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Effects of perch design on behaviour and health of laying hens

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Abstract

EU-Directive 1999/74/EC stipulates that furnished cages and non-cage systems for laying hens should be provided with perches. This Directive allows for a wide variety in perch design features possibly affecting perch use and hen health. Perch material and shape mainly affect slipperiness and grip quality and, in this regard, plastic, metal and circular perches are inferior. The incidence of bumblefoot and keel bone deformities can be influenced by perch shape. Perch shapes which reduce localised pressure on the foot pad and the keel-bone are recommended. Several aspects of the arrangement of the perches in the cage or non-cage system are also important. A consistent preference for high perches is seen, provided there is a minimal distance of 19–24 cm between perch and roof. Accessibility of high perches should be ensured, for example by incorporating lower level perches from which hens can reach the higher levels. Such multi-height perch designs also allow behavioural differentiation according to perch height (with most passive behaviour on the higher perches). In non-cage systems, good accessibility can be achieved by minimising the angles between perches at different heights to smaller than 45° and by limiting the distance between horizontal perches to 1 m. The legislated minimum perch length provided per hen (15 cm) adequately allows for synchronised roosting behaviour on straight perches. However, in cross-wise perch designs, hens require more perch length per hen as the area close to the cross cannot be used optimally.

Keywords: *animal welfare, bumblefoot, laying hen, perch design, perch use, roosting*

Introduction

Perching is a natural behaviour in red jungle fowl, from which our domestic hens originated (McBride *et al* 1969). In feral conditions, domestic fowl generally roost in trees or bushes at night. Roosting up off the ground probably has survival value by reducing predation from night-hunting ground predators (Keeling 2002). In modern laying hens this perching behaviour has not been lost. Olsson and Keeling (2000) demonstrated that hens display signs of unrest which can be interpreted as frustration or as increased exploration behaviour when roosting is thwarted. Furthermore, hens are prepared to push through a weighted push-door to gain access to a perch (Olsson & Keeling 2002). In commercial conditions, perches are provided in both furnished cages and non-cage systems to improve the welfare of laying hens. Gunnarsson *et al* (2000) and Riber *et al* (2007) showed that early experience with elevated perches during rearing improves the ability of hens to deal with perches in complex housing systems for layers, later in life. The provision of perches allows for the expression of perching behaviour and perches can be used to escape from active feather peckers or aggressive hens (Wechsler & Huber-Eicher 1998; Cordiner & Savory 2001). Perches also seem to have positive effects on the physical condition of hens, for example by increasing bone strength (Hughes & Appleby 1989). However, keel-bone deformities (Appleby *et al* 1992; Abrahamsson & Tauson 1993), bumblefoot (Tauson & Abrahamsson 1994) and bone fractures (Freire *et al* 2003; Wilkins *et al* 2004) have also been associated with the use of perches. Bumblefoot is a local infection of the foot pad which causes a bulbous swelling (EFSA 2005). The acute state usually occurs around 30–40 weeks of age and is extremely painful. Intensive and/or long-term use of perches and misjudged landings can lead to development of keel-bone (sternum) deformities. The extent to which this condition is a welfare problem is unclear, but involvement of the pre-sternal bursa (bursitis) is considered painful (Tauson & Abrahamson 1994; EFSA 2005).

The only requirements concerning perches in the EU-Directive 1999/74/EC is that there has to be at least 15-cm perch length per hen (furnished cages and non-cage systems), that the perches, without sharp edges, must not be mounted above the litter (non-cage systems) and that the horizontal distance between perches must be at least 30 cm (non-cage systems). These rather limited requirements allow for a wide variety in perch design features (material, width, shape, etc) which might contribute to variations in perch use and hen health. Therefore, the objective of this

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study is to review the scientific literature on the effects of altering design features of perches on the behaviour, health and ultimately the welfare of laying hens.

Perch features affecting perch use and hen health

Perch length

Synchronism is important in roosting behaviour (Appleby 2004; Appleby *et al* 2004) and, as such, perch space should be sufficient for all birds to perch simultaneously (Appleby *et al* 1992). According to Directive 1999/74/EC, 15-cm perch length per hen should be provided. Previous research supports this recommendation (Appleby *et al* 1992), although Appleby (1995) found no significant difference in perch use at night between a perch length of 14 and 15 cm per hen. He concluded that a perch space of 14 cm was adequate for medium hybrid laying hens. For light hybrid laying hens however, Tauson (1984) suggested that 12-cm perch length per hen is sufficient.

Perch material

Currently, the most common materials for the construction of perches in commercial systems are wood, plastic and metal. Lambe and Scott (1998) compared rectangular wooden, metal and plastic perches and found no difference between the different materials in the duration of time that hens spent perching. They also found no difference in perching time between hard (wooden rectangular perch) and soft (wooden perch covered with a layer of foam rubber) perches. Appleby *et al* (1992) found that, although most time was spent perching on a softwood perch, followed by a vinyl-padded and metal perch and least of all on a plastic perch, these differences were again not statistically significant. It was suggested that a slightly rough surface was preferred because softwood and vinyl-padded perches provided most grip for the feet of the hens, whereas plastic perches had the smoothest surface. This suggestion was later supported by Scott and MacAngus (2004) who showed that the behaviour of hens indicated that metal and PVC perches were more slippery than wooden perches. They concluded that surface modifications, such as the inclusion of grooves, may reduce slipperiness, and hence should be investigated further. As well as texturally, wood also has the advantage of being cheap and easy to use. However, it has the disadvantage of being liable to wear (hardwood has been reported to withstand wear from the hens' feet and claws much better than softwood [Tauson & Abrahamsson 1994]). Moreover, it is difficult to clean and disinfect and provides attractive hiding places for red mites (*Dermanyssus gallinae*) (Lambe & Scott 1998).

Cross-section and shape

In commercial situations, it is often perches with rectangular and circular cross-sections that tend to be used. Lambe and Scott (1998) found no significant differences in perching time between these two perch types during a 48-h observation period. However, Duncan *et al* (1992) found a trend for more perching on rectangular perches compared to circular perches during the day, but not at night. In the latter study, it was reported that the hens' feet slipped backwards and forwards during feeding from the circular perches indicating that they were unstable. Both perch shape and material (see above) seem to affect perch slipperiness. Therefore, circular perches with a smooth surface (eg metal) seem inappropriate with regard to stability.

Oester (1994) showed that the shape of perches had an effect on the development of bumblefoot. Channeled perches (rectangular perch with a groove in the middle) and double perches (two thin parallel perches close together, acting as a single perch) resulted in fewer bumblefoot lesions than a rectangular (with and without a cover of rubber) perch or a mushroom-shaped perch. Duncan *et al* (1992) found that perches with a rectangular cross-section caused less damage to the feet of birds than those with a circular cross-section. However, Tauson and Abrahamsson (1994) reported more bumblefoot problems with rectangular perches than with circular perches and, according to Rönchen *et al* (2008), circular perches did not appear to negatively influence foot-pad health. Tauson and Abrahamsson (1994) also showed that a plastic, mushroom-shaped perch caused more bumblefoot lesions than a wooden rectangular narrow (3.5 cm), a wooden rectangular wide (5.3 cm) and a circular perch with flattened lower and upper surfaces. Valkonen *et al* (2005) reported that foot-pad condition was poorer in cages with plastic perches than in cages with wooden perches. However, the shape could also have influenced the foot-pad condition because the wooden perches were circular or rectangular whereas the plastic perch was T-shaped. For most of the studies mentioned above on bumblefoot lesions, it is difficult to reach conclusions on specific perch features since different materials were used.

Perch shape clearly affects the incidence of keel-bone deformities. Circular perches caused more damage to the keel bones of hens than rectangular perches, probably because they imply great localised pressure to the keel bone in roosting hens (Tauson & Abrahamsson 1994).

Perch width and size

It has been described that under natural conditions hens clasp their feet around branches (Blokhuis 1984) and they also do so around perches smaller than the length of the hens' feet in commercial situations. Wider structures preclude gripping and the use of the digital tendon locking mechanism (Tauson & Abrahamsson 1994). Although the use of 4–5 cm wide perches is widespread in commercial situations, little research has been done on hen preferences for perch width.

Appleby *et al* (1998) found less perching during the day on rectangular 3.8-cm wide perches compared to those 6-cm wide in a first trial, but not in a second. In a preference test offering the same perch widths, there was no difference in time spent on the perches. Struelens *et al* (2009) investigated the preference for 7 perch widths (1.5 to 10.5 cm) in two experimental set-ups: one with two long perches gradually broadening and narrowing stepwise and another with seven separate short perches differing in width. During the night, hens showed no perch width preferences. During daytime, in both experimental designs, a narrow perch of 1.5 cm was least preferred by the laying hens. For wider perches, results from both experiments were not univocal. Perch use increased with increasing perch width in one experimental set-up, but not in the other. The latter showed a preference for 4.5 cm wide perches as opposed to 1.5 cm perches.

In a large scale study on non-cage commercial farms, Niebuhr *et al* (2008) found that the width of perches had a significant effect on keel-bone alterations (deviations and fractures). There were significantly more keel-bone alterations (deviations and fractures) with decreasing perch width (K Niebuhr personal communication 2009).

Perch height

In multi-tiered, non-cage systems, perches are found at different heights whereas in furnished cages, perches are often placed 6-to-8 cm above the cage floor which is sufficiently high to allow floor eggs to roll to the egg collection belt and sufficiently low to allow easy passage of hens across the cage. However, in a recently developed cage system, the 'kleinvoliere' (bigger version of a furnished cage with among other things an increased cage height compared with EU-standards), a minimum of two perches at different heights are required (van Horne *et al* 2007).

The height at which perches are placed in the cage or pen would appear to be an important factor in perch design as it has been frequently observed that birds use the highest accessible structures for perching at night. For example, Lambe and Scott (1998) reported that hens roosted on the drinker line and on top of the nest box which were positioned higher than the perches. Preference for the highest perches at night has been documented for cages (Struelens *et al* 2008a), floor pens (Olsson & Keeling 2000) and aviary systems (Abrahamsson & Tauson 1995; Oden *et al* 2002). Newberry *et al* (2001) also reported a strong preference for the highest perch in young pullets during the day.

Non-cage systems offer more possibilities than furnished cages for the incorporation of elevated perches or tiers. It is not clear whether the low perches in furnished cages are perceived as 'true' perches by the laying hens (EFSA 2005). Nevertheless, they are used intensively by laying hens when they are the only option available (Abrahamsson & Tauson 1993; Wall *et al* 2002). Although low perches are heavily used by laying hens, a preference test with the choice between perches of height 6, 11, 16, 21, 26, 31 and 36 cm, showed that even in low cages hens preferred perches higher than 6-to-8 cm. In 45 cm high cages, the preferred perch height was 16–21 cm (Struelens *et al* 2008a).

In a cage environment and, to a lesser extent, in multi-tiered non-cage systems, hens are restricted by height. Not only is the distance between floor and perch crucial, the distance from the perch to the roof is also an important factor in perch use. Struelens *et al* (2008a) concluded that a distance of 19-to-24 cm between perch and roof is necessary for most birds to roost. Consequently, higher cages allow for higher perches. For example, 45-cm high cages (the minimum cage height according to EU-Directive 1999/74/EC) would allow the opportunity for perches to be 21-cm high (45–24 cm = 21 cm), whereas cages 55 cm-high would allow perches to be 31-cm high (55–24 cm = 31 cm). When introducing higher perches, an important aspect is accessibility; the restricted environment of a furnished cage, can make it difficult for hens to jump or fly to the higher perch levels. Therefore, stepwise perch designs should be introduced or higher perches combined with lower levels to allow hens to use them for access to higher perches (Struelens *et al* 2008a). Such an approach would be likely to cause behavioural differentiation according to perch height. Struelens *et al* (2008a) showed that behavioural differentiation, with more standing and walking on lower perches and more sitting and sleeping on higher perches during the day, was clearly in evidence in 150-cm high cages and to a lesser extent in those at a height of 55 and 50 cm. It appeared that the higher the cage, the more pronounced the differentiation. Behavioural differentiation has also been reported in non-cage systems. For example, Hansen (1994) reported that the majority of resting behaviour of hens in two types of aviary systems was performed on the upper levels, and Rodenburg *et al* (2008) described a clear separation of active birds, in the scratching area or on low perches, and resting or preening birds on high perches in non-cage systems. Behavioural differentiation according to perch height was also reported in small floor pens by Appleby and Duncan (1989).

As well as perch use, other factors should be taken into account in determining the optimal perch height for hen welfare. For example, Wechsler and Huber-Eicher (1998) demonstrated that feather damage was more severe in hens housed with low (45 cm) versus high (70 cm) perches. The effect of perch height on feather damage was pronounced for the lower body parts (breast, legs, vent) in particular, suggesting that hens in pens with low perches were exposed to severe feather pecks when located on the perches. Indeed, feather pecking directed at the vent was more frequent in pens with low rather than high perches. They concluded that perches for resting hens should be positioned well above the reach of hens standing on the floor or on elevated platforms in non-cage systems. Higher perches can also have an impact on hen hygiene because perching hens can defaecate on lower-standing birds (Moinard *et al* 1998). Perches also seem to have a positive effect on bone strength. Bone fragility or cage layer osteoporosis is a well-known condition in laying hens that is related to several causal factors including the level of egg production, the mineral content of the diet and the amount of physical activity (Webster 2004; EFSA 2005). Increased humerus and tibia strength have been recorded by several authors in cage systems with low (6–8 cm) perches compared to cages without perches (Hughes & Appleby 1989; Abrahamsson & Tauson 1993). As well as time spent perching, the activity (stepping on or off perches, wing movements) of the hens appears to have an influence on bone strength (Appleby *et al* 1992; Tauson & Abrahamsson 1994). For example, Tauson and Abrahamsson (1994) found a stronger humerus in the Bareham and Elson Get-Away cages, with higher perches, compared to furnished cages with lower perches. Scholz *et al* (2008) showed that the heterophil-to-lymphocyte ratio (long-term stress indicator) was lower in hens kept in a small group housing system or 'kleinvoliere' compared to hens housed in furnished cages, indicating that hens in the small group system experienced less stress. The perch heights in the small group housing system seemed to have an effect on hens' stress levels because the treatment with perches of 6-cm high (front perch) and 20-cm high (back perch) appeared to impose less environmental stress than treatment with perches at 27.5 (front perch) and 20 cm (back perch). Possible explanations for this could be the more secluded perching possibilities in the first treatment and the obstruction of easy passage in the second (Scholz *et al* 2008).

Arrangement

In furnished cages, one perch positioned parallel to the feed trough is often unable to provide enough perch space per hen in order for the legislative minimum of 15 cm (according to the EU-Directive) to be met. Possible alternatives are the incorporation of multiple parallel perches, the construction of T-perches or the construction of cross-wise perches, all of which are seen commercially. There are only two published studies investigating the effect of cross-wise perch designs on perch use. Wall and Tauson (2007) found that although perches arranged in a cross provided more perch space per hen (15 cm) than a straight perch (12 cm) fitted across the cage, perch use at night was similar or lower compared to the straight perch. Struelens *et al* (2008b) studied the effect of cross-wise perch designs on perch use during day and night and found significant effects in both periods. They concluded that the addition of a 30-cm perch cross-wise to another perch should not be included in the total amount of perch length provided as it did not lead to an increase in mean number of hens perching. Results also indicated that in cross-wise perch designs, some parts, close to the crossing, cannot be used by the hens, but further studies are needed the determine the precise distance. There were also indications that the process of taking roosting positions was more disturbed with cross-wise perches.

Due to the high incidences of bone fractures reported in non-cage systems (Freire *et al* 2003; Wilkins *et al* 2004) probably as a result of accidents during movement between perches or platforms (Gregory *et al* 1990), some studies focused on the angle, distance and visibility of perches. Scott *et al* (1997) and Moinard *et al* (2004) found that hens could move more easily upwards than downwards. For example, Moinard *et al* (2004) demonstrated that behaviours indicating inaccurate landing control (long time to achieve balance, clumsy or missed landings) were more frequent on downward than upward jumps. Scott *et al* (1997) found that angles greater than 45° between perches at different heights were difficult for birds to negotiate. Moreover Lambe *et al* (1997) showed that frustrated behaviour was associated with descending perches separated by more than 45°. Scott and Parker (1994) studied the effect of increasing distances between perches at the same height on hens' behaviour and showed that hens cannot readily move between horizontal perches greater than 1 m apart. Scott *et al* (1999) found a considerable number of unsuccessful landings when the distance between perches was 1.5 m. Moinard *et al* (2005) showed that hens were often able to jump from or into a 15-cm space between obstructions, but that this required changes in take-off and landing behaviour. For example, to avoid an obstructing hen directly ahead, hens would prefer to walk along the take-off perch and then take-off on a path perpendicular to the landing perch thereby avoiding a diagonal path when jumping. Besides perch arrangement affecting the movement of hens through the housing system, rearing conditions can also have an effect. For example, Gunnarsson *et al* (2000) concluded that rearing without perches during the first 8 weeks of life, impairs hens' spatial cognitive skills.

The effect of light intensity (usually maintained between 5 and 10 lux in commercial systems [Appleby *et al* 1992]), on landing accuracy was investigated by Moinard *et al* (2004). They found no significant effect of lighting condition (5, 10 or 20 lux) on take-off, flight and landing behaviours. These behaviours were also unaffected by the level of contrast between the perch and background. In contrast, Taylor *et al* (2003) demonstrated that at very low light intensities hens took longer to jump, were less likely to jump and showed a high frequency of vocalisation when required to jump from a start perch to a destination perch. The effects of light intensity (0.8, 1.5, 6.0 or 40 lux) on the ability of hens to jump between perches in this experiment was only seen at relatively low light intensities, indicating that in commercial systems it is unlikely this would affect the movement of hens during the light period. However, very low light intensities can restrict the movement of hens during dawn or dusk periods or during the lights-off period. Taylor *et al* (2003) showed that altering perch colour (light colour) could solve this problem.

Conclusion and animal welfare implications

The objective of this study was to review the scientific literature concerning the effects of altering perch design features on the behaviour, health and ultimately the welfare of laying hens. A firm grip of hens' feet onto perches appears highly significant and it seems that perch material and cross-section contribute to this. Slipperiness is increased with PVC and metal perches and circular perches. The shape of the perch seems mainly to influence incidences of keel-bone deformity and, albeit less clearly, bumblefoot. In general, in order to reduce the incidence of these disorders, perch shapes that reduce the localised pressure on the keel bone and distal foot pad, respectively, are recommended. Perch height is an important factor in perch use. Therefore, perches should be positioned at as great a height as possible and at different levels to encourage behavioural differentiation. In determining the optimal height, the distance between perches and the roof, perch accessibility, the potential for feather pecking and the ease of passage should all be taken into account. It seems that not all laying hens are able to perch simultaneously in cage systems with cross-wise perches that provide 15-cm perch length per hen. Therefore, in these designs, the minimum perch length per hen should be increased or cross-wise perch designs should be prohibited. To minimise the risk of injury, the angle between perches at different heights should be no greater than 45° and the distance between horizontal perches should be no more than 1 m.

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