



Question to EURCAW-Poultry-SFA

Reference of the query: Q2E-Poultry-SFA-2022-003

Query received 06/07/2022

Date of admissibility: 07/07/2022

Replied sent: 06/09/2022

Background context provided by the solicitor

None

Question

1. What are the causes of caudal keel bone fractures?
2. What is the prevalence of caudal keel bone fractures in different Member States?
3. Do caudal keel bone fractures have negative welfare consequences?

Key words: Health and body condition, skeletal damage,

Level: Husbandry

Type of production: Laying Hen

Answer

Background arising from expertise

In a first phase, the Centre will deliver a short answer to the query about the three following questions with the information currently available on caudal keel bone fractures in laying hens. In a second phase, the Centre will provide additional information based on technical and scientific activities (activity 3) planned for the next work programme, WP23-24.

The query refers to fractures in the caudal part of the keel bone in laying hens.

1. What are the causes of caudal keel bone fractures (KBF)?

The ossification of the caudal part of the keel in laying hens is likely not completed until 30 to 40 weeks of age (Toscano et al., 2020). The cartilaginous composition of the keel and the ongoing ossification during peak production result in a keel that is weaker than that of older hens and may explain why KBF are often found at the caudal part of the bone, which is the last part to be ossified (Casey-Trott et al., 2017; Thøfner et al., 2020).

[Questions to EURCAW](#) is a service provided by the EU Reference Centres for Animal Welfare. EURCAW-Poultry-SFA offers it via its website. The service is open to CAs, NRC, SBs and their representatives of EU Member States and to the EU-Commission. Within its resource limits, the Centre will provide a scientifically supported answer. However, neither the Reference Centre, nor the experts involved can be held responsible for its use. EURCAW-Poultry-SFA was designated by the European Union on 4 October 2019 through Regulation (EU) 2019/1685, in accordance with Articles 95 and 96 of Regulation (EU) 2017/625.



Poor bone quality and collision are possible causes for all types of keel bone fracture, but it is likely that there are additional causes for caudal keel bone fractures. Thøfner et al. (2020) suggests that these may be related to the depletion of the hen's body reserves (as a result of breeding for a smaller bird and a higher egg production) in combination with biomechanical effects on the tip of the keel bone of wing flapping or the egg laying process. Further research indicates a breed predisposition and relations with hen size and elevated (early) production levels (Candelotto et al., 2020; Riber et al., 2018; Toscano et al., 2020). Indeed, selection for efficient egg production could be a major contributing factor. In a pilot study on 29 hens and roosters from the ancestor, the red junglefowl, only one keel bone fracture has been observed, however, 10 hens and 1 rooster had a very slight deviation (Kittelsen, 2020). In addition, Thøfner et al. (2021) found that fracture risk was greater for hens that were younger at onset of lay and that laid heavier eggs at the onset of lay, as well as for those hens that had a lower body weight at end-of-lay.

More research is needed to determine the causes of caudal KBFs.

2. What is the prevalence of caudal keel bone fractures in different Member States?

No information about prevalence for caudal keel bone fractures in the MS is available. However, figures about the prevalence of KBFs in general are available, but one should bear in mind that these data have been collected by different observers, sometimes using different methods of assessment. Armstrong et al. (2020) reported prevalence of KBF between 20 to 96% of birds within commercial flocks in various countries (Belgium; Canada; Denmark; The Netherlands; Switzerland and UK). Estimates of KBF prevalence increase with age, rising from 5.5% of birds affected within a flock at onset of lay to as many as 97% by the end of a production cycle.

In the furnished cage system, there is a greater percentage of hens having caudal fractures only (rather than a combination of caudal and medial fractures) and such fractures are more difficult to detect by palpation (Thøfner et al., 2021). This may lead to a greater underestimation of keel bone fractures in hens in furnished cages than in non-cage housing systems.

More research is needed to develop a valid, reliable and feasible method for detection of caudal KBF.

3. Do caudal keel bone fractures have negative welfare consequences?

Laying hens with keel bone fractures show differences in time spent on highly motivated behaviours (e.g., perching, nest use, locomotion), indicating reduced mobility and potentially negative affective states including pain, discomfort and distress (reviewed in Riber et al., 2018). Furthermore, since keel bone fractures are associated with inflammation, then alteration of nutritional and metabolic requirement and reduced egg production would be expected (Rufener et al., 2019). Furthermore, the presence of KBF reduces frequency of outdoor range access (Richards et al., 2011).

Focusing on more direct assessments of movement and pain, hens with KBFs display greater latencies to fly down from perches 100 and 150 cm above the floor to obtain a food reward than hens without fractures,



and administration of various analgesics resulted in reduced latencies in only fractured birds (reviewed by Armstrong et al., 2020). Furthermore, Armstrong et al. (2020) studied the hippocampal neurogenesis in layers housed in multitier systems and concluded that KBFs lead to a negative affective state lasting at least 3–4 weeks.

However, all these welfare consequences are not specific for caudal KBFs. Fractures at the caudal part of the keel bone are more difficult to detect by palpation (Thøfner et al., 2021). Many of the studies on the welfare consequences of KBF, particular studies from before 2016, have used palpation to assess the keel bone status, meaning that most of the fractured hens likely had fractures in other places than the caudal part.

More research is needed to cover the gap of knowledge on potential welfare consequences of particularly the caudal KBFs.

Conclusion

The exact causes of caudal KBFs are unknown but some hypotheses (that may act alone or in synergy) are:

- Late ossification of the caudal part of the keel.
- Poor bone quality and collision (valid for all types of keel bone fracture).
- Depletion of the hen's body reserves in combination with biomechanical effects on the tip of the keel bone of wing flapping or the egg laying process.
- Early onset of lay, heavier eggs at the onset of lay and a lower body weight at end-of-lay.

The prevalence of caudal KBFs is unknown in the different MSs.

KBF is likely to cause pain and associated negative affective states. Nothing specific is known about the particular case of caudal KBFs.

Recommendation arising from expertise

More research is needed to determine the causes of caudal KBFs.

More research is needed to develop a valid, reliable and feasible method for detection of caudal KBF.

More research is needed to cover the gap of knowledge on potential welfare consequences of particularly the caudal KBFs.

Relevant references and others documents

Armstrong, E.A., Rufener, C., Toscano, M.J., Eastham, J.E., Guy, J.H., Sandilands, V., Boswell, T., Smulders, T.V., 2020. Keel bone fractures induce a depressive-like state in laying hens. *Sci Rep* 10, 3007.

Candelotto, L., Stratmann, A., Gebhardt-Henrich, S.G., Rufener, C., van de Braak, T., Toscano, M.J., 2017. Susceptibility to keel bone fractures in laying hens and the role of genetic variation. *Poult Sci* 96, 3517-3528.



- Casey-Trott, T.M., Guerin, M.T., Sandilands, V., Torrey, S., Widowski, T.M., 2017. Rearing system affects prevalence of keel-bone damage in laying hens: a longitudinal study of four consecutive flocks. *Poult Sci* 96, 2029-2039.
- Kittelsen, K.E., Moe, R.O., Hansen, T.B., Toftaker, I., Christensen, J.P., Vasdal, G., 2020. A Descriptive Study of Keel Bone Fractures in Hens and Roosters from Four Non-Commercial Laying Breeds Housed in Furnished Cages. *Animals (Basel)* 10.
- Riber, A.B., Casey-Trott, T.M., Herskin, M.S., 2018. The Influence of Keel Bone Damage on Welfare of Laying Hens. *Front Vet Sci* 5, 6.
- Richards, G. J. *et al.* Continuous monitoring of pop hole usage by commercially housed free-range hens throughout the production cycle. *Veterinary Record* 169, 338 (2011).
- Rufener, C., Baur, S., Stratmann, A., Toscano, M.J., 2019. Keel bone fractures affect egg laying performance but not egg quality in laying hens housed in a commercial aviary system. *Poult Sci* 98, 1589-1600.
- Thofner, I., Hougen, H.P., Villa, C., Lynnerup, N., Christensen, J.P., 2020. Pathological characterization of keel bone fractures in laying hens does not support external trauma as the underlying cause. *PLoS One* 15, e0229735.
- Thofner, I.C.N., Dahl, J., Christensen, J.P., 2021. Keel bone fractures in Danish laying hens: Prevalence and risk factors. *PLoS One* 16, e0256105.
- Toscano, M.J., Dunn, I.C., Christensen, J.P., Petow, S., Kittelsen, K., Ulrich, R., 2020. Explanations for keel bone fractures in laying hens: are there explanations in addition to elevated egg production? *Poult Sci* 99, 4183-4194.