. Even though organic poultry are given possibility to species-specific behaviour by allowing access to outdoors and rearing them in free range-systems, organic and other free-range systems present both positive and negative welfare consequences to chickens, as compared to caged and confined systems. For example, feather pecking in laying hens occurs both in conventional battery cages and in alternative housing systems (*Appleby* and *Hughes*, 1991). It causes animal welfare problems, as it may lead to injuries, economic losses because of increased food consumption in deplumed birds and even the death of birds (*Mahboub*, 2004). The status of birds' integument has a considerable impact on the interpretation of their health and welfare. This applies also in evaluation of different housing systems in commercial production. Most studies of laying hen welfare in different housing systems therefore now include an assessment of integument condition (*Tauson et al*., 2005). The present research was part of larger project whose main goal was to get a knowledge about suitability of Prelux-G laying hens to perform under the rules of confined (cages) and organic (free range) production. The aim of this research was to record the welfare status of Prelux-G hens by measuring their plumage status in two housing systems: organic (free range) and conventional battery cages.

MATERIALS AND METHODS

Hundred and sixty-three laying hens of Slovenian provenance Prelux-G were included in the study and reared according to standard deep litter technology till 18 weeks of age. Birds were not beak-trimmed. At 18 weeks of age 113 hens were moved into individual cages (floor area of 1250 cm^2/cage) in the three-floor batteries in the hen-house without windows, while 50 pullets and one cock were placed in the free range. Hens in free range were housed in a brick house. There were 1.8 hens per m^2 in the house on straw and shavings. The brick house was equipped with a sand bath (0.2 m^2 trough with silicious sand), eight individual nests, round drinker, two round feeders, a hen-perch, and a window surface 1.9 m^2. Additional light was provided in free range after 20 weeks of age. The light in battery house was increased gradually until 14 h light: 10 h dark at 31 weeks of age. The free range area varied during the rearing period between 4 m^2 and 12 m^2 per hen. Free range areas were available from the moving-in till the end of rearing. The shortest free range was used in December (6 hours a day) and the longest in summer months (12 hours a day). Since the aim of the study was to compare plumage status of Prelux-G laying hens under Slovenian production conditions the standard feeding mixture for hens in battery cages and certified organic poultry diet for hens in free range were used. Hens in battery cages were fed *ad libitum* on the complete feeding mixture containing 17.0% crude protein and 3.0% crude fat. In free range hens were fed on organic feeding mixture "Biokraft Lege" (Unser Lagerhaus Warenhandels Gmbh, Klagenfurt) with daily controlled amounts. Organization which certify organic poultry and eggs in Slovenia requires that most of the ingredients in poultry rations be organically grown. Because of that we *checked whether a diet is acceptable to organic certifying organization and additionally we analysed the chemical composition of organic feeding mixture which contained 16.0% crude protein and 3.2% crude fat.* Hens finished all feeds. The farmer also strewed 1 kg of oats on litter and depending on the time of the year the hens were able to find a part of their feed by scavenging in the pasture. Feed intake on the pasture was not recorded. All birds were marked with metal leg rings. Hen weight, egg production, feed consumption, mortality and plumage status were recorded. In *Table 1*, the production results as affected by housing system for the Prelux-G laying hens are summarized.

Table 1

Production results by housing system for prelux-G laying hens

Group	Cumulative number of eggs per hen-housed	Hen-housed egg production (%)	Mortality (%)	Feed g/day/hen	Feed g/egg	Body weight at 72 wk of age (kg)
I (cages)	297	80.8	3.5	120.3	147.6	2.5
II (free range)	282	77.5	2.0	135.4*	178.1*	2.4

*without feed found on the pasture.

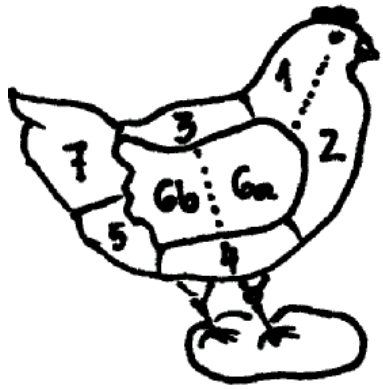
Hen-housed egg production for a production period of 52 weeks was worked using the following formula: 100×total number of eggs produced by a flock/364×total number of hens housed. Cage egg production extended from 17.5% (21 weeks) to 94.4% (33 weeks) with a mean of 80.8%, and similar values for free range egg production ranged

from 9.1% (21 weeks) to 88.8% (35 weeks) with a mean of 77.5% (*Table 1*). The difference between two types of housing systems was only 3.3% of eggs for a period of 52 weeks. Cumulative egg production was 297 eggs/hen-housed in cages and 282 eggs/hen-housed in free range (*Table 1*). Mortality rate during 52 weeks of production period was higher in cages (3.5%) than in free range (2.0%) The feed required per one egg showed better results for the cages (147.6 g/egg) than for the free range (178.1 g/egg, *Table 1*). For scoring of hen' integument several methods of scoring systems (subjective scoring, planimetry) have been presented during the years.

Since using a total body score can only hardly explain or describe possible reasons for the deterioration of the plumage (*Freire et al*., 1999; *Kjaer*, 2000) or wear from different parts of the environment (*Tauson*, 1984) we used planimetry for measuring denuded areas on six body parts (head, neck above; head, neck below; back; breast; abdomen; wings-coverts). Based on the estimation scheme (*Figure 1*) we first measured with a tape measure and later on calculated the surface of denuded and frayed areas. Flight feathers (wings-primary feathers; tail) were differentiated in number and also in damaged compared to feathers from the rest of the body.

Figure 1

The body parts used for measuring plumage status: 1 - head, neck above; 2 - head, neck below; 3 - back; 4 - breast (breast-bone area); 5 - abdomen (back part); 6 - wings (6a – coverts, 6b – wing primary feathers); 7 - tail (adapted from *Keppler et al*., 2001)



Due to the nature of distributions of denuded areas the studied traits were analysed with the procedure GENMOD with generalized linear models. Housing system and age of hens as fixed effects with levels and interaction between them were included into the statistical model. Log-normal distribution was assumed. Since many measurements had value 0 before log calculations, a small positive value (0.01) was added. Damages to the wing primary feathers and tail feathers were not included into statistical analyses because they were not measured but only noticed in the case of presence. Model used was $y_{ijk}= \mu + R_i + S_j + RS_{ij} + e_{ijk}$ where y_{ijk} was assessment of denuded areas on the certain part of hen body; μ was population mean value; R_i was fixed effect of i-th housing system; S_j was fixed effect of j-th age of hens; RS_{ij} was interaction between housing system and age of hens; e_{ijk} was residual.

RESULTS AND DISCUSSION

In both housing systems the most widely extended denuded areas were found on abdomen and breast and the lowest on wings-coverts and back. This is in accordance with *Mahboub* (2004) who at the age of 35 weeks recorded large denuded areas on the breast among Lohmann Traditional hens housed in three systems (poultry house (floor system) without grassland – group I; poultry house (floor system) with 2.5 m^2 grass area/hen – group II; poultry house (floor system) with 10 m^2 grass area/hen – group III). Housing system does not significantly affect the plumage status on abdomen ($p=0.5626$) while for all other parts of the body a significant difference ($p<0.0001$) was noticed between housing systems (*Table 2*). The age of hens had a statistically significant influence on estimated plumage status in all parts of birds ($p<0.0001$). This is in accordance with what was reported in the literature that regardless of used housing systems, feather cover of laying hens usually deteriorates by age (*LaBrash* and *Scheideler*, 2005). The causes of plumage deterioration are mainly two: feather pecking and/or abrasion against equipment. *Bilcik* and *Keeling* (1999) suggested that measuring denuded areas is considered a reliable method for the assessment of feather pecking activity in the flock.

Table 2

Sources of variability and statistical significance of their influence on plumage status in certain parts of birds and estimations of differences between housing system and age (estimated differences are on log scale)

Body part	p-value			Estimated difference ± SE	
	Housing system	Age	Housing system×Age	Housing system	Age
Head and neck above	<0.0001	<0.0001	<0.0001	6.97±0.22	-1.32±0.22
Head and neck below	<0.0001	<0.0001	<0.0001	5.02±0.24	-3.94±0.24
Back	<0.0001	<0.0001	<0.0001	-0.98±0.24	-5.34±0.24
Breast	0.0002	<0.0001	0.2140	1.05±0.27	-2.40±0.27
Abdomen	0.5626	<0.0001	0.1798	-0.14±0.25	-1.64±0.25
Wings-coverts	<0.0001	<0.0001	0.1542	3.22±0.29	-2.78±0.29

SE – standard error.

On the other hand, *Kjaer* (2000) explained that the lack of correlation between feather pecking behaviour and plumage condition might be attributed to the fact that a high intensity of feather pecking soon results in a denudation of most hens, after which point further feather pecking only has a little damaging effect and therefore cannot be documented by scoring of the plumage condition. Scores for plumage condition may be also very useful for explaining causes to increases in energy requirement from poor insulation of the body. In one of such studies *Ward et al.* (2001) discovered that due to the condition of the feathering, in the pectoral region, plumage of free range birds was more resistant to heat loss from the body than that of broiler birds.

The interaction between housing system and age was statistically significant for head and neck above, head and neck below and for back (*Table 2*). Since the interaction between housing system and age had a statistically significant influence on head and

neck above and below as well as on back for these parts of bodies the estimated mean values were exposed.

In head and neck above of hens in battery cages at age 36 and 72 weeks a significant augment of denuded areas was noticed (between 2.86 cm^2 and 39.65 cm^2). In both ages the difference between housing systems referring to the denuded areas were statistically significant ($p<0.0001$), with exception of free range hens at age 36 and 72 weeks ($p=1.0000$).

Concerning the head and neck below the interactions between ages and housing systems were always statistically significant. The antilog of estimations of mean values found significantly increased values at higher age of hens. Therefore denuded areas in battery cages augment with bird age from 10.28 cm^2 to 77.48 cm^2. In free range the denuded areas are smaller but the difference among ages is high (between 0.01 cm^2 and 5.53 cm^2).

Regarding the denuded areas on the back only at age 36 weeks no statistically significant differences among housing systems ($p=1.0000$) was found while in all other cases the influence of housing system in interaction with bird's age was statistically significant ($p<0.0001$). Except head and neck below and neck above the free range hens had more extensive denuded areas on the back during laying period in comparison to the hens from battery cages.

Planimetric measurements of denuded areas on head and neck above and below, back, breast, abdomen and wings-coverts were statistically analysed. We used the method with log measured values. In battery cages the estimations of mean value of back (-2.43) and head and neck below (3.34) (*Table 3*) deviated most. Antilog to the results in Table 3 showed the estimated mean value in cm^2. In back it was 0.18 cm^2 and in head and neck below 28.22 cm^2. In free range the estimated mean value was the highest in abdomen (11.94 cm^2) and the lowest in the head and neck above (0.01 cm^2).

At age 36 and 72 weeks the most frayed and denuded were abdominal areas (4.90 cm^2; 25.28 cm^2) following by head and neck below at age 72 weeks (16.45 cm^2) and breast (18.54 cm^2). *Mahboub* (2004) observed that in free range feather pecking on the belly was the most pronounced followed by rump and tail. From these findings, the belly area was the main region pecked in the hens that spent more time in the outside winter garden. In this run, the target bird spent more time in dustbathing, foraging and scratching and thereby facilitates access to the belly in these positions.

In the battery cages in most hens we found damages to the wing primary feathers at age 72 weeks following by hens with damages to the tail feathers. In free range at age 72 weeks there were nearly half of hens with damages to the wing primary feathers while the percentage of hens with damages to the tail feathers was significantly higher. The damage on the primary wing feathers and tail may be attributed to abrasion at the walls of the passages between inside and outside areas.

Probably due to the abrasions on the cage front was the feather loss on head and neck below more pronounced in the cages than in the free range. According to *Hughes* (1980) feather loss from abrasion is typically worse in cages.

Hens in a free range exhibited significantlly larger denuded areas on backs in comparison with caged hens. This observation may be explained by the presence of mature cock and mating process. The relationship between the presence of cockerels with the hens and feather pecking is unclear. *Odén et al.* (1999) described positive effect of cocks in the flock on reduction of aggressivity, but no effect on feather pecking behaviour. Contrarily, *Bestman* and *Wagenaar* (2003) found the presence of cockerels in the flock of hens to be a factor preventing feather pecking.

Table 3

Least square means (LSM ± SE) for denuded areas in certain plumage areas of hens (LSM are on log scale)

Body part	LSM ± SE			
	Housing system		Age (weeks)	
	Battery cages	Free range	36	72
Head and neck above	2.36±0.15	-4.61±0.16	-1.78±0.15	-0.46±0.16
Head and neck below	3.34±0.17	-1.68±0.18	-1.14±0.17	2.80±0.18
Back	-2.43±0.17	-1.45±0.17	-4.61±0.17	0.73±0.17
Breast	2.24±0.19	1.19±0.19	0.52±0.19	2.92±0.19
Abdomen	2.34±0.17	2.48±0.18	1.59±0.17	3.23±0.18
Wings-coverts	0.21±0.20	-3.01±0.21	-2.79±0.20	-0.01±0.21

LSM – least square mean, SE – standard error.

CONCLUSIONS

The free range hens, in comparison to the caged birds, had significantly better feather condition on head and neck above, head and neck below, breast, wings-coverts and poorer feather condition on back. Caged hens experienced severe feather loss on head and neck below as they rubbed constantly against the wire cages. In free range as well as in battery cages the most extensive denuded areas were found in the abdominal part.

The highest percentage of hens in both housing systems had damages to the wing primary feathers following by tail feathers while damages to the cover feathers were hardly noticed. In battery cages we noticed more frayed feathers and damages to the feathers and skin.

Beside plumage condition welfare of animals can be also assessed by registering mortality. The mortality was higher in the battery cages than in the free range. Claims that conversion to cage-free housing would necessarily increase mortality are thus not supported by present scientific data.

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