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THE EFFECT OF SPACE ALLOWANCE IN THE CAGE AND FLOOR SYSTEMS ON FEATHER CONDITION AND EGG PRODUCTION

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Abstract: The egg production sector is in a transitional period with regard to the permitted housing systems, i.e. rearing in conventional cages under certain conditions to the complete ban of any form of cage system. The changes were caused by concern for the layer wellfare but with the expected effects on productivity as well. The aim of the research was to determine the effects of the floor space allowance in cage and non-cage housing systems on the feather score and egg production of laying hens of three ages, from the aspect of the regulated minimum and optimal space in the cage system (C) and the space provided in the extensive rearing system with hens in smaller groups in the facility (extensive indoor -EI). In order to determine the feather score, the body weight of the laying hens and the weight of the eggs, three groups of laying hens were formed: C4 (564 cm^2 per hen, cage system), C3 (751 cm^2 per hen, cage system) and EI (3000 cm^2 per hen, extensive indoor). The feather score and body weight of laying hens were determined in three ages of hens (30, 40, 50 weeks), by individual assessment and measurement of all hens in the experiment. The hen-day egg production and egg weight were determined in the same weeks of laying age. In addition to the expected decrease in feather score with the age of hens, results indicated a significant interaction between age and space allowance per hen. Observed by individual body parts, as well as based on the overall feather score, the space allowance per hen exhibited a full, cumulative effect at 50 weeks of age. Based on the space allowance, it was possible to rank the overall feather score, with the laying hens with the most space having the best feather score. The effect of the space allowance on the body weight of the laying hens was manifested through the space available on the feeder, which resulted in the lowest ($p<0.01$) body weight

values recorded in laying hens of the C4 group. Egg production was not significantly influenced by the space allowance per hen ($p=0.069$), but a connection between egg production and the housing system can be concluded. The average egg weight, in addition to the known effect of layer age, was the lowest ($p<0.01$) in the group with the least space allowance per hen.

Key words: laying hen, cage, non-cage systems, feather score, egg production

Introduction

Feather condition is an indicator of the health status of laying hens and is one of the parameters used to assess welfare. To some extent, feather damage and wear is a normal process related to the age of the layer. Feather damage occurs as a consequence of feather pecking, an abnormal behavior with a prevalence in the flock between 24 and 94 % *(Mens et al., 2020).*

Previous studies suggest that feather pecking is a multifactorial problem with a genetic basis. Individual selection for high egg production led to changes in behavior patterns and the occurrence of severe feather pecking (SFP), which leads to cannibalism *(Nicol et al., 2013).* In the studies of *Campe et al. (2018)* and *Ozenturk et al. (2022),* differences in feather condition between genotypes of laying hens are related to feather colour. The level of stress and state of fear in the flock has been linked to feather pecking based on the finding of lower corticosterone levels in second-generation hens selected for low mortality due to feather pecking, compared to non-selected hens (*Rodenburg et al., 2013*). Also, the authors indicate the importance of environmental conditions, which, by establishing an interaction effect with the genotype, can lead to certain deviations in the mentioned association. Many factors that exert effects on the welfare of laying hens, causing stress, influence the occurrence of feather pecking *(Mens et al., 2020).*

The effect of the housing system on the condition of the feathers can be manifested through the space allowance and the enrichment of the space. In cage systems, the cage material plays a significant role in the condition of the feathers, and it can increase the wear and damage of the feathers by abrasion *(Widowski et al., 2017)*. In non-cage systems, exposure of birds to feather pecking in large groups is increased. Also, the condition of feathers in non-cage rearing systems is affected by the way manure is managed, through air quality, as well as the type of floor: wire slatted floor or floor with litter (*Decina et al., 2019*). By comparing cage and non-cage housing systems, better feather condition of laying hens was determined in a floor system with litter *(Zorman Rojs et al., 2020; Pichova et al., 2016).* Similarly, in the free range system, a better condition of the feathers was determined compared to the laying hens in conventional and enriched cages (*Dikmen et al.,*

2016). However, there are different study results. *Petrik et al. (2015)* find no differences in feather scores in laying hens reared in conventional cages and floor systems. Similarly, no differences have been demonstrated in the study by *Khumput et al. (2019)* between hens in conventional and enriched cages. In the same study, stocking density in a cage system shows a greater effect on feather condition than cage type. The effects of stocking density on feather condition in non-caged systems are inconsistent, somewhat influenced by group size, and require further investigation *(Nicol et al., 2013; Liebers et al., 2019).*

Poor feathering makes thermoregulation difficult, increases energy needs and, in this sense, increases food consumption *(Sarica et al., 2008).* A high correlation between feathering of hens and food consumption, as well as higher egg production of hens with better feather condition, was confirmed in the study by *Glatz (2001),* while differences in egg weight were not determined.

Changes in the egg production sector related to housing systems are implied by the concern for the welfare of the laying hens. The tendency is to completely abandon cage systems in the EU as inhumane and undesirable. In Serbia, the egg production sector has been in a transition period towards the banning of conventional cages for the last decade. The currently valid legislation on animal welfare allows for laying hens to be reared in conventional cages under certain conditions, which, among others, refer to compliance with the minimum floor space allowance of 550 cm^2 per layer, excluding the feeding area.

Based on the above, the objective of the study was to determine the effects of the floor space allowance in caged and non-caged housing systems on the condition of feathers and the production of laying eggs at three ages, from the aspect of the regulated minimum and optimal space allowance in the cage system (C) and the space provided by extensive rearing of laying hens in smaller groups in the facility (extensive indoor - EI).

Material and Methods

The trial was carried out using Isa Brown laying hens, which at the age of 16 weeks were moved into a facility with conventional cages and into a facility with extensive indoor system that was divided into pens. The cage floor space allowance, per hen was 564 cm^2 and 751 cm^2, respectively, which was achieved by having 4 and 3 hens per cage, respectively. The hens had access to two nipple drinkers per cage and a feeding space length of 12.3 cm and 16.3 cm, respectively. The pen in the extensive indoor system provided floor space allowance of 3000 cm^2 per hen (3 hens/m^2), which allowed the hens considerable mobility within the box. Each box was equipped with two bell feeders, one round drinker and three nests for 20 hens. The pen floor was covered with chopped straw litter. The diet for laying hens was identical for hens in both rearing systems, with the same mixtures according to the hybrid manufacturer's recommendations for each stage of the

production cycle. Other technological norms (lighting, ventilation, temperature) were aligned with the needs of hybrids and were controlled in both facilities. During the production cycle, following parameters were recorded daily: number of eggs, feed consumption, mortality.

In order to determine the condition of the feathers, body weight of laying hens and weight of eggs, three groups of laying hens were formed: C4 (564 cm^2 per hen, cage system), C3 (751 cm^2 per hen, cage system) and EI (3000 cm^2 per hen, extensive indoor), with 3 repetitions (cage tier segment, i.e. pen), a total of 144 laying hens.

The condition of the feathers and the body weight of the laying hens were determined at three ages of hens (30, 40, 50 weeks), by individual assessment and measurement of all the hens in the trial. The hen-day egg production and egg weight were determined in the same weeks of laying age. During each week, three days in a row, all eggs laid within 24 hours were recorded, sampled and measured for each cage, pen, and layer group.

Feather score was determined by evaluating the feathers of five body parts (neck, breast, back, wings and tail). In addition, by summing up the scores, the total feather score was determined. A feather rating scale of 1 to 4 was applied, with a score of 1 indicating complete bare skin or skin with few feathers; 2 – a greater number of exposed places, more than 1/2 of the surface; 3 – a small part of the skin stripped (1/3) or feathers damaged (worn/deformed); 4 – complete feather coverage, undamaged or slightly worn feathers *(Sarica et al., 2008).*

Statistical data processing was performed using the STATISTICA software package (StatSoft Inc., 2012). A two-factorial analysis of variance of the effect of group and laying age on the feather score was applied. In addition, the effect of the group, that is, the floor space allowance, on the condition of the feathers was examined by a one-factor analysis of variance in each of the examined weeks of laying age. Hen-day egg production, body weight of laying hens and egg weight were analyzed by two-factor analysis of variance of the effect of group and laying age. The significance of the differences was assessed by LSD post hoc test. Data for feather score and hen-day egg production were transformed before statistical analysis in arcsine values.

Results

The results of the two-factor analysis of the variance of the effect of the space allowance per layer and their age on the condition of feathers are shown in table 1. A significant influence of both investigated factors, as well as their interaction on the overall feather score, was determined. It is observed that the overall feather score decreased with the age of laying hens and increased with the larger space allowance per layer.

The effect of the layer age showed the same, already mentioned, regularity of decreasing scores with a higher age of laying hens, as well as with regard to the feather score by individual regions of the body. In regard to the examined space allowances per layer, certain deviations were found regarding the influence on the condition of the feathers on the back and breast. The feather scores for the laying hens' back was not significantly influenced by the group, i.e. by the space allowance, nor by the interaction effect of the group and the layer age. The condition of the feathers on the breast was the best scored in the EI group, while the differences between the cage system were not significant regardless of the differences in the floor space allowance.

Table 1. Effects of space allowance and layer age on feather score (scoring scale 1-4)

Feather score, point		Neck	Breast	Back	Wings	Tail	Total
Experim. group	C4	3.10 ± 1.04^{c}	3.17 ± 0.89^{b}	3.47 ± 0.85^{ns}	3.37 ± 0.66^{c}	2.99 ± 1.02^{c}	16.10 ± 3.73^{c}
	C3	3.41 ± 0.87^{b}	3.33 ± 0.76^{b}	3.67 ± 0.64^{ns}	3.54 ± 0.53^{b}	3.33 ± 0.69^{b}	17.29 ± 2.82^{b}
	EI	4.00 ± 0.00^{a}	3.81 ± 0.51^{a}	3.62 ± 0.75^{ns}	3.97 ± 0.16^{a}	3.74 ± 0.46^{a}	19.14 ± 1.23^{a}
Age, week	30	4.00 ± 0.00^{a}	3.93 ± 0.29^{a}	3.97 ± 0.18^{a}	3.83 ± 0.38^{a}	3.89 ± 0.32^{a}	19.61 ± 0.66^{a}
	40	3.66 ± 0.64^{b}	3.45 ± 0.68^{b}	3.65 ± 0.70^{b}	3.64 ± 0.50^{b}	3.34 ± 0.67^{b}	17.75 ± 2.05^{b}
	50	2.82 ± 1.07^{c}	2.91 ± 0.89^{c}	3.13 ± 0.91^{c}	3.40 ± 0.68^{c}	2.82 ± 0.95^{c}	15.08 ± 3.63^{c}
Significance							
Group		***	***	ns	***	***	***
Age		***	***	***	***	***	***
Interaction		***	***	ns	***	***	***

C4-564 cm^2/hen, cage; C3-751 cm^2/hen, cage; EI-3000 cm^2/hen, extensive indoor
NS-non significance; **- $p<0.01$; ***-$p<0.001$; a, b, c- significant differences for the same row

In order to get a clearer view of the effect of space allowance, a one-factor analysis of the effect of space allowance on the feather score in three laying ages was performed (table 2). The obtained results showed that in 30-week-old hens, the floor space allowance had no significant influence on the overall feather score. At the age of 40 weeks, the differences in the overall feather scores were differentiated between the EI group, on the one hand, and the C3 and C4 groups, on the other hand. The overall feather score between the C3 and C4 groups did not differ. At the next age period (50 weeks), overall feather score was clearly differentiated between all three groups in relation to floor space allowance. Laying hens with the largest space allowance (EI) had statistically significantly highest total feather scores and it decreased with the reduction of available space in groups C3 and C4.

Looking at the feather scores by body regions, at 30 weeks of age, the effect of space allowance was manifested only on wing feather scores. A significant difference was found between the EI and C4 groups. At 40 weeks of age, feather scores differed significantly for all body regions, except the back

feather score, between space allowances in EI and C3, or EI and C4. Feathers on the neck were scored significantly worse in the C4 group compared to the C3 and EI groups. In other regions of the body, significant differences were found in the feather scores between laying hens housed in cages, regardless of space allowance per layer, and laying hens reared extensively indoors. According to the total feather score in the 50th week of laying age, the significance of differences in the feather scores by body parts was established between all three groups. The best condition of the feathers individually, in all body regions, was determined in the EI group, followed by C3 and the worst in the C4 group. The only deviation was in the feather score for the back, which did not differ significantly between laying hens in the EI and C3 groups, while laying hens in the C4 group had significantly worse feather score compared to both groups.

Table 2. Effect of space allowance on feather scores (scoring scale 1-4) of different body parts in laying hens at 30, 40 and 50 weeks of age

Feather score, point	Experimental group						p-value
	C4		C3		EI		
	Mean	SD	Mean	SD	Mean	SD	
30 week							
Neck	4.00	0.00	4.00	0.00	4.00	0.00	NS
Breast	3.98	0.16	3.90	0.30	3.90	0.38	NS
Back	4.00	0.00	3.98	0.15	3.92	0.27	NS
Wings	3.65^{b}	0.48	3.83^{ab}	0.38	4.00^{a}	0.00	***
Tail	3.83	0.38	3.88	0.33	3.95	0.22	NS
Total	19.45	0.68	19.60	0.70	19.78	0.58	NS
40 week							
Neck	3.30^{b}	0.79	3.69^{a}	0.60	4.00^{a}	0.00	***
Breast	3.20^{b}	0.72	3.31^{b}	0.64	3.87^{a}	0.47	***
Back	3.60	0.59	3.71	0.64	3.64	0.87	NS
Wings	3.53^{b}	0.55	3.45^{b}	0.50	3.97^{a}	0.16	***
Tail	3.10^{b}	0.81	3.29^{b}	0.55	3.64^{a}	0.49	***
Total	16.73^{b}	2.18	17.45^{b}	1.93	19.13^{a}	1.13	***
50 week							
Neck	2.00^{c}	0.75	2.55^{b}	0.86	4.00^{a}	0.00	***
Breast	2.33^{c}	0.69	2.79^{b}	0.78	3.66^{a}	0.63	***
Back	2.80^{b}	1.04	3.31^{a}	0.78	3.26^{ab}	0.83	**
Wings	2.95^{c}	0.71	3.33^{b}	0.57	3.95^{a}	0.23	***
Tail	2.05^{c}	0.88	2.83^{b}	0.70	3.61^{a}	0.55	***
Total	12.13^{c}	3.02	14.81^{b}	2.87	18.47^{a}	1.48	***

C4-564 cm^2/hen, cage; C3-751 cm^2/hen, cage; EI-3000 cm^2/hen, extensive indoor
NS-non significance; **- p<0.01; ***-p<0.001; a, b, c- significant differences for the same row

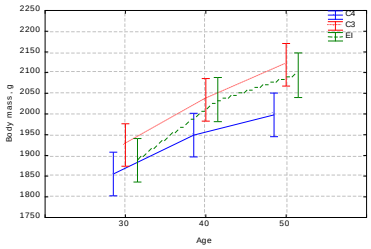

Figure 1. Body weight of laying hens, (g)

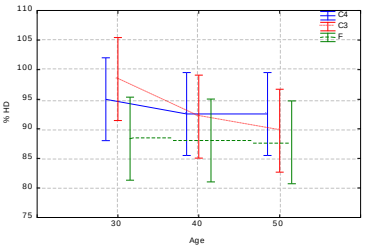

Figure 2. Hen-day egg production, %

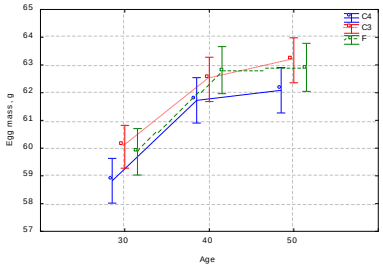

Figure 3. Average egg weight, g

The body weight of laying hens was influenced by the space allowance ($p<0.01$) and age of laying hens ($p<0.001$), without the interaction effect of these two factors ($p= 0.725$) (Fig.1). Laying hens with the least available space (C4) had the significantly lowest body weight (1934.1 g) compared to the C3 (2026.2 g) and EI (2003.9 g) groups.

Observed in relation to age of laying hens, differences between groups were confirmed at week 40, when laying hens in C4 had significantly lower body weight compared to C3 and EI groups, and subsequently, at week 50, when a difference was confirmed only between C3 and C4 groups. Although the laying hens in the C4 group met the minimum requirement in the available length of the feeder, the larger feeding space for layers in the C3 group resulted in higher body weight. In the extensive indoor system, the effect of a larger feeding area on body weight was reduced by greater mobility of laying hens.

The expected trend of decreasing hen-day egg production (% HD) with laying age was confirmed, which in the weeks 30, 40 and 50 was 93.92%, 90.87%, 89.97%, respectively. Due to the short time interval in which the trial was conducted in relation to the production cycle of laying hens (72-90 weeks) and therefore, the time required for a significant drop in laying capacity, the determined differences were not statistically significant. The effect of space allowance per

laying hen was not significant (p=0.069) for egg production. However, both groups of laying hens in cages had a higher hen-day egg production (93.3% and 93.4%), regardless of cage space allowance, compared to the extensive indoor group (88%). On the other hand, the drop in egg production in the observed period was the lowest in the EI group and the largest in the C3 group, which started with the highest laying capacity in the week 30 (Fig. 2).

Data on egg weight confirmed, as expected, an increase in egg weight with laying age (p=0.003). The average egg weight in the 30th week (59.59g) was significantly lower compared to the weeks 40 and 50 (62.72g and 62.33g). From the perspective of the space allowance, the egg weight in the C4 group was significantly lower ($p<0.01$) compared to the C3 and EI groups, which was not statistically different from each other. The interaction effect of the space allowance per laying hen and the age on the egg weight was not present (Fig. 3).

Discussion

Most studies confirm the results of our study on the decrease in overall feather score with the age of laying hens *(Petrik et al., 2015; Widowski et al., 2017; Liebers et al., 2019).* The greatest loss of feathers observed at the age of 50 weeks was on the neck and tail, which is partially in agreement with the findings of *Ozenturk et al. (2022)* who find the greatest loss of feathers at the end of the laying period on the back and tail. In a study by *Campe et al. (2018),* based on the overall feather score for the whole body, the effect of age on the condition of the feathers was confirmed, the feather condition worsened with the age of the laying hens, while the effect of age on the condition of the feathers of individual body parts was significant for the feather score for the head, breast and cloaca. Worse condition of feathers in the area of the back, tail and cloaca according to *Rodenburg et al. (2019)* arises as a consequence of feather pecking associated with a diverted form of foraging behavior, while the worse condition of feathers on the head and neck indicates the establishment of a social hierarchy which, according to *Mens et al. (2020)* represents normal behavior in contrast to the previous ones that are only seen in captive birds. *Yamak and Sarica (2012)* based on the established positive correlation between feather score and laying age, indicate the possibility of predicting the condition of feathers in older laying age based on the assessment performed in the earlier weeks of age.

The feather score was the best in the EI group with the largest space allowance per laying hen in the extensive indoor rearing system with litter. *Widowski et al. (2017)* report a dual effect of stocking density, based on the effect of space allowance and the effect of group size. Larger groups of laying hens represent a potential hazard due to greater exposure to layers "peckers" which, according to *Daigle et al. (2015),* when they develop this form of behaviour, about 5% constantly peck their feathers, while the percentage of victims is about 30.

Based on the results obtained in this study, it can be said that the effect of group size in EI was not present, and that the space allowance influenced the best feather scores overall and by body parts for laying hens in this group. A certain contribution to the condition of the feathers in the EI group was also made by the floor system with litter, which according to *Declina et al. (2019)* shows a lower prevalence of feather damage compared to wire and slatted flooring. Better feather condition in the floor system compared to the enriched cages and the aviary system is reported by *Zorman Rojs et al. (2020).* Similarly, in the enriched cages compared to the floor system with litter, there was more feather damage in the study by *Pichova et al. (2016),* while *Petrik et al. (2015)* find no differences in feather condition between conventional cage and floor systems.

If we compare the condition of the feathers of laying hens in the cages, the differences in the feather score were observed in older layers, where the larger space allowance in the cage resulted in a better condition of the feathers. The obtained results can be considered as a consequence of more available space on the feeder and less stress due to competition for food *(Ozenturk et al., 2022).* Similar results are reported by *Sarica et al. (2008)* comparing available cage spaces of 500; 667; 1000 or 2000 cm^2/laying hen. The feather score for individual parts of the body collectively gives an overall score of the condition of the feathers, while their analysis can identify the causes that lead to a worse condition of the feathers, which could remain hidden in the overall score *(Campe et al., 2018*). Accordingly, it is observed that the condition of the breast feathers in the cage system, regardless of the available space, is a consequence of frictional wear from the slatted material of the cage.

The problem of feather condition is mainly viewed from the aspect of behavior and welfare of laying hens, while the relationship between feather condition and production parameters has been significantly less researched. The results of our study indicate that the space allowance significantly affects the body weight of the laying hen and the average egg weight, while egg production is not significantly influenced by the space allowance. In a study by *Widowski et al. (2017),* the effect of cage stocking density on productivity parameters, i.e. hen-day egg production, egg weight and egg mass per laying hen, is completely absent. A higher body weight of laying hens in cages with a larger space allowance is determined by *Sarica et al. (2008),* but contrary to our findings, egg production is also higher in cages with lower stocking density, as well as egg weight. The rationale for the obtained results lies in more available food during the experimental period. *Glatz (2001)* states a high correlation between feed consumption and feathering of hens. In the same study, hens with worse feather condition have a 16% higher consumption compared to hens with better feathering. Also, egg production is higher in hens with better feathering, but there are no differences in egg weight. Food consumption is not presented in our study due to the expected large differences between cage and extensive indoor systems in terms

of mobility of laying hens and therefore energy needs. According to *Yamac and Sarica (2012),* the optimal laying age for assessing the condition of feathers is 40 weeks due to the established positive correlation with egg production in the weeks 50 and 60. In this way, it is possible to evaluate the profitability of the flock. This study shows a correlation between better feather condition, higher egg production and lower food consumption. *Fidan and Nazligul (2013)* link less available space on the feeder in a cage with a larger number of hens with a worse condition of the feathers. By comparing cage (conventional and enriched) and free range systems, *Dikmen et al. (2016)* show better feather scores for laying hens in the free range system. These hens have both a higher body weight at the end of production, as well as a higher egg production compared to cage systems which show no differences from each other, which is contrary to our results.

Conclusion

The results confirm the significant effect of space allowance and age on the condition of the layers' feathers. In addition to the expected decrease in feather score with the age of laying hens, the results indicate a significant interaction between age and space allowance per laying hen. Observed by individual body parts, as well as based on the overall feather score, space allowance per laying hen exhibited a full, cumulative effect at 50 weeks of age. Based on the space allowance for laying hens, it was possible to rank the overall feather score, with the laying hens with the most space having the best feather scores. The effect of space allowance on body weight was manifested through the available space on the feeder, which resulted in the lowest ($p<0.01$) body weights in the C4 group. Egg production was not significantly influenced by the space allowance per layer ($p=0.069$), but a connection between hen-day egg production and rearing system could be established. The average egg weight, in addition to the known effect of laying age, was the lowest ($p<0.01$) in the group with the least space allowance per laying hen.

Finally, the results of the study, based on the tested parameters of the welfare and productivity of laying hens, indicate that the rearing of laying hens in a cage system with 751 cm2 of available space per laying hen is most justified.

Efekti raspoloživog prostora u kaveznom i podnom sistemu na stanje perja i proizvodnju jaja

Zdenka Škrbić, Miloš Lukić, Veselin Petričević, Snežana Bogosavljević-Bošković, Simeon Rakonjac, Vladimir Dosković, Nataša Tolimir

Rezime

Sektor proizvodnje jaja se nalazi u tranzicionom periodu u pogledu dozvoljenih sistema gajenja, odnosno, od gajenja u konvencionalnim kavezima pod određenim uslovima do potpune zabrane bilo kakvog oblika kaveznog sistema. Promene su implicirane zabrinutošću za dobrobit nosilja ali sa očekivanim efektima i na produktivnost. Postavljeni cilj istraživanja je bio da se utvrde efekti raspoloživog podnog prostora u kaveznom i nekaveznom housing systems na stanje perja i proizvodnju jaja nosilja u tri starosti, sa aspekta propisanog minimalnog i optimalnog prostora u kaveznom sistemu (C) i prostora obezbeđenog ekstenzivnim gajenjem nosilja u manjim grupama u objektu (extensive indoor -EI). U cilju utvrđivanja stanja perja, telesne mase (body weight) nosilja i mase (weight) jaja, formirane su tri grupe nosilja: C4 (564 cm^2 po kokoši, kavezni sistem), C3 (751 cm^2 po kokoši, kavezni sistem) i EI (3000 cm^2 po kokoši, extensive indoor). Stanje perja i body weight nosilja su utvrđeni u tri starosti kokoši (30, 40, 50 nedelja), individualnim ocenjivanjem i merenjem svih kokoši u ogledu. Prosečna nosivost i masa jaja su utvrđeni u istim nedeljama starosti nosilja. Pored očekivanog smanjivanja ocene perja sa starošću nosilja, rezultati su ukazali na značajnu interakciju starosti i veličine dostupnog prostora po nosilji. Posmatrano po pojedinačnim delovima tela, kao i na osnovu zbirne ocene perja, raspoloživ prostor po nosilji je ispoljio potpuni, kumulativni efekat u 50. nedelji starosti. Na osnovu veličine dostupnog prostora za nosilje moguće je izvršiti rangiranje ukupne ocene perja, pri čemu nosilje sa najviše prostora su imale najbolje ocene perja. Efekat raspoloživog prostora na telesnu masu nosilja je ispoljen preko prostora dostupnog na hranilici, što je rezultiralo najmanjim ($p<0.01$) telesnim masama nosilja u C4 grupi. Proizvodnja jaja nije bila pod značajnim uticajem veličine prostora po nosilji ($p=0.069$) ali bi se mogla konstatovati povezanost između hen-day egg production i sistema gajenja. Prosečna masa jajeta je pored poznatog efekta starosti nosilja, bila najmanja ($p<0.01$) u grupi sa najmanjom veličinom dostupnog prostora po nosilji.

Ključne reči: kokoš nosilja, kavezi, nekavezni sistemi, ocena perja, proizvodnja jaja

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