

# WELFARE PARAMETERS AND KEEL BONE DAMAGE IN LAYING HENS REARED IN DIFFERENT PRODUCTION SYSTEMS

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**Abstract:** The aim of this study was to determine the effect of housing system and the age of hens on welfare parameters and the prevalence of keel bone damage in laying hens. In this study two housing systems were evaluated: aviary system and enriched cages. From each system and age, we used 50 randomly selected hens from different cages and tiers. The results showed significant differences between systems in the type of keel bone damage. There was no significant difference in keel deviation between systems, but the higher prevalence of keel fractures was found in aviary system. In addition, significant effect of the age of hens was found on the occurrence of keel fractures. Footpad dermatitis had statistically higher occurrence in enriched cages at 62 weeks of age. Hens from aviary system had significantly better plumage score compared to hens from enriched cages but only at 42 weeks of age.

**Key words:** keel bone damage, housing system, welfare, laying hens, aviary, enriched cages

## Introduction

In 2012 EU countries banned conventional cages for the welfare reasons, when Directive 1999-74-EC came to force. In Serbia this directive will come to force in 2024. This will lead to transitioning to new housing systems in poultry production which are significantly better when it comes to animal welfare. However, new systems generated new problems, such as keel bone damage (KBD), which also endangers hen's welfare. There are two types of KBD - keel fractures (KF) and keel deviation (KD) and both can be painful to the bird and reduce productivity (*Harlander-Matauschek et al., 2015*). Fractures are characterized by sharp bends, shearing and fragmentation of the keel bone. Keel fractures can lead to pain and stress response in hens (*Riber et al., 2018; Wei et al., 2019*). Deviations

are characterized by an abnormally sharpened structure that deviates from a theoretically perfect 2-dimensional straight plane (*Casey-Trott et al., 2015*). Prevalence of KBD ranges from 5% to as high as 97% depending on housing system and age of hens (*Rodenburg et al., 2008; Wilkins et al., 2011; Petrik et al., 2015; Riber and Hinrichsen, 2016; Regmi et al., 2016*).

Besides keel bone condition there are many other traits that indicate welfare of laying hens. *Nicol et al. (2009)* described plumage score as one of the major welfare indicators because feather pecking is one of the most important causes of feather damage, and presents major welfare problem (*Habig and Distil, 2013*). Also, foot pad dermatitis and skin lesions are important because they are forms of contact dermatitis, affecting skin in contact with irritating materials (*Green et al., 1985; Martins et al., 2016; Thofner et al., 2019*).

The aim of this study was to determine the effect of housing system and the age of hens on welfare parameters and the prevalence of keel bone damage in laying hens.

## Material and Methods

In this research two types of housing systems were examined: enriched cages with full equipment and aviary system. Fifty hens were randomly selected from each housing system at the middle and at the end of production cycles (43 and 63 weeks of age, respectively). From enriched cages hens were taken from different cages and levels, and from aviary system hens were taken from the floor and different tiers.

Assessment of keel bone damage was performed by palpation. The prevalence of KBD was assessed using the technique of palpation according to the method described by *Scholz et al. (2008)*. Palpation was done by running fingers alongside and over the keel bone. It was determined whether the damage was present or not.

Other welfare parameters included in this research were: plumage condition, skin lesions, comb pecking wounds, footpad dermatitis and claw length. Plumage condition was assessed by using the method described by *Tauson et al. (2005)*, scale ranging from 0 (highly damaged plumage) to 4 (very good plumage). Footpad dermatitis, skin lesion and comb pecking wounds were assessed on the scale from 0 to 2 depending on severity, according to Welfare quality assessment protocol for poultry (2009) (0 presenting no visible damages, and 2 presenting severe damage). Claws were assessed by its length, and were described either as normal or long.

Statistical analysis was performed using Statistica 13.5. Analysis of variance ANOVA was used to compare the mean values between evaluated parameters among housing systems and age of hens. Post hoc analysis was

performed using Mann Whitney test. Results of statistical analysis were considered significant when the  $p \leq 0.05$ .

## Results and Discussion

The results of this research showed high occurrence of KBD in both housing systems. The higher prevalence of KBD was detected in aviary system compared to enriched cages. Besides that, the main difference in these two housing systems is in the type of KBD. In aviary system main cause of KBD were keel fractures (KF), and in enriched cages the main type of KBD were keel deviations (KD) (table 1). Regarding the keel deviation (KD), it's occurrence was relatively uniform between housing systems, without statistically significant differences. These results are expected since the KD is caused mainly by the pressure of the keel bone on metal perches which are present in both housing systems. Also, there was no effect of age of hens on the occurrence of KD, since the keel bone ends its ossification until 40 weeks of age (*Toscano et al., 2020*) and keel deviations are not likely to develop after that time.

**Table 1. Prevalence of keel bone damage in laying hens in different housing systems and in different phase of production cycles**

Type of KBD	43 weeks of age		62 weeks of age	
	Aviary system	Enriched cages	Aviary system	Enriched cages
Keel deviation (KD), %	27.3	29.2	23.3	30
Keel fracture (KF), %	16.4 <sup>a</sup>	4.2 <sup>b</sup>	30 <sup>c</sup>	3.3 <sup>b</sup>
KF+KD (KBD), %	43.7 <sup>ab</sup>	33.4 <sup>ab</sup>	53.3 <sup>a</sup>	33.3 <sup>b</sup>

<sup>a,b,c</sup> Values with different superscript within the same row are statistically significant

*Đukić Stojčić et al. (2017)* investigated the influence of the housing system on the occurrence of KBD, and found that as many as 39% of hens in enriched cages had KBD. High frequency of KBD in this housing system can be attributed to metal perches. The assumption that perches have a key role in developing KBD was confirmed by other authors too (*Rodenburg et al., 2008; Wilkins et al., 2011; Đukić Stojčić et al., 2017*).

Statistical analysis showed significantly higher occurrence of keel fractures in aviary system compared to enriched cages (table 1). Some authors explain this by the increased risk of accidents and falls in more extensive housing systems (*Vits et al., 2005; Sandilands et al., 2009; Wilkins et al., 2011; Lay et al., 2011*). Also, in our research, keel fractures were highly related to the age of laying hens, but only in aviary system. This can be explained by the fact that in aviary system birds are more active, and have more chances of injury which only get worse with the age of

hens. Similar results were reported by *Eusemann et al. (2018b, 2020)*. *Habig and Distl (2013)* and *Sherwin et al. (2010)* found that the incidence of fractures in laying hens at the end of the production cycle in enriched cages ranged from 30 to 53.3%.

**Table 2. Prevalence of welfare parameters in different housing systems and in different phase of production cycles**

Welfare parameters	43 weeks of age		62 weeks of age	
	Aviary system	Enriched cages	Aviary system	Enriched cages
Footpad dermatitis (FPD), %	9.1 <sup>a</sup>	6.6 <sup>a</sup>	10 <sup>a</sup>	33.3 <sup>b</sup>
Plumage	3.89 <sup>a</sup>	3.62 <sup>b</sup>	3.60 <sup>b</sup>	3.58 <sup>b</sup>
Skin lesions	-	-	-	-
Comb pecking wounds	-	-	-	-
Long claws, %	-	-	-	6.6

<sup>a,b</sup>Values with different superscript within the same row are statistically significant

Higher occurrence of FPD was established in hens housed in enriched cages compared to aviary system (table 2). It is interesting that there was no significant difference in young age, but the difference was significant at the age of 62 weeks. One of the explanations for the higher occurrence of FPD in enriched cages is the existence of metal wire from which the cage is made. Other authors reported that up to 39% of bird had foot pad dermatitis in non-cage systems (*Abrahamsson and Tauson, 1995; Gunnarsson et al., 1995; Wang et al., 1998; Rönngen et al., 2008*).

Generally, the plumage condition of the birds in both housing systems was satisfactory. The best plumage score had hens housed in aviary system at 43 weeks of age. Statistically significant differences were found between hens housed in aviary system and enriched cages at 43 weeks of age, but not at the 62 weeks of age. *Staaveren et al (2021)* found that the housing system affected plumage, and that plumage from cage systems had a poorer assessment of plumage compared to hens from non-cage housing systems, which is in accordance with the results obtained in this study. Perches and other equipment can lead to problems in plumage condition in laying hens (*Sepour et al., 2015*). Significant deterioration of plumage was found with increasing age of hens, which is in accordance with the results of other authors (*Rönchen et al., 2007; Habig and Distl, 2013, Schreiter et al., 2020*).

Only 6.6% of laying hens at the end of the production cycle had long claws in the enriched cages, while in the aviary system there were no hens with long claws. Also, no long claws were found in younger hens reared in enriched cages. No statistically significant differences were found between the housing system as well as the age of the laying hens, regarding claw length. Further, no hens with skin

lesions and comb pecking wounds were found in either housing systems at both ages.

## Conclusion

Significant differences in occurrence and the type of KBD were found between the housing systems. Generally, higher occurrence of KBD was found in aviary system compared to enriched cages. Regarding the type of the KBD higher prevalence of keel fractures was found in aviary system, while in case of KD there were no significant differences between systems. In addition, significant effect of the age of hens was found only on the occurrence of keel fractures.

Regarding the welfare parameters, higher incidence of footpad dermatitis was detected in enriched cages compared to aviary system, but only at 62 weeks of age. Also, housing system had significant effect on plumage condition which was better in aviary system at 42 weeks of age.

Based on all of the above, it can be concluded that housing systems and age have a significant impact on the occurrence and the type of keel bone damage and some welfare parameters (FPD, plumage score and claw length). Further research is needed to determine specific risk factors of KF and KD in order to develop strategies for reducing the incidence of this multifactorial welfare issue.

## Parametri dobrobiti i deformacija grudne kosti kokoši nosilja u različitim sistemima držanja

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## Rezime

Cilj ovog rada bio je da se utvrdi efekat sistema držanja i starost na parametre dobrobiti i učestalost deformacija grudne kosti kod kokoši nosilja. U ovom istraživanju su ocenjena dva sistema držanja: avijarni sistem i obogaćeni kavezi. Iz svakog sistema i proizvodnih ciklusa koristili smo 50 slučajno odabranih kokoši iz različitih kaveza i nivoa. Rezultati su pokazali značajne razlike između sistema u tipu oštećenja grudne kosti. Nije bilo značajne razlike u devijacijama grudne kosti između sistema, ali je veća učestalost fraktura grudne kosti utvrđena u avijarnom sistemu. Pored toga, utvrđen je značajan uticaj starosti kokoši na pojavu fraktura grudne kosti. Dermatitis tabanskih jastučića imao je statistički veću pojavu u obogaćenim kavezima u starosti od 62 nedelje. Kokoši iz avijarnog sistema imale su znatno bolju ocenu operjalosti u poređenju sa kokošima iz obogaćenih kaveza,

ali samo u starosti od 42 nedelje.

**Ključne reči:** deformacija grudne kosti, sistem držanja, dobrobit, kokoši nosilje, avijarni sistem, obogaćeni kavezi

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