

THE INFLUENCE OF ENVIRONMENTAL ENRICHMENT WITH DIFFERENT KIND OF WOOD ON SOME BEHAVIOURAL AND FATTENING TRAITS OF RABBITS HOUSED IN INDIVIDUAL WIRE CAGES

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ABSTRACT

The influence of addition of different types of wooden sticks as gnawing material for environmental enrichment on some behavioural and fattening traits was studied on 48 male New Zealand White rabbits of Slovenian male line SIKA. Animals were housed individually in wire cages equipped with feeder and nipple drinkers. Feed and water were available *ad libitum*, the duration of lighting was 12 hours. According to the type of wood placed in the cage, rabbits were equally allotted to four groups: control, oak, lime and Norway spruce. Rabbit behaviour was studied on 16 focus animals using continuous 24 hours video recording. Environmental enrichment had no significant influence on fattening traits and behaviour, except for eating, wood gnawing and frequency of caecotrophy. Rabbits in Norway spruce group ate significantly less time and less frequently and gnawed wood significantly longer and more often than rabbits in oak group.

Key words: rabbits / enriched environment / wood / animal behaviour / ethology / fattening traits

VPLIV OBOGATITVE OKOLJA Z RAZLIČNIMI VRSTAMI LESA NA NEKATERE ETOLOŠKE IN PITOVNE LASTNOSTI KUNCEV V INDIVIDUALNIH KLETKAH

IZVLEČEK

V raziskavo, kjer smo proučevali vpliv obogatitve okolja z letvami za glodanje iz različnih vrst lesa na obnašanje in pitovne lastnosti kuncev, je bilo vključenih 48 samcev pasme beli novozelanec slovenske linije SIKA (očetovska linija). Živali so bile uhlevljene individualno v žične kletke, opremljene s krmilnikom na zalogo in kapljičnim napajalnikom. Krmo in vodo so imele na razpolago po volji, trajanje osvetlitve je bilo 12 ur. Glede na vrsto lesa, iz katerega je bila letev, ki smo jo namestili v kletko, so bili kunci razporejeni v štiri enako velike skupine: kontrola, hrast, lipa in smreka. Obnašanje kuncev smo proučili s pomočjo 24-urnih video posnetkov 16 fokusnih živali. Obogatitev okolja je značilno vplivala le na trajanje in frekvenco žretja in glodanja lesa ter na pogostost cekotrofije. Kunci v skupini s smrekovimi letvami so žrli značilno manj časa in manj pogosto ter glodali les večji delež dneva in bolj pogosto kot kunci v skupini s hrastovimi letvami.

Ključne besede: kunci / obogateno okolje / les / obnašanje živali / etologija / pitovni parametri

INTRODUCTION

Like many other domestic animals rabbits too have experienced the effect of intensive husbandry. They were moved from solid floor with bedding to wire cage floor, which keeps them from lying in their faeces (Love, 1994), assures good control of parasitism and enables

more uniform product (Morisse and Maurice, 1994, cited in Morisse *et al.*, 1999). Despite of domestication, behaviour of the wild rabbit and domesticated rabbit under semi natural conditions was very similar (Love, 1994). Accordingly, artificial environment provided by husbandry, can seriously disrupt normal behaviour. Conventional wire cage system prevents rabbits to perform their natural behaviour, such as rearing up on the hind legs, digging, foraging and nearly all locomotive activities (Gunn and Morton, 1995). Their gnawing possibilities are also very limited (Maertens and Van Oeckel, 2001). Considering gregarious nature of rabbits, single caging can also lead to behavioural abnormalities (Held *et al.*, 1995). Rabbits housed in such conditions become restless and frequently change the activities (Lehmann, 1987). Stereotyped behaviours, such as biting, chewing or licking bars, feeders, water nipple, walls or grid floor, pawing or digging in the corner, excessive fur pulling and head swaying are very often a sign of frustration anxiety and boredom (Laboratory animals, 1993).

Wire cage systems can be enriched with straw or hay, grass, branches with leaves and gnawing sticks, which enable rabbits to perform their natural activities (Lidfors, 1997), mitigate the effect of stressors (Berthelsen and Hansen, 1999) and may reduce stereotyped behaviour. Stauffacher (1992, cited in Lidfors, 1997) found out, that in semi-natural enclosure rabbits spent about 20% of the time chewing wood branches. He suggested that rabbits should have gnawing sticks in their cages.

The aims of this study were to examine if the addition of wooden stick as an environmental enrichment to wire cages influences the behaviour and fattening traits of individually housed rabbits. We also wanted to determine if different types of wood have different influence on rabbits' behaviour and fattening traits.

MATERIAL AND METHODS

Animals and housing

The research took place in autumn and lasted nine weeks. It included 48 male New Zealand White rabbits of Slovenian male line SIKa. Animals were housed at the age of 38 days individually in wire cages measuring 37.5 x 40 x 30 cm, equipped with a feeder and nipple drinker. They were fed *ad libitum* with the complete feed mixture for fattening rabbits offered once a day between 7 and 9 in the morning. 12 hours light:12 hours dark schedule was used, with the lights on from 6:00 a.m. to 6:00 p.m. During the experiment ambient temperature varied from 21 to 25 °C and relative humidity between 35 and 57%. Right after the individual housing animals were allotted to four groups, each containing 12 rabbits, according to the type of wooden stick fixed horizontally in the rabbit's cage. For gnawing material the first group received oak sticks, the second lime, and the third Norway spruce sticks. The control group was left without wooden sticks. The mortality rate was 8.3% (4 rabbits: two in the oak, one in the lime and one in the Norway spruce group), which is in intensive breeding systems within usual limits.

Measurements and behavioural observations

Weight of individual rabbit and feed intake were recorded weekly till the age 101 days. These data were used for the calculation of the following fattening traits: daily gain, daily feed intake and feed conversion ratio.

To establish the influence of different type of wooden stick on rabbits' behaviour, 16 focus animals (4 from each group) were recorded for 24 hours by infrared video camera (WV-BP330/Panasonic). Simultaneously we were able to capture only four animals therefore one week was needed to complete one observation day for all 16 focus rabbits. Recordings of the

first and the last experimental week were afterwards analysed by two observers with the "Observer 4.1" program (Noldus), during which the duration of the behavioural elements was continually registered. We observed inactivity, rearing up (sitting with forepaws lifted from the floor), eating, drinking, caecotrophy, wood gnawing, biting wire and feeder, grooming, sniffing, hopping, stretching and contact with the neighbour rabbit. Additionally, all behaviours except inactivity, were grouped together in "activity". The frequencies of inactivity and grooming were too high, since we separately observed more types of inactivity and grooming, which were later joined together. During the single act of inactivity or grooming, animals often switched from one type to another, but the "Observer" counted every type as a separate act. Therefore in these two behaviours the information on mean duration is more reliable than the frequency. The systematic influence of transvaluated frequencies was the same in all four groups, therefore the comparison between them was possible.

Statistics

Statistical data analysis was conducted using statistical program package SAS (SAS..., 2001). Duration and frequency of behavioural traits were not normally distributed and were therefore analysed with nonparametric Wilcoxon rank-sum test with Bonferroni-Holms correction for multiple comparison of groups. Fattening traits (daily gain, daily feed intake and feed conversion ratio) were normally distributed and analysed with GLM procedure. The statistical model included fixed effects of mother (M_i) and group (G_j), and weight of the animal at the beginning of experiment as independent variable (x_{ijk}).

$$y_{ijk} = \mu + M_i + G_j + bx(x_{ijk} - \bar{x}) + e_{ijk}$$

In this study only the results for the effect of group are presented since this effect was the main objective of our research.

RESULTS AND DISCUSSION

Behaviour

Single caged fattening rabbits spent a major proportion of 24 hours inactive (Table 1), namely from 55 to 60%. Similar proportions were observed also in rabbits in laboratory cages (Gunn and Morton, 1995), group caged rabbits (Morisse and Maurice, 1997; Dal Bosco *et al.*, 2002), rabbits housed in different kind of pens (Morisse *et al.*, 1999) and enclosure (Lehmann, 1987). The most common observed activities were grooming (16–19%), sniffing (8–12%) and eating (7–8%). Our findings are in accordance with other studies, where the percentage of time spent for grooming ranged from 16 to 22.9% (Gunn and Morton, 1995; Podberscek *et al.*, 1991; Metz, 1987; Morisse *et al.*, 1999; Hansen and Berthelsen, 2000) and for eating from 7.7 to 14% (Gunn and Morton, 1995; Metz, 1987; Morisse *et al.*, 1999). Rabbits in our study performed sniffing much longer than reported in other studies. Gunn and Morton (1995) observed sniffing only in 0.38% of the whole day, and Hansen and Berthelsen (2000) in 50 to 54 min. (3.47 to 3.75%).

Enrichment of cages with different types of wooden sticks had no significant influence on duration of observed behaviours, except eating and wood gnawing. Rabbits with Norway spruce sticks ate significantly less time than rabbits in oak group. According to findings of Metz (1987) and Morisse *et al.* (1999), who reported shorter time spent eating food pellets in rabbits kept in straw pens on account of gnawing and ingesting straw (Metz, 1987), a possible reason for shorter time of eating in spruce group could be a significantly greater proportion of time rabbits spent

gnawing. Oak wood is very dense and hard in comparison with Norway spruce and lime wood (Čermak, 1998; Pipa, 1990) and it also contains a large amount of tannin, about 10% (Pipa, 1990). Probably for these reasons rabbits preferred Norway spruce to oak wood. Difference in duration of wood gnawing between spruce and lime group was not significant ($P=0.3233$), although mean values differed substantially. This could be explained with the distribution of wood gnawing. Rabbits gnawed wooden sticks only few times per day. Therefore the distribution of data had large peak at zero and only minor percentage of observations at higher values, namely up to 9.7%. Mean values for such data can vary a lot but do not represent significant difference in distribution between groups. In enriched cages a trend of decrement of inactivity ($P=0.0580$) and correspondingly increased activity ($P=0.0599$) was noticed, which is in accordance with several studies (Metz, 1987; Huls *et al.*, 1991). Although rabbits in spruce group had significantly higher percentage of time spent wood gnawing, the highest percentage of activity was observed in oak and lime group. It is also surprising we did not observe any significant decrement in biting wire and feeder, which is one of the most common behavioural abnormalities in cage systems (Gunn and Morton, 1995; Laboratory Animals, 1993; Love, 1994). Namely, studies using different kind of environmental enrichment reported significant decrement of these kind of behaviours (Podberscek *et al.*, 1991; Lidfors, 1997; Jordan *et al.*, 2003).

Table 1. The influence of environmental enrichment on mean duration (percentage per hour) of rabbits' behaviours

Behaviour, %	Group				P-value
	Control	Oak	Lime	Spruce	
Inactivity	60.15	56.37	55.69	59.79	0.0580
Activity	39.88	43.63	44.31	40.21	0.0599
Grooming	16.40	18.74	18.54	18.27	0.1593
Sniffing	8.90	9.21	12.21	8.45	0.1225
Eating	7.99 ^{ab}	8.49 ^a	7.86 ^{ab}	6.91 ^b	0.0342
Caecotrophy	2.46	2.17	2.02	2.52	0.0869
Drinking	1.73	2.18	2.00	1.81	0.3623
Biting wire and feeder	1.62	2.16	1.15	1.21	0.8759
Contact	0.26	0.22	0.15	0.40	0.7274
Hopping	0.23	0.16	0.12	0.14	0.1080
Stretching	0.23	0.28	0.23	0.29	0.1631
Rearing up	0.04	0.02	0.01	0.005	0.7174
Wood gnawing	/	0.00 ^a	0.01 ^b	0.21 ^b	0.0005

Means in a row without and with the same superscripts were not significantly different ($P>0.05$).

Activity – all behaviours except inactivity

Hourly frequencies of eating and wood gnawing were, similar as duration of these activities, also significantly influenced by addition of wooden sticks (Table 2). The lowest frequency of eating and the highest frequency of wood gnawing were observed in Norway spruce group. As in duration of wood gnawing in frequency too, there was no significant difference ($P=0.3474$) between lime and spruce group. This could be again explained with the distribution of wood gnawing data. Significant influence of environmental enrichment was observed also in caecotrophy. Differences between groups for caecotrophy by multiple test were not significant but in lime group a trend of lower frequency was observed in comparison to the control group ($P=0.0870$).

Table 2. The influence of environmental enrichment on mean hourly frequency of the rabbits' behaviours

Behaviour	Group				P-value
	Control	Oak	Lime	Spruce	
Inactivity	8.94	8.67	8.43	9.78	0.1329
Activity	47.99	48.17	46.85	46.92	0.6648
Grooming	19.74	21.20	20.61	20.78	0.3690
Sniffing	15.25	15.08	14.95	14.81	0.7522
Eating	2.49 ^a	2.58 ^a	2.26 ^a	1.58 ^b	0.0006
Caecotrophy	2.20	1.77	1.68	2.07	0.0331
Drinking	1.51	1.94	1.86	1.44	0.2328
Biting wire and feeder	2.35	1.91	1.74	1.83	0.9665
Contact	1.12	0.93	1.01	1.31	0.8373
Hopping	1.58	0.83	1.19	0.88	0.1314
Stretching	1.70	1.88	1.43	1.88	0.2602
Rearing up	0.05	0.06	0.03	0.03	0.7367
Wood gnawing	/	0.00 ^a	0.09 ^b	0.30 ^b	0.0006

Means in a row without and with the same superscripts were not significantly different ($P > 0.05$).

Activity – all behaviours except inactivity

Fattening traits

Average daily gain in the entire trial period ranged from 34.17 to 37.05 g day⁻¹ (Table 3). These values were in accordance with our previous study (Jordan and Štuhec, 2002) and findings of Kermauner and Žgur (2002). Average daily feed intake, which ranged from 139.29 to 152.42±4.76 g day⁻¹, was except in the control group a bit lower than reported in the study of Kermauner and Žgur (2002). Feed conversion ratio during the entire fattening period ranged from 3.98 to 4.15. Similar findings were reported also by Kermauner and Žgur (2002).

Environmental enrichment had no significant influence on daily gain, daily feed intake and feed conversion ratio in the entire trial period. In our previous study we also observed no significant influence of the addition of wooden stick on daily gain (Jordan and Štuhec, 2002), as it was reported in studies of Lidfors (1997), Maertnes and Van Oeckel (2001), and Luzi *et al.* (2003), too.

Table 3 The influence of environmental enrichment on rabbits' fattening traits

	Group*				P-value
	Control	Oak	Lime	Spruce	
Daily gain, g day ⁻¹	37.05±1.45	35.14±1.58	34.17±1.48	35.91±1.56	0.5601
Daily feed intake, g day ⁻¹	152.42±4.76	144.65±5.20	139.29±4.87	142.22±5.16	0.2564
Feed conversion ratio, g g ⁻¹	4.15±0.08	4.15±0.09	4.10±0.08	3.98±0.09	0.3910

* Least square means with standard errors of estimates.

CONCLUSIONS

The addition of wooden stick to wire cages significantly influenced the duration and frequency of rabbits' eating and wood gnawing, and frequency of caecotrophy, but it did not influence fattening traits. Rabbits preferred gnawing Norway spruce and lime than oak, and the

type of wood significantly influenced only eating behaviour. The lowest frequency of eating and the highest frequency of wood gnawing were observed in Norway spruce group.

ACKNOWLEDGEMENT

This study was part of a research project funded by research grants from the Ministry of Education, Science and Sport of Slovenia. We would like to thank Monika Turk and Alenka Kočevar for their technical assistance.

REFERENCES

- Berthelsen, H./ Hansen, L.T. The effect of hay on the behaviour of caged rabbit (*Oryctolagus Cuniculus*). Anim. Welf., 8(1999), 149–157.
- Čermak, M. Tehnologija lesa 1. Železniki, Pami, 1998, 205 p.
- Dal Bosco, A./ Castellini, C./ Mugnai, C. Rearing rabbits on a wire net floor or straw litter: behaviour, growth and meat qualitative traits. Livest. Prod. Sci., 75(2002), 149–156.
- Gunn, D./ Morton, D.B. Inventory of the behaviour of New Zealand White rabbits in laboratory cages. Appl. Anim. Behav. Sci., 45(1995), 277–292.
- Hansen, L.T./ Berthelsen, H. The effect of environmental enrichment on the behaviour of caged rabbits (*Oryctolagus Cuniculus*). Appl. Anim. Behav. Sci., 68(2000), 163–178.
- Held, S.D.E./ Turner, R.J./ Wootton, R.J. Choices of laboratory rabbits for individual or group-housing. Appl. Anim. Behav. Sci., 46(1995), 81–91.
- Huls, W.L./ Brooks, D.L./ Bean-Knudsen, D. Response of adult New Zealand White rabbits to enrichment objects and paired housing. Lab. Anim. Sci., 41(1991), 609–612.
- Jordan, D./ Štuhec, I. The influence of environment enrichment (gnawing stick) on some performance and carcass traits of male rabbits. In: Proceedings of the 10th International Symposium: Animal Science Days: Environmental friendly and EU conform animal husbandry, Pecs, 2002-10-16/18. Acta Agraria Kaposvariensis, 6(2002)2, 195–200.
- Jordan, D./ Štuhec, I./ Pečlin, G./ Gorjanc, G. The influence of environment enrichment on behaviour of the fattening rabbits housed in the individual wire cages. In: 13. Arbeitstagung über Haltung und Krankheiten der Kaninchen, Pelztier und Heimtiere, Celle, 2003-05-14/15. Gießen, Verlag der DVG, 2003, 119–126.
- Kermauner, A./ Žgur, S. Growth and carcass traits of two rabbit genotypes: comparison of Slovene SIKa male line with commercial hybrids. In: Proceedings of the 10th International Symposium: Animal Science Days: Environmental friendly and EU conform animal husbandry, Pecs, 2002-10-16/18. Acta Agraria Kaposvariensis, 6(2002)2, 201–207.
- Laboratory Animals. Refinements in rabbit husbandry. Second report of the BVAAWF/RSPCA/UFAW Joint working group on refinement. Lab. Anim., 27(1993), 301–329.
- Lehmann, M. Interference of a restricted environment—as found in battery cages—with normal behaviour of young fattening rabbits. In: Agriculture: Rabbit production systems including welfare (Ed.: Auxilia, T.), Luxemburg, Commission of the European Communities, 1987, 257–268.
- Lidfors, L. Behavioural effects of environmental enrichment for individually caged rabbits. Appl. Anim. Behav. Sci., 52(1997), 157–169.
- Love, J.A. Group housing: Meeting the physical and social needs of the laboratory rabbit. Lab. Anim. Sci., 44(1994), 5–11.
- Luzi, F.M.G./ Ferrante, V./ Heinzl, E./ Zucca, D./ Verga, M./ Bianchi, M./ Cavani, C./ Petracci, M. Effect of environmental enrichment and group size on performance and carcass traits in rabbits. In: Book of abstracts of the 53rd Annual Meeting of the European Association for Animal Production (Ed.: Honing, Y.), Rome, Italy, 2003-08/09-31/03. Wageningen, Wageningen Pers, 2003, 203.
- Maertens, L./ Van Oeckel, M. The fattening of rabbits in pens: effects of housing and gnawing material on performance level and carcass quality. In: 12. Arbeitstagung über Haltung und Krankheiten der Kaninchen, Pelztier und Heimtiere, Celle, 2001-05-09/10. Gießen, Verlag der DVG, 2001, 156–161.
- Metz, J.H.M. Behavioural problems of rabbits in cages. In: Agriculture: Rabbit production systems including welfare (Ed.: Auxilia, T.), Luxemburg, Commission of the European Communities, 1987, 221–230.
- Morisse, J.P./ Maurice, R. Influence of stocking density or group size on behaviour of fattening rabbits kept under intensive conditions. Appl. Anim. Behav. Sci., 54(1997), 351–357.
- Morisse, J.P./ Boillrot, E./ Martenchar, A. Preference testing in intensively kept meat production rabbits for straw on wire grid floor. Appl. Anim. Behav. Sci., 64(1999), 71–80.

Pipa, R. Anatomija in tehnologija lesa. Tehnologija tvoriv. Ljubljana, Zveza inženirjev in tehnikov gozdarstva in lesarstva, Lesarska založba, 1990, 136 p.

Podberscek, A.L./ Blackshaw, J.K./ Beattie, A.W. The behaviour of group penned and individually caged laboratory rabbits. *Appl. Anim. Behav. Sci.*, 28(1991), 353–363.

SAS system for Windows. Release 8.02. Cary, NC, SAS Institute, 2001.