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The preferences of laying hens for perforated Astroturf over conventional wire as a dustbathing substrate in furnished cages

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Abstract

Following the 2012 European ban (1999/74/EC) of conventional battery cages, only furnished cages will be allowed for laying hens. However, even when furnished cages provide a pecking and scratching area most dustbathing occurs on the wire floor. This study aimed to investigate whether laying hens showed a preference for dustbathing on a covered wire floor rather than a conventional wire floor. Eight groups of 10 hens were housed in pairs of adjoining furnished cages. All hens were leg-ringed for individual identification. Each pair of cages consisted of one cage containing a wire floor covered with perforated Astroturf and a second cage containing a conventional wire floor, joined by a pophole through which hens had unrestricted access. Initial scan samples were taken to investigate the general behaviour of the hens on each floor type. Dustbathing was observed more frequently on Astroturf and no other behaviours were affected by the floor type. Scans were subsequently taken at 5 min intervals between 1130h and 1600h for 10 days, identifying the number of hens, and which individual hens, were dustbathing on each floor type. Data were analysed on a per cage basis, using the binomial sign test. A strong preference was found for dustbathing on Astroturf flooring that was apparent in all cages. Furthermore, the distribution of hens indicated this was not attributable to any overall preference for either floor type but was specific to periods when hens were dustbathing. This demonstrates that there is the potential to include Astroturf in the design of furnished cages, as a dustbathing substrate, in order to improve the welfare of laying hens.

Keywords: *animal welfare, Astroturf, dustbathing, laying hen, novel flooring*

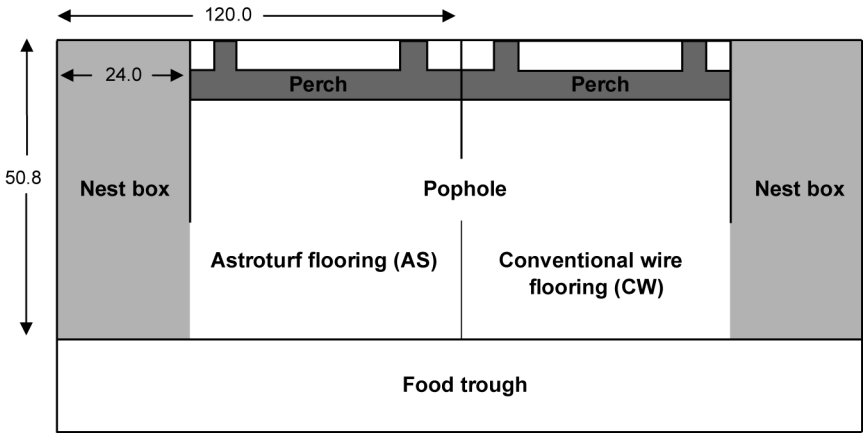
Introduction

Dustbathing is a behaviour, common among Galliforme birds (Simmons 1964), which is believed to function to maintain healthy feather and skin condition through the removal of excess stale lipids from the uropygial glands (van Liere & Bokma 1987; van Liere *et al* 1991). It is a strongly motivated behaviour and deprivation results in signs of stress (Vestergaard *et al* 1997); when subsequently given the opportunity to dustbathe there is a rebound effect with increased performance of the behaviour (Vestergaard 1982; van Liere & Wiepkema 1992).

From 2012, all conventional battery cages for laying hens will be banned under European Directive 1999/74/EC. Under the new regulations, furnished cages — containing a perch, nest box, and pecking and scratching area — will continue to be allowed. It is likely that many farmers will wish to use such systems because of the greater prevalence of problems, such as feather pecking, cannibalism and disease, found in non-cage systems (Appleby & Hughes 1991). Although dustbathing behaviour is not mentioned under the directive, many furnished cage designs attempt to provide for dustbathing in the pecking and scratching area.

In cage systems that lack a suitable loose substrate dustbathing behaviour is performed on the wire floor as 'sham' dustbathing (Lindberg & Nicol 1997; Vestergaard *et al* 1997). Sham dustbathing has been found to contain all the behavioural components of normal dustbathing, although not always at the same frequencies (Lindberg & Nicol 1997). Even when a pecking and scratching facility is freely available in furnished cages, the facility is used more for pecking and scratching than dustbathing (Appleby *et al* 2002) and much dustbathing may occur as sham dustbathing on the wire cage floor (Smith *et al* 1993; Lindberg & Nicol 1997). Although it is possible that sham dustbathing may satiate the hens' dustbathing motivation, and therefore may be sufficient for welfare, a number of problems exist: sham dustbathing on wire may result in plumage damage and abrasion; sham dustbathing on wire occurs at a lower frequency to dustbathing on litter (Vestergaard 1980); and hens strongly prefer litter substrates for dustbathing over wire and have been shown to work to gain access to litter substrates (Widowski & Duncan 2000). However, the provision of a loose litter substrate in furnished cages is problematic because of the constant need to replace the litter and the risk of lower

Figure 1



Overhead view of the layout of a pair of cages (dimensions shown are in cm).

quality eggs, which can be attributed to being laid in the litter; therefore, there may be a need to address the problem of providing a suitable facility for dustbathing without providing a loose litter substrate.

A number of studies have demonstrated preferences for certain dustbathing substrates: hens have been found to prefer sand over wood shavings (van Liere *et al* 1990), and peat over sand, sawdust or wood-shavings (Petherick & Duncan 1989); however, these studies have focused on loose litter substrates or conventional wire. To date, few studies have looked at the relative preferences for alternative non-litter substrates for dustbathing. Appleby *et al* (2002) fitted Astroturf pads with a sprinkling of sand in the dustbathing area of furnished cages, above the nest, and found that this was used by hens for dustbathing. Similarly, in a study looking at the effect of Astroturf on laying behaviour, it was observed that more hens dustbathed on artificial turf than on wire (Hughes 1993); however, no one has previously considered modifying the total floor area to encourage dustbathing, which might reduce or eliminate the problems of competition for a small space for dustbathing.

The aim of this study was to investigate the potential of Astroturf as a novel flooring for inclusion in furnished cage design as a possible dustbathing substrate. A number of methods exist to assess whether a material is a suitable substrate for dustbathing. First, different birds can be housed separately with different substrates and the quantity and quality of their dustbathing behaviour compared (eg Lindberg & Nicol 1997). Second, one can look at any rebound effects by allowing birds to dustbathe on different substrates and comparing the amount of dustbathing behaviour they exhibit when subsequently given access to a preferred substrate, such as peat or wood-shavings (eg Olsson *et al* 2002). Finally, different substrates can be presented simultaneously, thereby allowing birds to freely choose on which substrate to perform dustbathing; furthermore, the quantity and quality of dustbathing observed on each substrate can be measured (eg Petherick & Duncan 1989). This method was used in the present study; however, because of the large number of birds only the quantity of dustbathing was recorded. This study also examined the dustbathing behaviour of individual birds as it is not known how many birds make use of facilities such as the dustbathing area. The quality of dustbathing on novel non-litter substrates has been examined in another study (Merrill & Nicol 2005), although this did not specifically investigate Astroturf as a dustbathing substrate.

The primary aim of this study was to investigate whether laying hens show a preference for the Astroturf floor over a conventional wire floor as a dustbathing substrate. In addition, it is essential that a novel dustbathing substrate does not have a detrimental effect on other desirable behaviours; therefore, this study also considered the effect of the Astroturf on general behaviour within commercial furnished cages.

Materials and methods

Animals and housing

Eighty commercial medium-brown hybrid hens with intact beaks, housed at the University of Lincoln, were used in this study; hens were 36 weeks old at the beginning of the study. The hens were obtained from commercial breeders and were litter housed prior to being housed in furnished cages at 14 weeks old. All hens were leg ringed for individual identification. Hens were housed in groups of 10, in eight pairs of commercial furnished cages (made by Patchett Engineering) (see Figure 1); each pair of cages was labelled A–H. Cage dimensions were 120 × 50.8 cm (width × depth) and the floor was sloped at an angle of 8º. Each cage had a perch running the width of the cage, joined to the back of the cage by two smaller perches, providing a total of 28.8 cm of perch per hen between the two cages. Each cage had an enclosed nest box (24 × 50.8 cm, width × depth) lined with Astroturf. All cages contained claw shorteners. Cages were all single tiered, arranged in four rows each containing two pairs of cages. Each pair of cages consisted of one cage containing Astroturf on the whole cage floor (AS) and one cage with a conventional wire floor (CW); the two cages were joined by a pophole through which hens had free access. AS was chosen as the novel flooring because a previous study (Merrill 2004) indicated that AS is a substrate that might encourage dustbathing. The AS was shorter than the Astroturf lining the nest

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Table 1 Proportion of scans during which each behaviour was observed, on each floor type, with standard error (SE). Proportions are calculated from the total number of scans observed for all 80 hens on each floor type. The sum of total proportions observed on AS and total proportions observed on CW is equal to 1.

Behaviour	Proportion of observations on AS (± SE)	Proportion of observations on CW (± SE)
Dustbathing	0.037 ± 0.004[a]	0.010 ± 0.003[b]
Drinking	0.018 ± 0.002	0.017 ± 0.002
Pecking/scratching	0.008 ± 0.002	0.004 ± 0.001
Feather pecking	0.000 ± 0.000	0.002 ± 0.001
Eating	0.217 ± 0.011	0.210 ± 0.009
Nesting/laying	0.004 ± 0.001	0.001 ± 0.001
Perching	0.112 ± 0.006	0.121 ± 0.008
Preening	0.027 ± 0.004	0.027 ± 0.004
Comfort behaviours	0.000 ± 0.000	0.001 ± 0.000
Other behaviours	0.081 ± 0.006	0.098 ± 0.008

Significant differences: [ab] $P < 0.001$.

boxes and was perforated with approximately 2.5 cm square holes, spaced approximately 1.25 cm apart, to allow droppings to pass through. As the cages had been used in other studies, cage height — measured at the back of the cage — was either 45 cm (high) or 38 cm (low). Four pairs of cages consisted of one high cage and one low cage. The remaining four pairs of cages consisted of pairs of cages of the same height: both either high (two pairs) or low (two pairs). The position of the AS flooring in one of the two cages within each pair of cages was arranged to allow no bias for cage height, position within the row of cages or position within the room. Astroturf was placed in the cages two months before the start of the study to allow the hens to become habituated to it; the hens had no prior experience of Astroturf. Cages did not allow hens to access the pecking and scratching area above the nest box. Cages were lit by overhead incandescent bulbs providing a minimum light intensity of 15 lux (measured at trough level), with a day length of 16 h (0600h–2200h); temperature was maintained at a minimum of 21°C. Hens were fed layers mash early in the morning prior to the observation period and provided with water *ad libitum*.

Phase 1

Following a two-month period, during which the hens became habituated to the floorings and cages, scan samples were taken every 30 min, between 0900h and 1700h on four consecutive days. For each pair of cages, the number of hens engaged in each of several behaviours on each of the two floor types was recorded during every scan. Recorded behaviours included pecking or scratching at the floor, feather pecking, perching, drinking, eating, dustbathing, preening, and comfort behaviours, for example wing or leg stretches. Hens in the nest boxes (which were identical in both cages of each pair of cages) were recorded as nesting. Other behaviours were also recorded as a category, which included aggression or threats, and standing or sitting while not performing any of the previously listed behaviours.

Phase 2

Following Phase 1, the main dustbathing period was identified as occurring between 1130h and 1600h because 95% of all dustbathing observed occurred during this period (209 out of 219 scans). Following this, scan sampling was carried out at 5 min intervals by direct observation between 1130h and 1600h; all sampling was carried out by the same observer. At each scan, for each pair of cages, the number of hens on each floor type was recorded; the individual hens that were dustbathing on AS and those that were dustbathing on CW were also recorded. This was repeated for 10 days.

Statistical analysis

Data from Phase 1 were analysed using a multifactorial analysis of variance with floor type, cage-pair, cage height and day as factors. *Post hoc* analysis was carried out using Tukey tests.

In Phase 2, the observed number of scans for each possible distribution of hens on the two floor types was statistically compared to the expected frequencies from the binomial distribution of 10 hens between two cages using a χ^2 test, a technique used by Albentosa and Cooper (2005). For dustbathing, data were analysed on a per cage basis because hens within a pair of cages were not independent of each other. The binomial sign test was used to compare (for each pair of cages) the number of hens that were observed for more scans dustbathing on AS with the number of hens that were observed for more scans dustbathing on CW.

Results

Throughout the habituation period and study, the Astroturf proved robust and remained in good condition, undamaged by hens pecking at it. It also remained relatively clean because the majority of droppings passed through the perforations. However, it did become soiled directly under the perches; consequently, the Astroturf was removed from cages and cleaned on one occasion during Phase 2 of the study.

Phase 1

The number of scans observing each behavioural category, on each floor type, was calculated as a proportion of the total number of scans. The proportion of each of the behaviours observed on each floor type are summarised in Table 1. Dustbathing was found to occur significantly more frequently

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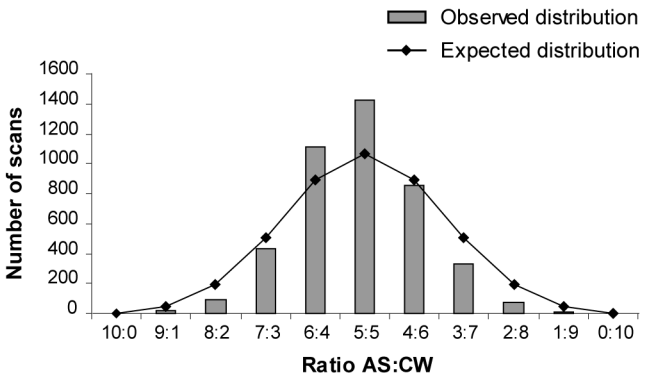
Figure 2



Observed and expected frequency distributions of hens on the two floor types. Observed indicates the total number of scans (across all pairs of cages) for each distribution of 10 hens. The expected number of scans is based on the random distribution of 10 hens as calculated from the binomial distribution.

on AS than on CW ($F = 29.973$, df = 1,54, $P < 0.001$). Feather pecking was observed during a total of 13 scans, 11 of which were observed on CW and 2 on AS; however, there were too few observations to be statistically significant. There was no significant difference in the occurrence of drinking, pecking and scratching, eating, nesting, perching, preening, comfort behaviour or 'other behaviour' between floor types; overall, very little aggression or threats were observed.

There was a significant difference in drinking between days ($F = 3.904$, df = 3,52, $P < 0.05$); *post hoc* analysis showed that a greater proportion of drinking was observed on day 2 than on day 3 ($P < 0.05$). There was also a significant effect for pecking and scratching between days ($F = 8.756$, df = 3,52, $P < 0.001$); *post hoc* analysis showed that a greater proportion of pecking and scratching was observed on day 3 than on day 1 ($P < 0.05$), day 2 ($P < 0.05$) or day 4 ($P < 0.05$). Furthermore, there was a significant difference for preening between days ($F = 6.505$, df = 3,52, $P < 0.001$); *post hoc* analysis showed that a greater proportion of preening was observed on day 1 than on day 3 ($P < 0.05$) and day 4 ($P < 0.05$). However, there was no significant effect for feather pecking, eating, nesting, perching, comfort behaviour or 'other behaviour' between days ($P > 0.05$).

There was a significant effect of cage height for perching ($F = 12.175$, df = 1,54, $P < 0.001$), with a greater proportion of perching observed in the high cages compared with the low cages; however, there was no significant effect of cage height for any of the 'other behaviours' observed in this study ($P > 0.05$). There was no significant effect of cage-pair for any of the behaviours ($P > 0.05$).

Phase 2

Distribution of hens

The observed and expected frequency distribution of hens is shown in Figure 2. The distribution of the number of scans of hens on each floor type was significantly different from the expected distribution if the hens had distributed themselves randomly between the pair of cages ($\chi^2 = 419.73$, df = 9, $P < 0.001$). The number of scans observed for the distribution of hens on each floor type was compared with the expected frequencies as calculated from the binomial distribution. A group size of five hens on each side of the cage-pairs was more commonly observed than expected ($P < 0.001$); six hens on AS were also observed more commonly than expected ($P < 0.001$). Eight hens on AS (and two hens on CW), three hens on AS, two hens on AS and one hen on AS were observed less frequently than expected ($P < 0.001$); nine hens on AS were also observed less frequently than expected ($P < 0.05$).

Dustbathing

All 80 hens were observed dustbathing on AS during at least one scan, whereas 25 hens were never observed dustbathing on CW. However, there was some variation between individual hens within cages; minimum, mean and maximum number of total scans during which dustbathing was observed in each cage-pair are shown in Table 2. Bouts of dustbathing were fairly evenly distributed over the 10 days of the study; however some hens were observed to perform high frequencies of dustbathing, and other hens performed low frequencies of dustbathing. For example, in cage-pair C, hen 23 was observed dustbathing during a total of 85 scans, with a median of 7 scans per day and an interquartile range of 6–11.5 scans per day, whereas in cage-pair A, hen 7 was observed dustbathing during a total of 16 scans, with a median of 1 scan per day and an interquartile range of 0–2 scans per day.

A significant preference was found for AS as a dustbathing substrate compared with CW (n = 8, $S = 0$, $P < 0.01$), which was apparent in all pairs of cages (see Figure 3).

Discussion

The results of this study demonstrate that the majority of laying hens observed showed a strong preference for the perforated Astroturf flooring (AS) rather than the conventional wire flooring (CW) as a dustbathing substrate. This preference was apparent in all cages and expressed by all except 6 of the 80 hens.

The results from Phase 1 of the study indicate that more dustbathing was performed on AS than on CW, but that no other behaviours were affected by the floor type. This supports the results of a previous study (Hughes 1993), which demonstrated that artificial turf was not used preferentially for any behaviours other than laying and dustbathing (in the current study the nest area was identical on both the AS cage and CW cage of the cage-pair and so no difference in the incidence of nesting/laying was observed); therefore, Astroturf does not appear to have a detrimental effect on the occurrence of other behaviours. Similarly, it does not appear to increase the likelihood of the occurrence of undesirable behaviours, such as feather pecking, which highlights the potential of Astroturf as an alternative flooring that could act as an artificial dustbathing substrate in furnished cages.

Phase 2 of the study investigated the dustbathing behaviour of the individual hens within the cages. Seventy-four out of

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Table 2 Descriptive statistics: minimum, mean and maximum number of total scans during which dustbathing was observed, separated by cage-pair.

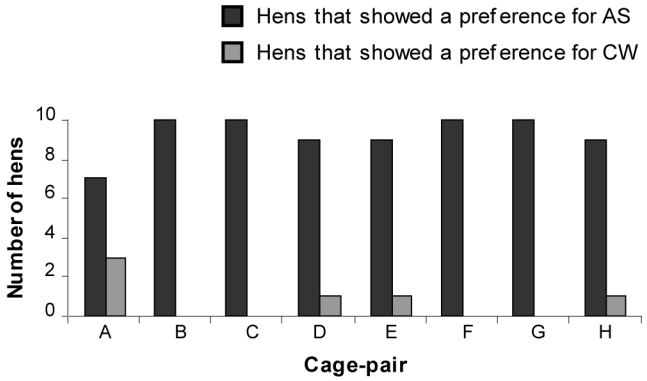
Cage-pair	Dustbathing on AS			Dustbathing on CW		
	Min	Mean	Max	Min	Mean	Max
A	10	36.3	103	0	7.9	34
B	9	44.1	77	0	1.1	5
C	4	36.2	81	0	1.1	6
D	2	23.7	39	0	4.0	21
E	7	29.0	58	0	4.0	26
F	5	36.4	85	1	3.2	12
G	3	28.7	55	0	8.2	41
H	8	23.1	38	2	8.2	35

a total of 80 hens were observed to dustbathe more often on AS, suggesting that AS was more preferable than CW as a dustbathing substrate. During the scan sampling period, hens were observed to most frequently distribute themselves evenly so that five hens were on each side of the cage-pairs. This distribution was observed significantly more frequently than would be expected if the hens had distributed themselves randomly. These results are similar to those found by Albentosa and Cooper (2005) in a study investigating cage height preferences (also see Cooper & Albentosa 2003, 2004). A distribution of six hens on AS and four hens on CW was also observed more frequently than expected, possibly suggesting that the hens may have had a slight preference for AS while still maintaining a near-even distribution between the two cages. Two possible conclusions can be drawn from this distribution. The first is that the hens had no overall preference for either floor type and were acting solely to maximise the amount of space between them or to maintain similar group sizes (ie five hens on AS and five hens on CW); if this were the case, then the observed preference for dustbathing on AS was solely due to its properties as a dustbathing substrate. The second is that the hens did have a preference for one of the floor types for reasons such as foot comfort. This preference, however, may have been masked by a trade-off with a stronger motivation to maximise space between the hens. It is possible that during dustbathing the value of space between the hens may be reduced, if so, the observed preference for dustbathing on AS may be attributable to some overall preference for AS over CW as a flooring material, expressed only during the performance of dustbathing, rather than the floor's properties as a dustbathing substrate. The possibility of a reduction in the value of space between the hens during dustbathing may be a function of the social nature of the behaviour. It has been frequently reported that when one hen begins to dustbathe it is joined by others (Wood-Gush 1989) and that the sight and sound of a companion dustbathing may stimulate dustbathing in nearby hens (Duncan *et al* 1998). Such a socially synchronised behaviour may be performed by a number of birds in close proximity to one another.

The observation that six hens dustbathed more frequently on CW than on AS raises the question as to why these hens showed a different preference to the majority of the hens. One possible explanation may be attributable to dustbathing being a socially synchronised behaviour and that when hens were observed dustbathing on the CW floor it was because they were motivated to do so by the presence of other hens dustbathing on AS. Because the space on AS was limited, these hens may have been forced to dustbathe on the less preferred substrate. An alternative explanation may be that hens were inhibited from dustbathing on AS by the presence of other hens. Lundberg and Keeling (2003) demonstrated that social factors can affect hens' dustbathing behaviour, and suggested that either high ranked hens were socially facilitated to dustbathe when viewing another hen dustbathing or were socially inhibited from dustbathing by viewing a standing hen. In the present study, it is possible that hens were socially inhibited from dustbathing on AS by the presence of other hens standing on AS. If such a situation occurred in this study, hens may still have been motivated to dustbathe but performed the behaviour on CW flooring. It is important to note, however, that little aggression or threats, which might have resulted in hens being excluded from either floor type, were observed.

Although the results of this study indicate that AS is preferred to CW as a dustbathing substrate, there is a potential negative impact of this material attributable to the build up of faeces. This study was conducted over a relatively short duration (3 months, including habituation to the

Figure 3



Dustbathing substrate preferences of hens in each cage-pair (A–H); preferences were determined by the floor type on which each hen was observed to perform the majority of its dustbathing.

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flooring), in comparison to commercial laying cycles, which last approximately 12 months, and the Astroturf was cleaned at one point during the study. Therefore, a build up of faeces over a full laying cycle might pose a health threat. This problem may, however, be easily resolved by the careful design and positioning of the Astroturf within furnished cages. As most droppings fell directly below the perches it might be better to position the Astroturf away from this area. This might be particularly simple to achieve in the larger models of colony cages that are designed to house 20, 40 or 60 birds.

This study demonstrates that an Astroturf floor is a substrate that is highly preferred by laying hens during dustbathing relative to conventional wire flooring. It is, however, important to note that the dustbathing observed on the Astroturf was 'sham' dustbathing in the absence of a loose substrate. Although such behaviour may be satisfying to the hens, it lacks the functional consequences of the normal behaviour (ie the removal of stale and excess lipids [van Liere & Bokma 1987; van Liere *et al* 1991]); therefore, there is a clear need to address the question of how satisfying such behaviour is to laying hens. Future research is required to investigate the motivations that underlie sham dustbathing and how performance of such behaviour affects laying hen welfare.

Animal welfare implications

Following the 2012 ban on conventional cages it is likely that many farmers will use furnished cages because of a range of problems associated with the alternative non-cage systems of egg production. Previous studies (eg Lindberg & Nicol 1997) have demonstrated that even if furnished cages provide litter in a pecking and scratching facility most dustbathing occurs on the wire cage floor. Because of the practical problems with providing a loose substrate there is a need to assess the potential of non-litter materials as dustbathing substrates. Astroturf is a durable material that is easy to maintain and the results of this study indicate that with careful positioning in cages, to avoid problems of soiling (ie not directly under the perch), Astroturf has the potential to be included in the design of furnished cages as a non-litter dustbathing substrate that will have no detrimental effect on other behaviour.

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