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Motivation to dust-bathe of laying hens housed in cages and in aviaries

S. Colson[1], C. Arnould[2‡] and V. Michel[1†]

[1]UEBEAC, AFSSA-LERAP, Zoopôle Beaucemaine BP 53, 22440 Ploufragan, France; [2]Station de Recherches Avicoles, INRA – Centre de Tours, 37380 Nouzilly, France

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New housing systems for commercial egg production, furnished cages and non-cage systems, should improve the welfare of laying hens. In particular, thanks to the presence of a litter area, these new housing systems are thought to satisfy the dust-bathing motivation of hens more than in conventional cages, in which no litter area is present. However, although apparently obvious, there is no concrete evidence that non-cage systems, particularly aviaries, satisfy hens' motivation to dust-bathe and thus improve hens' welfare in terms of dust-bathing behaviour. The aim of this study was to compare hens' dust-bathing motivation when housed for a long time under similar conditions to commercial conditions in laying aviaries (with litter) and in conventional cages (without litter). Three treatments were compared: hens reared in floor pens then housed in conventional cages, hens reared in furnished floor pens then housed in a laying aviary, and hens reared in rearing aviaries then housed in a laying aviary. All three treatments provided access to litter during the rearing period. After transfer to the laying systems, access to litter was maintained for the aviary hens but stopped for the cage hens. Twelve groups of four hens per treatment were tested 36 to 43 weeks after transfer. The hens were placed in sawdust-filled testing arenas, and latency to dust-bathe, duration and number of dust baths, and number of hens dust-bathing were recorded. Latency to dust-bathe was shorter, dust baths were longer and more numerous and more hens dust-bathed among cage hens than among aviary hens. Our results indicate that hens' motivation to dust-bathe was more satisfied in laying aviaries than in conventional cages. Thus, laying aviaries improve hens' welfare in term of dust-bathing behaviour compared with conventional cages.

Keywords: animal welfare, behaviour, dust-bathing, poultry, production systems

Introduction

In many countries, laying hens are mainly housed in conventional cages during the laying period (for example, in 2002, in France, about 83% of the hens were housed in conventional cages; Chalimbaud (2003)). Under this system, space is restricted and the only furnishings are nipples and feed troughs. In Europe, Council Directive 1999/74/EC is intended to improve laying hens' welfare by imposing more spacious housing systems with more furnishings: furnished cages and non-cage systems (aviaries and floor systems, with or without access to outdoor areas). These imposed systems are expected to diversify the behavioural repertoire of hens, e.g. dust-bathing in a suitable substrate.

According to the European Food Safety Authority report (EFSA, 2005), dust-bathing in a dry and friable substrate is a behavioural priority that maintains hens' feathers in good condition (Van Liere and Bokma, 1987; Van Liere, 1992). Various techniques have been used to study motivation to dust-bathe, in particular after a deprivation period (Vestergaard, 1982; Hogan *et al.*, 1991; Vestergaard *et al.*, 1999). The reports have shown that when hens are deprived of litter, their motivation to dust-bathe increases: latency to dust-bathe decreases, and the intensity (number of elements composing the dust baths), number and length of dust baths all increase when hens are given access to a litter after a deprivation period. Studies have been performed on young chicks (Hogan *et al.*, 1991; Vestergaard *et al.*, 1999) and on adult hens (Vestergaard, 1982) under research conditions with groups of two birds (Hogan *et al.*, 1991; Vestergaard *et al.*, 1999) or 50 birds (Vestergaard, 1982) and with short deprivation periods (less than 5 days).

There is no evidence that the laying systems imposed by Directive 1999/74/EC provide sufficient access to

‡Present address: Physiologie de la Reproduction et des Comportements, UMR 6175 – INRA-CNRS-Université de Tours-Haras Nationaux - Centre de Tours–Nouzilly, 37 380 Nouzilly, France
† E-mail: v.michel@ploufragan.afssa.fr

litter to enhance hens' welfare in terms of dust-bathing behaviour. To the best of our knowledge, no studies have compared adult hens' motivation to dust-bathe in conventional cages *v.* aviaries. Different studies compared the effect of different designs of furnished cages (Appleby *et al.*, 1993) and different flooring materials (Merrill *et al.*, 2006) on dust-bathing behaviour, but Guesdon (2004) performed the only study, under conditions close to commercial conditions, comparing motivation to dust-bathe in hens housed in conventional cages *v.* furnished cages. None of the aviary studies published has shown that it was possible for every hen to perform dust-bathing. As it has been observed that hens present uneven spatial distribution (Hansen, 1994; Carmichael *et al.*, 1999; Channing *et al.*, 2001; Odén *et al.*, 2002), there may be inadequate access to litter, and the litter provided in aviaries may be of poor quality in the second part of the laying period.

The aim of this experiment was to compare the motivation of adult hens to dust-bathe in a suitable substrate when they were housed for a long time under conditions close to commercial conditions in laying aviaries (with litter) and in conventional cages (without litter). This experiment is a part of a study comparing welfare of laying hens (housed in both of these housing systems) and adaptation to laying aviaries of hens previously reared in various conditions (Colson *et al.*, 2005a, b and c and 2006; Michel *et al.*, 2005). In the present study, two rearing systems for pullets assigned to laying aviaries were used: rearing aviaries and furnished floor pens.

Material and methods

Animals and housing

The experiment was performed on ISA Brown hens. They arrived at 1 day of age, were beak-trimmed at 9 days, transferred from rearing to laying systems at 17 weeks, and slaughtered at 69 weeks of age.

Three treatments were compared: one involving cage hens (5 060 "C hens") and two involving aviary hens (2 560 "A1 hens" and 2 560 "A2 hens"). C hens were reared in seven floor pens each measuring 69 m^2 and covered with litter (847 cm^2 of litter area per pullet). After transfer, the hens were allotted to four three-tier batteries of conventional cages (five hens per cage: 582 cm^2 of usable area per hen) for the laying period. The cages (Big Dutchman, Germany) were 60 cm wide, 48.5 cm deep and 40 cm high (at 2/3 depth) with two water nipples at the rear and an automatic feeding-chain at the front. A1 hens were reared in three furnished floor pens each measuring 69 m^2, covered with litter, and containing perches and two slatted platforms (742 cm^2 of litter area per pullet). After transfer, the hens were housed in a laying aviary (Natura Nova, Big Dutchman, Germany; Figure 1). A2 hens were reared in four rearing aviaries (Natura Rearing type, Big Dutchman, Germany) each measuring 24 m^2 and containing litter areas (208 cm^2 of litter area per pullet). They were identical to laying aviaries but adapted to pullets' size and without nest boxes. After transfer, they were housed in a second laying aviary. The laying aviaries were 7.5 m wide and 30 m deep, giving 1 149 cm^2 of usable area per hen.

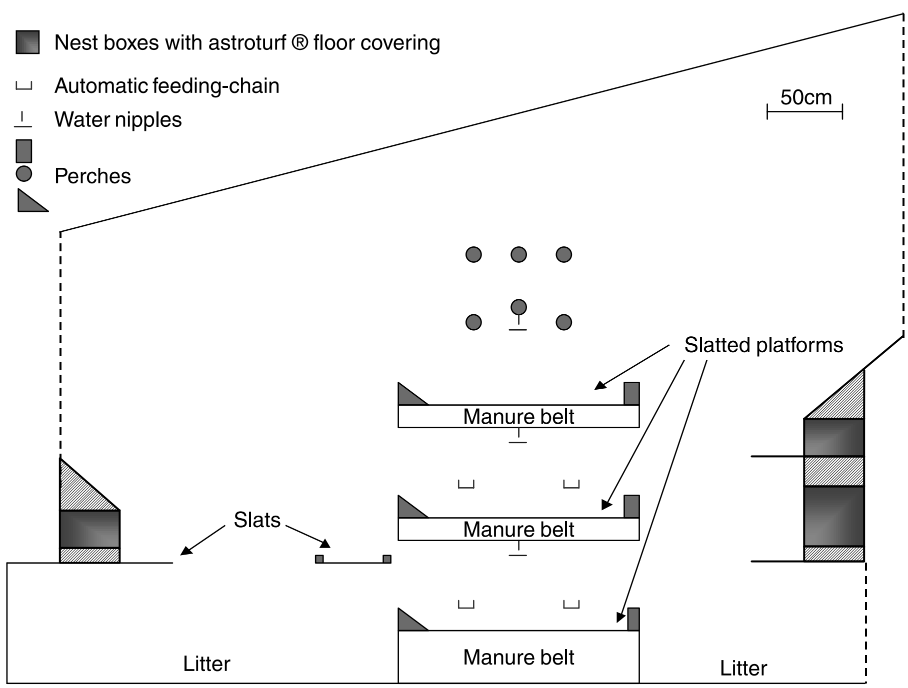

Figure 1 Cross-sectional view of the laying aviary (Natura Nova, Big Dutchman, Germany) housing the A2 hens (hens previously reared in rearing aviaries). The laying aviary where the A1 hens were housed (hens previously reared in floor pens furnished with perches and slatted platforms) was the mirror image of this one.

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Conventional cages and laying aviaries were installed in two barns in which all conditions (lighting, temperature, etc.) were standardised and similarly controlled. During the laying period, hens were given 16 h of light.

In all three treatments, the hens had access to litter for 16 weeks before they were transferred to the laying systems. After transfer, litter access was maintained for A1 and A2 hens whereas C hens were deprived of litter.

Test arenas and procedure

The test arenas were 100 cm wide, 100 cm deep and 80 cm high. They were composed of a wire lid, a bare wooden floor, two contiguous wooden walls and two contiguous wire walls, similar to those used by Guesdon (2004). All test arenas contained one tray feeder, one flow drinker, and a piece of Astroturf® for laying (40 × 40 cm) designed to be a compromise between nest boxes in aviaries and no nests in cages.

Twelve groups of four hens per treatment were tested from 36 to 43 weeks after transfer, i.e. 36 to 43 weeks of litter deprivation for C hens. All hens were tested only once. Each group of four C hens was housed in the same cage. The cages sampled were distributed across all the batteries. Each group of four A1 and four A2 hens was constituted of hens close together. For each aviary, the 12 groups were sampled from 12 areas distributed on the length and the height of aviary. About 2 h before the light was turned off, the hens were carried in a closed plastic box to a test arena. They were individually identified, placed in the test arena, and left undisturbed. Eight hours after the light was turned on, when the time of laying had passed and the hens' motivation to dust-bathe should be maximum (Vestergaard, 1982; Vestergaard *et al.*, 1990), the piece of Astroturf® was removed, sawdust was added (a layer of about 10 cm high, covering all the floor of the arena) and the hens were then observed for 5 h. As there was no test location available outside of barns, the hens were tested in their own setting, i.e. in a test arena located in the cage barn for C hens, and in another test arena located in the aviary barn for A1 and A2 hens. Test arenas were visually isolated from the rest of the barn.

Focal sampling on video recording was used to record latency to dust-bathe, duration and number of dust baths per hen, and the number of hens dust-bathing. Based on current knowledge, typical dust-bath bouts can be divided into two phases (Borchelt, 1974; Van Liere, 1992; Duncan *et al.*, 1998). During the first phase, the hens stand and scratch the substrate. During the second phase, hens squat or lay down, and perform the following elements: vertical wing shaking, bill-raking, head or side-rubbing, side-lying (sometimes with leg-wing stretching), and scratching. Only the second phase, which can be defined more precisely, was recorded in our tests. This phase can be interrupted several times in the course of the same dust bath. When the interruption was longer than 10 min, it was considered that a new dust-bath bout had begun (Vestergaard *et al.*, 1990; Hogan and Van Boxel, 1993; Duncan *et al.*, 1998).

Statistical analyses

Dust baths recorded as lasting less than 5 min did not meet the full definition of a dust-bath as they did not contain all the elements of a typical bout. They were considered as remnants or forerunners of typical bouts, and were discarded.

The statistical unit was the group of four hens. For the latency to dust-bathe and the number of dust baths per hen, means were calculated per group on the four hens. For duration of dust baths, means were calculated per group on all dust baths performed. As data had a non-normal distribution and samples were of small size, variables were analysed using non-parametric tests, i.e. Kruskal-Wallis one-way analysis of variance for overall comparison of the three treatments (d.f. = 2), followed by pair comparisons using the Mann-Whitney U-test (d.f. = 1) when significant. The level of significance was set at $P < 0.05$. Analyses were performed using the Systat 9.0 software package (Systat Software Inc., Richmond, CA, USA).

Results

The treatment effects were significant for all variables (KW = 21, $P < 0.001$ in all cases). Latency to dust-bathe was shorter (Figure 2a), dust baths were longer (Figure 2b) and more numerous (Figure 2c), and more hens dust-bathed (Figure 2d) among C hens than among A1 and A2 hens.

Discussion

Our results show that the motivation to dust-bathe was higher in cage hens (deprived of litter) than in aviary hens (with litter). In our laying aviaries, access to litter seemed to be sufficient to satisfy the dust-bathing motivation of the hens. Moreover, even though the percentage of hens on litter was lower in hens from rearing aviaries than in hens from furnished floor pens (Colson *et al.*, 2005c), this difference in terms of use of space had no effect on motivation to dust-bathe.

We cannot exclude that the observed differences in hens' motivation to dust-bathe arose from the different experiences lived not only in the laying environments but also in the rearing environments. Indeed, the rearing environments may have differentially satisfied the motivation to dust-bathe or have influenced the hens' development in unknown ways. However, we focussed on the impact of the full production system (rearing and laying) on motivation to dust-bathe during the tests. Hens housed in the two aviary production systems tested had a similar motivation to dust-bathe, in spite of a great difference in the surface of litter available per pullet between rearing aviaries (200 cm^2) and furnished floor pens (742 cm^2), whereas the size of the litter area available per pullet was much more similar between furnished floor pens and floor pens (847 cm^2). Thus, it is probable that the difference in motivation to dust-bathe found between aviary and cage

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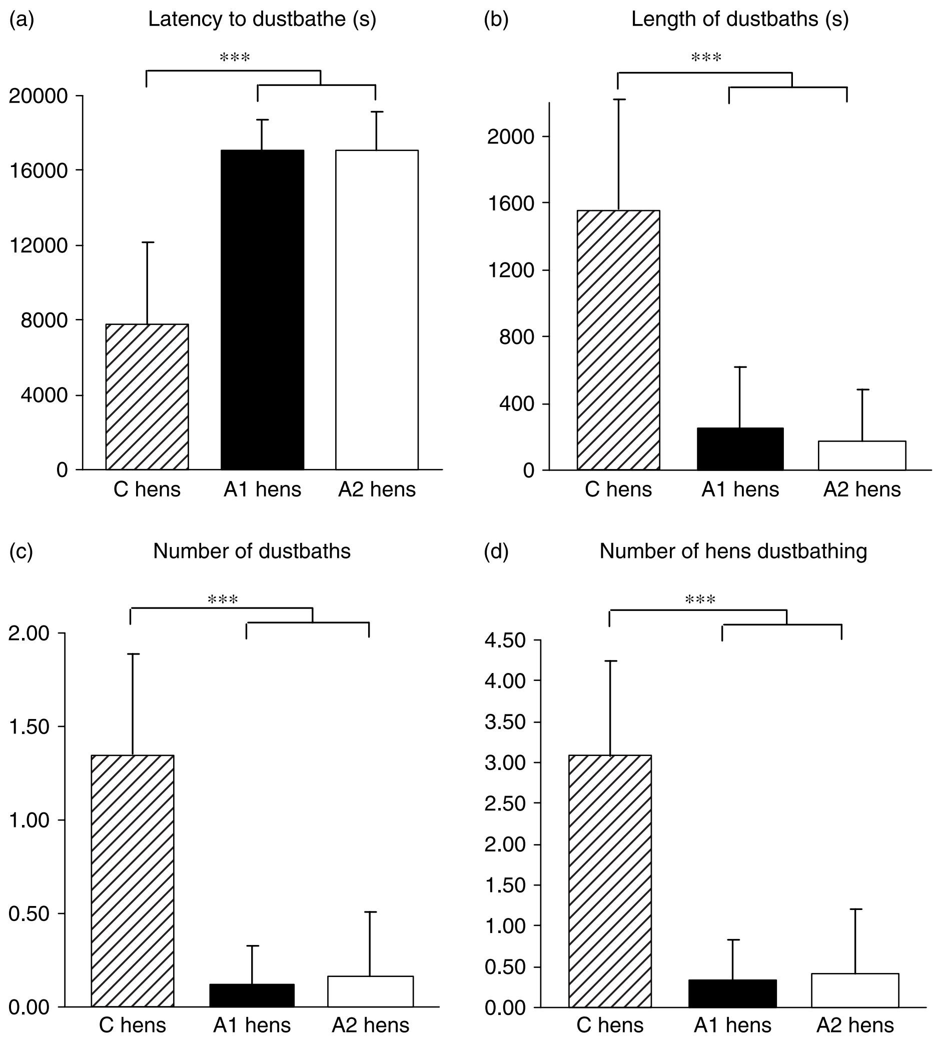

Figure 2 Means ± standard deviations for latency to dust-bathe (a), length of dust baths (b), number of dust baths (c) and number of hens dust-bathing (d) measured during the five hours of observation, for each treatment: C hens reared in floor pens and then housed in conventional cages - A1 hens reared in furnished-floor pens (with perches and slatted platforms) and then housed in a laying aviary - A2 hens reared in rearing aviaries and then housed in a laying aviary. (*** $P < 0.001$).

hens was mainly due to differences in laying systems rather than differences in rearing systems.

In our experiment, the substrate available during our tests (sawdust) was different from the litter of laying aviaries. Hens preferentially choose a familiar substrate for dust-bathing (Vestergaard and Hogan, 1992). Consequently, aviary hens may have preferred to dust-bathe in a similar substrate to the litter of laying aviaries rather than in the sawdust provided in the test-arenas. This unfamiliar substrate probably do not prevent hens from dust-bathing, as it has been shown that when they are sufficiently motivated, hens can dust-bathe even if the substrate is inappropriate, as on wire floor (Olsson *et al*., 2002).

We cannot exclude the possibility that aviary hens were more disturbed by the test situation than cage hens. Indeed, the aviary hens were perhaps less familiar within each group tested than cage hens, and the former lived a greater change of environment between living conditions and test arenas (marked space reduction) and were certainly more disturbed by the absence of a nest-box in the test arenas. This may have decreased their motivation to dust-bathe (Vestergaard, 1982) and explains the fact that the average duration of dust baths performed by aviary hens was less than the values cited in the literature, which ranged from 20 to 30 min in favourable conditions such as *ad libitum* litter (no deprivation), low density and high luminosity (Vestergaard, 1982; Vestergaard *et al*., 1990). However, we observed less than 21% of aviary hens showing pacing, attempts to exit or nesting behaviour during the tests, and in less than 9% of the cases it lasted more than 30 min. The time hens spent in the test-arenas before observation was considered to be long enough to limit disturbances.

According to our results, aviaries seem to provide an improvement on conventional cages in terms of dust-bathing behaviour. Such an improvement in furnished cages is not an obvious conclusion. Indeed, in parallel to our experiment, Guesdon (2004) performed a study on the dust-bathing motivation of hens housed in conventional and furnished cages. Hens' motivation was tested 16 to 27 weeks after their transfer to cages. The same testing

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method as ours was used to compare hens' motivation to dust-bathe between two types of conventional cages and four types of furnished cages. Different frequencies of sawdust distribution in the furnished cages were used: never, every 2 weeks, weekly and daily. Motivation to dust-bathe was similar in all treatments, with hens showing shorter mean latencies to dust-bathe than hens housed in cages in our experiment. These results indicate that in Guesdon's experiment (Guesdon, 2004), hens housed in conventional and furnished cages were at least as well motivated to dust-bathe as our cage hens, probably because of a litter deprivation effect. Indeed, Guesdon (2004) reported that the dust boxes of furnished cages were empty of any litter most of the time.

The fact that sham dust baths are performed in furnished as well as in conventional cages (Lindberg and Nicol, 1997; Olsson and Keeling, 2002) and are shorter than the dust baths performed in litter areas (Lindberg and Nicol, 1997) reinforces the supposition that there is certainly some amount of litter deprivation in furnished cages. Thus, in contrast with litter areas in aviaries, the litter areas of furnished cages tested in previous studies do not seem to offer any welfare improvement in terms of dust-bathing behaviour.

Conclusion

Aviary hens showed a low motivation to dust-bathe during our tests, whereas cage hens showed a high motivation. Therefore, in our experimental conditions, and in contrast to conventional cages, laying aviaries seemed to satisfy the hens' motivation to dust-bathe and also to provide an improvement in the hens' welfare in terms of dust-bathing behaviour compared with conventional cages.

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