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DIGGING AND ITS WELFARE IMPLICATIONS FOR FARMED BLUE FOX

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Abstract

Our study sought to clarify farmed blue foxes' (*Vulpes lagopus*) digging motivation on two different digging substrates, sandbox and plates. The plates were either on the wall or on the floor; the sandbox was always on the floor. A standard cage without any digging substrate was used as a control. We also evaluated the effects of the digging substrates on the animals' welfare. Each group comprised 20 juveniles kept in male-female pairs in conventional wire-netting cages. Our results showed that the motivation to dig for a specific goal (sandbox present) is no greater than that to perform digging behaviour per se only (plates present). There was a statistically significant difference in the dirtiness of the fur coat between the groups ($P<0.001$). The pelts originating from foxes kept in cages with a sandbox were dirtier than those from foxes kept in standard cages or in cages with a digging plate on the wall. Analyses of behaviour from video recordings and walking tests did not reveal any marked differences between the groups. Furthermore, the weight gain in animals with digging plates was similar to that in animals kept in standard cages. The variation in body weight development was highest in foxes with a sandbox. These findings indicate that the sandbox tends to have an adverse effect on body size. No statistical difference was found in haemoglobin, haematocrit, red blood cell or white blood cell values between the groups, and all the values were within a normal range. There was a slight tendency for the adrenal glands to be heaviest in the sandbox group ($P = 0.1$). The adrenal glands tended to be lightest in the group with a digging plate on the wall. A digging plate on the cage wall was considered to be the most suitable digging substrate for farmed blue foxes. A sandbox on the cage floor seems to be least acceptable because it makes the fur coat dirty and may cause problems for hygiene and thermoregulation.

Key words: *Vulpes lagopus*, animal welfare, digging, fur animal production, motivation

A major factor contributing to the welfare of a farmed animal is its ability to fulfil its behavioural needs under given housing conditions (Dawkins, 2004). These behavioural needs have a certain hierarchy of importance. As not all environmental features occurring in the wild can be provided under housing conditions, the animals must be given environmental enrichments that satisfy their most important needs (Dawkins, 1990).

The motivation of a blue fox (*Vulpes lagopus*) to use different enrichments under farm conditions has been studied intensively during the last 15 years (e.g. Korhonen et al., 1996; Mononen, 1996; Korhonen et al., 2002; Korhonen et al., 2003; Koistinen et al., 2009). According to these studies, the only enrichments required are a platform and a wooden block for chewing. Recently, however, the provision of additional enrichments such as a concrete floor and a nest box and also extra space has been required. Discussion about the need for a concrete floor has been particularly lively because a fox's opportunity for digging could be essential to its wellbeing (European Convention, 1999; Hovland and Bakken, 2000). However, this has not yet been scientifically proven. The hierarchy of importance of different enrichments for blue foxes is currently a subject of research (Koistinen et al., 2009; Korhonen and Koistinen, 2009).

Clarification of a fox's need to dig is a crucial and urgent issue in fur farming (Korhonen et al., 2004). Sweden, Holland and Germany have already forbidden fox farming because present housing conditions do not permit essential behaviours such as digging. In Denmark, cages have to be equipped with a piece of solid floor material to satisfy the foxes' need for digging and solid contact (Nielsen and Larsen, 2006). The simplest and cheapest solution is to insert a solid plate for digging on the cage wall. The other, presumably more problematic, solution is to insert the plate on the floor. This could be the answer if foxes are required not only to be able to dig but also to make contact with a solid floor material with their feet.

The digging substrates previously studied for farmed foxes are an earthen floor and a sandbox. It would seem that it is not the purpose of the digging behaviour that is essential for the farmed fox but rather the possibility to dig per se (Korhonen et al., 2004). If this is the case, then the need to dig could be satisfied by providing a simple digging substrate such as a plate, not an entire earthen floor or even sandbox. The setup of the present study was constructed to test this hypothesis. Our primary aim here was to clarify farmed foxes' digging motivation with two different digging plates: one on the cage floor and one on the cage wall. Such plates would permit the foxes to dig without achieving a tangible goal such as making a nest or finding food. A true digging substrate, i.e., a box with sand, was also provided to permit the animals to perform goal-directed digging as well (Korhonen et al., 2003; 2004). Our secondary aim was to establish the welfare implications of the digging substrates studied.

Material and methods

Subjects and experimental groups

The study was carried out at the Fur Farming Research Station of MTT Agrifood Research Finland, western Finland (63.54°N, 23.54°E). It comprised four experimental groups housed in four different cage setups: 1) a standard cage (105 cm long × 115 cm wide × 70 cm high) without digging substrates, which housed the control group; 2) a standard cage (105 cm long × 115 cm wide × 70 cm high) with

a solid metal plate (210 mm × 297 mm) on the wall for digging and scratching; 3) a standard cage (105 cm long × 115 cm wide × 70 cm high) with a solid metal plate (210 mm × 297 mm) on the floor for digging and scratching; 4) a standard cage (105 cm long × 115 cm wide × 70 cm high) with a metal sandbox for digging and scratching (80 cm × 40 cm × 14 cm, L×W×H). The sandbox had a 10 cm layer of sand (ca. 25 kg, particle size 0–18 mm) on the bottom. The experimental groups were formed at weaning on 22nd July. There were 20 foxes in each group (one male and one female per cage). At weaning, a platform (45 cm from the floor) and a wooden block for chewing (7 cm Ø × 35 cm long) were also placed in the cages. In group 2, the plate was fitted on the right-hand side of the cage, 30 cm from the base of the wall. In group 3, the plate was placed on the floor. Once or twice a day, the animals were fed equally large portions (750–1000 g daily) of fresh fox feed made by the local feed kitchen (Kannus Minkinrehu Ltd).

Measured variables

The animals were weighed four times during the experiment: at weaning on 22nd July, and on 3rd September, 1st October and 25th November. Behavioural responses to capture were evaluated twice: on 3rd September and 1st October. The foxes were caught with neck tongs. Capture time was measured from the moment the cage door was opened until the moment the fox was caught. The response to capture (capture test) was classified as confident, fearful or passive (Korhonen et al., 2001). The dirtiness of the digging substrates was checked nine times during the study (Figure 1). The condition was evaluated on a scale from 1 to 4, where 1 = clean, 2 = nearly clean, 3 = slightly dirty and 4 = very dirty. The reactions of the foxes to humans were evaluated by a walking test (Korhonen et al., 2001) in which an assistant walked slowly past the cages and wrote down the behavioural reactions of the foxes. The test, which was made between 23rd September and 3rd October, was performed by the same person twice a day, at 8 am and 1 pm, on five consecutive days.

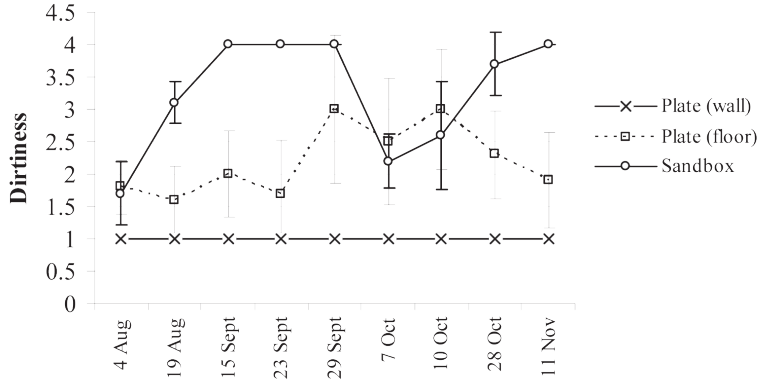

Figure 1. Dirtiness of digging substrates measured during the study. Sandboxes were cleaned on 1st of October. Scale of dirtiness varied between 1 and 4, where 1 = clean, 2 = nearly clean, 3 = slightly dirty and 4 = very dirty. There was a statistically significant difference between groups ($P<0.001$)

The behaviour of the foxes in each group was video recorded twice during the experiment (12th August and 9th September). The recording equipment consisted of 12 black-and-white surveillance cameras, three time-lapse video recorders (Hitachi) and three quads (GS-MS Quad Display). When it was dark, the cages were lit with 25 red lamps (25 W). The behaviour of the foxes was analysed by instantaneous sampling at 5-minute intervals (Jauhiainen and Korhonen, 2005). The data were analysed between 10 am and 8 pm each recording day. On 7th October, a feeding test was conducted to evaluate the level of confidence or fear in foxes in the presence of humans. An assistant gave a fox a portion of fox feed and stood in front of the cage. The time it took for the fox to come to eat was measured. If the fox did not come to eat within 30 seconds, it was classified as fearful and the test was aborted (Korhonen et al., 2001). A ball test was conducted to evaluate the explorative behaviour of the foxes (Rouvinen et al., 1999). Frequent explorative behaviour towards a novel object typically indicates good welfare of an animal (Mononen, 1998). A novel object, in this case a basketball was placed in the cage and an assistant measured the time it took for the fox to touch the ball. If contact was not made within 30 seconds, the test was aborted. The test was always performed by the same assistant. Blood samples were taken from the foxes on 25th November and sent to the clinical laboratory of MTT at Ypäjä. The blood samples were used to determine the haemoglobin (Hb) and haematocrit (HCT) levels, the red blood cell (RBC) count and the white blood cell (WBC) count. Pelting took place on 25th November. The pelts were sent to Finnish Fur Sales, Vantaa, for measurement of length and weight and for evaluation of colour, mass, coverage and quality. The carcasses were prepared and the adrenal glands, liver, spleen and heart were weighed.

Statistical analysis

Statistical analyses were made with the SAS system for Windows 9.1 and SAS Enterprise Guide 3.0. The effects of experimental group on the weights of animals, capture time and fur properties (weight, length, purity of colour, mass, coverage and quality) were analysed with the general linear model (GLM), where cage nested within group was used as a random factor. Pair-wise comparisons between experimental groups were performed with Tukey's test. The assumption of a normal distribution was checked by graphical methods, which were scatter diagrams of residuals and predicted values for constancy of residual variance, and box-plot for normality of residuals (Korhonen et al., 2004). The Kruskal-Wallis ANOVA was used to analyse the results for fur dirtiness, walking test and behaviour. The pair-wise comparison was made according to Siegel and Castellan (1988). Organ weights were analysed with Linear Mixed models using the body weight (in November) as a covariate. Pair-wise comparisons were made with Tukey's test. The assumption of a normality was checked as in the GLM procedures. The Fisher Exact test was applied to analyse the results of the food test, ball test and capture reactions. Actual means with SD are given in Tables.

Results

Weight development

At the beginning of the study, the mean weights of the foxes in the different groups were the same (Table 1). Furthermore, weight development during the growing season was normal in all groups. The foxes with a sandbox weighed the least and those with a plate on the wall the most at the end of the study, but there was no statistical difference between the groups. Individual body weight variation was highest in the foxes with a sandbox.

Table 1. The weights of blue foxes and the time needed to catch a fox from a cage (Mean±SD). There was no statistical difference between groups

Parameter	Date	Standard	Plate (wall)	Plate (floor)	Sandbox
Body weight (kg)	22.7	2.1±0.2	2.0±0.2	2.0±0.2	2.0±0.2
	3.9	6.0±0.5	6.0±0.4	6.0±0.5	6.0±0.5
	1.10	9.5±0.7	9.5±0.6	9.4±0.2	9.0±1.3
	25.11	13.8±1.1	14.4±1.2	14.0±1.4	13.3±1.9
Capture time (s)	3.9	1.9±0 8	1.8±0.6	2.0±0.6	2.2±1.3
	1.10	6.9±1.2	7.0±1.4	6.7±1.0	7.0±1.2

Feed consumption

Food intake was the same in all groups. The foxes had a good appetite, average feed consumption being 750 g/animal at the beginning of the study. From 15th August, the average feed portion was 850 g/animal and between October and November 1000 g/animal.

Capture

It took only a few seconds to catch a fox in a cage in September but the time increased as the foxes grew, and was about 7 seconds in October. Capture time did not differ statistically between the groups (Table 1). In September, the number of confident animals in groups 1–4 was 4, 5, 2 and 0, respectively, and that of fearful animals 7, 3, 11 and 11, respectively ($P<0.05$). In October, the number of confident animals in groups 1–4 was 1, 1, 3 and 5, respectively and that of fearful animals 10, 8, 10 and 7, respectively. The differences between the groups were not significant in October.

Organ weights

No statistical difference was found in organ weights between the groups (Table 2), although a slight tendency ($P = 0.1$) was noted for the adrenal glands to be heaviest in the sandbox group. The adrenal glands tended to be lightest ($P = 0.1$) in the group with a digging plate on the wall.

Table 2. The weights of different organs and the results for a small blood picture (Mean±SD). There was no statistical difference between groups

Parameter	Standard	Plate (wall)	Plate (floor)	Sandbox
Adrenal gland (mg)	427±98	379±79	395±88	450±85
Heart (g)	47.2±4.2	42.6±4.7	46.3±4.3	42.6±4.5
Spleen (g)	10.0±3.2	7.5±1.3	9.1±1.7	9.5±2.0
Liver (g)	348±95	388±95	383±92	358±111
Haemoglobin (g/l)	155±10	160±6.3	157±7.3	157±10
Haematocrit (%)	49.3±6.0	50.1±6.1	49.9±1.9	49.4±0.9
White blood cells (10^9 cells 1^{-1})	8.4±2.4	7.2±1.7	7.9±0.8	8.4±1.6
Red blood cells (10^9 cells 1^{-1})	8.4±0.6	8.7±0.3	8.4±0.5	8.4±0.5

Blood picture

The animals remained healthy throughout the study. The blood picture parameters showed that general health was good in all groups (Table 2). There was no statistical difference in haemoglobin (Hb), haematocrit (HCT), red blood cells (RBC) or white blood cells (WBC) values between the groups, and all values were within a normal rage (Korhonen et al., 2001).

Fur properties

The results of the evaluation of fur properties are given in Table 3, which shows a statistically significant difference in fur dirtiness between the groups ($p<0.001$). The pelts from the foxes housed in cages with a sandbox were dirtier than those from the foxes housed in standard cages or cages with a digging plate on the wall. The pelts from the foxes in cages with digging plates on the floor were also dirty. The pelts from foxes housed in cages with a sandbox lost the most grading points.

Table 3. The evaluation of the fur properties (Mean±SD). Letters a and b mark the difference between groups

Parameter	Standard	Plate (wall)	Plate (floor)	Sandbox	P-value
Length (cm)	128.4±5.5	128±4.3	127.3±6.3	126.7±6.9	NS
Weight (g)	817±95.7	826±87.0	826±105.2	817±123.7	NS
Purity of colour	4.7±0.6	4.8±0.5	4.7±0.5	4.8±0.6	NS
Mass	5.9±1.8	6.8±1.2	6.3±1.6	6.2±2.7	NS
Coverage	7.1±0.8	7.0±1.2	6.8±1.0	6.8±1.0	NS
Quality	5.9±1.8	6.8±1.2	6.3±1.6	6.2±.7	NS
Dirtiness	1.0±0.0 a	1.1±0.3 a	1.6±0.8 ab	2.0±0.7 b	<0.0001
Minus points	–0.2±0.6 a	–0.3±0.7 a	–1.3±1.8 ab	–2.4±1.8 b	<0.01

Confidence and exploravity

Only a small number of foxes in any group responded confidently to the feeding test (Table 4). The foxes in cages with a digging plate on the wall tended to be

the most confident. The mean time it took for a fox to start eating was 17.5 seconds in a standard cage, 17.3 seconds in a cage with a plate on the wall, 17.0 seconds in a cage with a plate on the floor and 19.0 seconds in a cage with a sandbox. The number of cases was very low in all groups, and so no statistical analysis was made. Furthermore, there was no major difference in the tendency to explore a novel object between the groups (Table 4). Only a couple of foxes per group showed explorative behaviour during the ball test. Again, owing to the small number of cases, no reliable statistical analysis could be conducted. However, the foxes in cages with a sandbox seemed to be the least keen to explore a novel object, whereas the foxes (n = 2) in cages with a digging plate on the floor were the most eager to make contact with a novel object.

Table 4. Percent of foxes that came to eat in presence of a man and percent of foxes touching a novel object

	Standard	Plate (wall)	Plate (floor)	Sandbox
Feeding test (%)	10	15	5	10
Time to eat	17.5	17.3	17	19
N	2	3	1	2
Ball test (%)	10	10	10	5
Time to contact	6.5	7.5	5.5	17
N	2	2	2	1

Behaviour

Behaviour as analysed from video recordings is presented in Table 5. The interest shown by the foxes in the enrichments (sandbox or digging plates) was not high in general. In August, the foxes were most interested in the digging plate on the floor, but in September all enrichments were equally uninteresting. The enrichments did not seem to affect overall activity, i.e., the foxes were equally active in all groups. Digging and scratching were as frequent in foxes with a digging plate as in those with a sandbox. All the foxes seemed to spend most of their time on the platform. The foxes with a sandbox tended to sniff and lick more in August than did those in the other groups. Passive activity, i.e., sitting, standing and resting, was most frequent in the foxes with a digging plate on the floor, but the difference between the groups was not apparent in September.

The behavioural reactions to the walking test are given in Table 6. The foxes were most frequently to be found on the platform, or standing or sitting in their cages. As a whole, the foxes in cages with a sandbox tended to be found on the platform more often than did those in the other three groups ($P = 0.07$). Standing was significantly more frequent in September ($P = 0.001$). Resting during the walking test tended to decrease in September ($P = 0.05$) and there was no statistical difference between the groups. Resting tended to differ between the groups in August ($P = 0.08$), but with Tukey's adjustment the tendency ceased to exist. Retreating decreased significantly in all except the sandbox group during the experiment and there was no difference between the groups. When approached, the foxes jumped onto the platform significantly less in September ($P = 0.003$).

Table 5. The percent of occurrence of behaviours during two recording sessions (Mean ± SD). Behaviours are measured using instantaneous sampling method with 5 min interval. Letters a and b mark a statistical difference between groups

	Behaviour	Standard	Plate (wall)	Plate (floor)	Sandbox	P-values
August	Use of enrichment	-	0.5±0.4	8.3±7.5	1.7±0.9	NS
	Activity	12.7±4.5	13.3±7.5	14.6±4.6	15.4±5.9	NS
	Sit	5.4±2.4	7.8±4.7	5.9±3.1	5.0±2.7	NS
	On the platform	33.2±26.6	27.07±17.6	35.3±21.6	40.6±27.0	NS
	Contact with a block	0.3±0.2	0.8±0.2	0.7±0.5	0.6±0.4	NS
	Social contact	3.7±2.5	3.6±3.5	3.8±1.7	5.4±3.9	NS
	Dig/scratch	-	0.3±0.5	0.2±0.3	0.2±0.4	NS
	Eat	3±1.7	2±1.8	2.3±1.6	2.3±1.7	NS
	Sniff/lick	-	0.3±0.7 a	0.6±0.8 ab	1.0±0.7 b	<0,01
	Defecate/urinate	-	0±0	0±0	0.1±0.2	NS
	Stationary activity	-	0±0	7.5±7.4	0.4±0.5	<0,01
September	Use of enrichment	-	0.2±0.6	1.0±2.1	1.4±1.1	NS
	Activity	9.6±3.2	10.0±4.8	11.7±5.9	8.9±4.8	NS
	Sit	7.3±4.6	6.8±3.3	2.5±2.5	6.7±2.9	NS
	On the platform	27.6±22.0	38.5±26.4	39.3±28.0	40.4±24.4	NS
	Contact with a block	0.2±0.1	0.4±0.2	0.2±0.1	0.3±0.2	NS
	Social contact	2.5±1.4	2.6±1.7	4.1±3.2	2.8±1.6	NS
	Dig/scratch	-	0.2±0.5	0.1±0.3	0.1±0.4	NS
	Eat	3.1±2.0	2.7±1.6	2.4±1.0	2.2±1.4	NS
	Sniff/lick	-	0.1±0.2	0.2±0.5	0.4±0.7	NS
	Defecate/urinate	-	0±0	0±0	0±0	NS
	Stationary activity	-	0±0	0.8±2.1	0.9±1.2	NS

Table 6. Reactions of the foxes to a man walking by the cage (walking test) (mean±SD). The letters a and b indicate a statistical difference between test occasions. * Only a group with plate on the floor and a group with a sandbox were tested. Note the number of observations on a plate/sandbox in a plate group

	Behaviour	Standard	Plate (wall)	Plate (floor)	Sandbox	P-values (group)
August	On the platform	22.1±21.3	21.2±16.8	27.9±17.1	38.8±29.3	NS
	Sit	21.6±15.9 ab	24.6±16.1 b	20.0±15.1 ab	11.3±11.6 a	<0.05
	Stand	36.3±23.3	28.8±22.2	28.8±19.4	30.0±18.2	NS
	Rest	5.4±4.2	8.8±4.6	12.1±11.9	3.8± 1.3	NS
	Approach	2.1±1.6	1.4±1.3	2.1±1.6	0.8±0.6	NS
	Retreat	8.3±6.0	7.1±6.8	5±4.4	4.2±3.7	NS
	Trot	0±0	0.8±0.6	0.4±1.9	0±0	NS
	Eat	1.7±1.4	0.8±0.6	1.7±0.4	0.4±0.9	NS
	On the plate/sandbox	-	-	0±0	8.3±13.0	<0.001*
	Jump onto a shelf	2.5±6.7	0.8 ±0.6	2.1±1.0	2.5±1.9	NS
September	On the platform	22.0±20.4	22.1±20.5	31.4±26.9	35.7±19.9	NS
	Sit	17.9±15.3	17.1±15.8	20.7±19.4	15±11.7	NS
	Stand	50.7±27.6	46.4±24.0	38.6±20.3	32.1±21.7	NS
	Rest	4.3±8.2	8.6±6.8	4.3±3.5	0.7±0.9	NS
	Approach	1.4±1.1	2.1±2.0	1.4±1.1	0±0	NS
	Retreat	0±0	1.4±1.3	0±0	0.7±3.2	NS
	Trot	0±0	1.4±4.4	0±0	0±0	NS
	Eat	2.1±1.2	0.7±0.9	3.6±2.4	1.4±1.3	NS
	On the plate/sandbox	-	-	0±0	14.3±11.4	<0.001*
	Jump onto a platform	0.71±3.2	0±0	0±0	0±0	NS

Dirtiness of digging materials

The dirtiness of digging substrates was assessed nine times during the study (Figure 1). Before the substrates were cleaned, there was a statistical difference of $P<0.001$ between the groups. The sandbox was the dirtiest and the plate on the wall the cleanest. After the enrichments had been cleaned, the statistical difference remained ($P<0.001$), the sandbox still being the dirtiest and the plate on the wall the cleanest.

Discussion

Digging seems to be species-specific behaviour for the Arctic fox (*Alopex lagopus*) in the wild (Frafjord, 1986). Typically, wild foxes dig to make shelters or to cache and retrieve food. Thus, digging is very much a question of survival and a specific goal. The most commonly farmed colour type of Arctic fox is the blue fox. It is known that foxes under farm conditions also perform digging-like behaviour (Hovland and Bakken, 2000; Korhonen et al., 2003). However, on farms, digging has little to do with survival because the farmer provides the foxes with shelter and regular food. As a species, the fox may have two different digging motivations: digging for a certain survival-supporting goal as is done in the wild, and digging because digging *per se* may be rewarding, i.e., it provides sensory feedback from the feet and muscles (cf. Hughes and Duncan, 1988; Harri et al., 1999; Korhonen et al., 2003, 2004). Here, digging plates permitted the foxes to dig without any visible goal. The sandbox, on the other hand, gave the foxes a chance to engage in other goal-directed behaviours. Our previous study (Korhonen et al., 2004) showed that the sandbox may serve as an actual digging substrate tracing an earthen floor.

The existence of a digging substrate in a cage allows the foxes to dig at will. Thus, it is their choice. Previous studies have shown that the time spent by farmed foxes on digging typically ranges from 4 to 15 min daily (Hovland and Bakken, 2000; Korhonen et al., 2003). In our study, the amount of digging is given as a percentage of performed behaviours in Table 5. If this is converted to minutes daily, the times for a sandbox and plate on the floor are 12 min and for a plate on the wall 18 min. So, these times fit well with the previous ones. They also reveal that the motivation to dig for a specific goal (sandbox group) is no greater than the motivation to perform digging behaviour per se only (plate groups). Plates thus suffice to satisfy the foxes' need to dig under farm conditions. Furthermore, the amount of daily digging is actually rather low. It is also difficult to establish whether the foxes were in fact compensating for some other behaviour by digging. Analyses of behaviour by video recordings and a walking test did not reveal any substantial differences between the groups. It thus looks as if the digging substrates provided do not essentially change the general behaviour of foxes from that observed in standard cages. The dirtiness of the digging substrate may be a crucial problem under farm conditions (Korhonen et al., 2003). As the results showed, both the sandbox and the digging plate on the floor get dirty within a few weeks because the foxes defecated and urinated on them.

The motivation to eliminate was highest on sand. The digging plate on the wall, on the other hand, remained clean throughout the study. Its use for digging was also highest. It would seem then that a plate on the wall could compensate for a sandbox as equipment for digging and scratching; it can also be recommended in terms of hygiene. Evaluation of fur properties revealed that the coat was dirtiest in the foxes with a sandbox in their cage. In other fur parameters, there were no significant differences between the groups. However, fur quality was most variable in the foxes with a sandbox. Thus, there were several foxes with lower quality pelts but also those with normal quality pelts in the sandbox group. Such variation is not acceptable from the farmer's point of view.

Prolonged stress is known to increase the size of the adrenal glands (Korhonen et al., 2001). Here, we found a certain tendency for the adrenals to be heaviest in animals with a sandbox and lightest in those with a plate on the wall. This finding coincides well with the dirtiness of the sandbox and plate and also with the dirtiness of the animals in these groups. We are thus tempted to conclude that dirtiness of both the digging substrate and the fur coat may in the long run be stressful to foxes. A dirty fur coat is undoubtedly unpleasant for foxes. Not only is it a problem from the hygienic point of view but it also lowers the thermophysical properties of the coat and thus prevents normal heat regulation (Hovland and Bakken, 2000; Korhonen et al., 2000). The digging substrates tested did not make any difference to the difficulty of catching the foxes in the cages. However, the reactions of the foxes at capture (capture test) were not totally unambiguous. At the first testing session, in September, there were significant differences between the foxes in their reactions to capture, those with a digging plate on the floor being the most confident and the least fearful. However, at the second testing session, in October, there were no longer any significant differences between the groups. It is difficult to say what caused this change.

Homogeneity of the production animal stock is essential for successful farming today. Variations in animal size typically also mean variations in fur prices. The weight gain of foxes with digging plates was similar to that of foxes kept in standard cages. Variations in body weight development were greatest in the foxes with a sandbox, suggesting that sandboxes have an adverse effect on body growth.

Conclusions

A plate located on the cage wall can be considered the most suitable digging substrate for farmed blue foxes. A sandbox on the cage floor is least recommended because it makes the fur coat dirty and may present problems for hygiene and thermoregulation.

Acknowledgements

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Kopanie i jego wpływ na dobrostan fermowych lisów niebieskich

STRESZCZENIE

Celem badań było określenie czynników motywujących fermowe lisy niebieskie (*Vulpes lagopus*) do kopania przy użyciu dwóch rodzajów podłoża: piaskownicy i płyt. Płyty umiejscowiono na ścianie lub na podłodze, natomiast piaskownicę tylko na podłodze. Standardowa klatka bez podłoża do kopania posłużyła jako kontrola. Oceniano również wpływ podłoża do kopania na dobrostan zwierząt. Każda grupa składała się z 20 młodych lisów utrzymywanych parami (samiec i samica) w tradycyjnych klatkach z siatki drucianej. Wyniki wskazują, że motywacja do kopania w określonym celu (obecność piaskownicy) jest nie większa niż motywacja do kopania jako takiego (obecność płyt). Stwierdzono statystycznie istotną różnicę w zabrudzeniu futra pomiędzy grupami ($P<0,001$). Skóry pochodzące od lisów z klatek z piaskownicami były bardziej zabrudzone od skór lisów utrzymywanych w standardowych klatkach lub w klatkach z płytą do kopania umieszczoną na ścianie. Analiza zachowania na podstawie nagrań wideo i testów ruchu nie wykazała wyraźnych różnic pomiędzy grupami. Ponadto, przyrosty masy ciała u lisów z płytami do kopania były podobne do przyrostów zwierząt z klatek standardowych. Zróżnicowanie rozwoju masy ciała było najwyższe u zwierząt mających do dyspozycji piaskownicę. Wyniki te wskazują, że obecność piaskownicy może mieć niekorzystny wpływ na wielkość ciała. Pomiędzy grupami nie stwierdzono statystycznych różnic w zawartości hemoglobiny, hematokrytu, erytrocytów i leukocytów, a wszystkie wartości mieściły się w prawidłowym zakresie. Stwierdzono nieznaczną tendencję do najwyższej masy nadnerczy w grupie z piaskownicą ($P = 0,1$). Masa nadnerczy była najniższa w grupie z płytą do kopania umieszczoną na ścianie. Najbardziej odpowiednim podłożem do kopania dla fermowych lisów niebieskich okazała się płyta umieszczona na ścianie. Piaskownica na podłodze klatki jest najmniej zadowalająca, ponieważ zabrudza futro i może powodować problemy związane z higieną i termoregulacją.