

## THE INFLUENCE OF ENVIRONMENTAL ENRICHMENT WITH DIFFERENT KIND OF WOOD ON CARCASS QUALITY OF INDIVIDUALLY CAGED RABBITS

Ajda KERMAUNER<sup>a)</sup>, Silvester ŽGUR<sup>b)</sup>, Dušanka JORDAN<sup>c)</sup> and Ivan ŠTUHEC<sup>d)</sup>

<sup>a)</sup> Univ. of Ljubljana, Biotechnical Fac., Zootechnical Dept., Groblje 3, SI-1230 Domžale, Slovenija, M. Sc.

<sup>b)</sup> Same address as <sup>a)</sup>, Assist.Prof., Ph. D.

<sup>c)</sup> Same address as <sup>a)</sup>

<sup>d)</sup> Same address as <sup>a)</sup>, Prof., Ph. D.

### ABSTRACT

The influence of addition of different types of wooden sticks as gnawing material for environmental enrichment on the carcass 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. The experiment lasted from 38<sup>th</sup> day of age to 103<sup>rd</sup> day, when rabbits were slaughtered and carcass traits were measured. Twenty-four hours after slaughter the pH value and colour of meat were recorded. The addition of wooden stick to wire cages had no important influence on carcass characteristics. Among three enriched groups with different kind of wood only meat of rabbits with spruce stick partly exhibited different colour: meat from SPRUCE group had darker colour (CIE L\*: 57.05) than from OAK (59.40) and LIME (59.71) groups and less red (a\*: 3.73) and in tendency less yellow colour (b\*: 1.10) than meat from OAK group (a\*: 4.66, b\* 1.96).

Key words: rabbits / environmental enrichment / wood / carcass quality / meat quality

## VPLIV OBOGATITVE OKOLJA Z RAZLIČNIMI VRSTAMI LESA NA KLAVNO KAKOVOST INDIVIDUALNO UHLEVLJENIH KUNCEV

### IZVLEČEK

Proučevali smo vpliv obogatitve okolja z letvami za glodanje iz različnih vrst lesa na klavne lastnosti kuncev pitancev. V poskusu je bilo 48 samcev pasme beli novozelandski slovenske mesne 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 katere je bila letev, ki smo jo namestili v kletko, so bili kunci razporejeni v štiri enako velike skupine: kontrola, hrast, lipa in smreka. Poskus je trajal od 38. do 103. dne starosti, ko smo kunce zaklali in izmerili klavne kazalce. Štiriindvajset ur po zakolu smo merili še barvo in pH vrednost mesa. Obogatitev okolja na klavne kazalce ni vplivala. Med skupinami z različnimi vrstami lesa je najbolj odstopala barva mesa kuncev, ki so imeli letve iz smrekovega lesa: meso skupine SMREKA je bilo bolj temno (CIE L\*: 57,05) od skupin HRAST (59,40) in LIPA (59,71), manj rdeče (a\*: 3,73) in v tendenci manj rumeno (b\*: 1,10) od skupine HRAST (a\*: 4,66, b\* 1,96).

Ključne besede: kunci / obogatitev okolja / les / klavna kakovost / kakovost mesa

## INTRODUCTION

Animals housed in intensive breeding system (wire cages) are held in a barren environment, in which they are restricted to express their natural 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 locomotor activities (Gunn and Morton, 1995). Their gnawing possibilities are very limited as well (Maertens and Van Oeckel, 2001).

Rabbits need to gnaw due to continuous growth of their incisor teeth. Gnawing is also connected with digestive process and nervous system. It is well known that stress can influence the excreting of hormones and enzymes and consequently the digestive process and the appearance of digestive disturbances in rabbits.

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) and mitigate the effect of stressors (Berthelsen and Hansen, 1999). Stauffacher (1992, cited in Lidfors, 1997) found out that in semi-natural enclosure rabbits spent about 20 % of the time chewing on wood branches. He suggested that rabbits should have gnawing sticks also in their cages.

There are only few studies in literature described the influence of cage or pen enrichment. Mirabito *et al.* (2000) studied the presence of a wooden stick or hay in caged rabbit fatteners and no deterioration of performances was observed in cages with enrichment. Maertens and Van Oeckel (2001) studied the addition of gnawing wooden stick in pens with 30 rabbits and they observed decrease of aggressiveness (fighting between rabbits). Daily weight gain and slaughter weight were higher in caged rabbits, while there were no differences between pen housed rabbits with or without the gnawing stick. Luzi *et al.* (2003b) found no significant effect on rabbits fattening traits when wooden sticks were added to the cages with 2, 3 or 4 animals per cage. Among carcass traits rabbits with environmental enrichment exhibited lower redness (a\*) and higher content of water in the meat. The reduction of abnormal behaviours, increased growth and higher carcass weight were reported by Luzi *et al.* (2003a) when wooden stick was added to the cages with 8 fattening rabbits in *semi plein air* conditions. Authors stated that this improvement may indicate an improvement in welfare conditions in intensive rabbit breeding.

The inclusion of sawdust in the feed of rabbits can improve digestive process and utilisation of other nutrients; better resistance to coccidiosis was also found (Koritnik and Banožić, 1974). Meat of rabbits with added sawdust had no unfavourable taste or smell. The authors recommend pine, fir and spruce sawdust and dissuade from oak sawdust due to its unpalatability.

The objective of our experiment was to study the effect of addition of wooden sticks to individual wire cages as an environmental enrichment on carcass quality of fattening rabbits. Rabbits may prefer different kind of wood so we used oak, lime and Norway spruce sticks. In the first part of this study the behaviour and fattening traits were also observed (Jordan *et al.*, 2004).

## MATERIAL AND METHODS

The research took place in autumn and lasted nine weeks. 48 male New Zealand White rabbits of Slovenian meat line SIKA (paternal line) were weaned at 35<sup>th</sup> day of age. At the age of 38 days animals were housed individually in wire cages, equipped with a feeder and nipple drinker. They were fed *ad libitum* with the complete feed mixture for fattening rabbits (170 g CP/kg, 140 g CF/kg, 10.4 MJ DE/kg). The ambient temperature varied from 21 to 25 °C, relative humidity between 35 and 57 % and 12 hours light: 12 hours dark schedule was used. According to the type of wooden stick fixed horizontally in the rabbit's cage right after the individual housing, animals were allotted to four groups, 12 rabbits in each. As a material for gnawing the first group

received oak sticks (OAK), the second lime (LIME) and the third Norway spruce sticks (SPRUCE). The control group (CONTROL) was without wooden sticks.

Animals were slaughtered at 103<sup>rd</sup> day of age and slaughter weight, warm carcass weight (excluding head and lower parts of legs, including liver and kidneys), weight of liver, kidneys, separate digestive organs (with their content) and fat on digestive tract were measured. The proportions (%) of liver, kidneys and separate digestive organs with respect to the slaughter weight were calculated. Cold carcass weight without kidneys and liver was recorded 24 h after slaughter. After that kidney fat was removed and meat colour and pH<sub>24</sub> were measured on the cross section between last thorax and first lumbar vertebra. The observations of behaviour and fattening traits are described in Jordan *et al.* (2004).

Statistical analysis was performed by SAS statistical package (SAS, 2001) with GLM procedure. Effects of mother and group as fixed effects and slaughter weight as independent variable were included in the model. For the analyses of proportions of internal and digestive organs the regression on slaughter weight was removed from the model for it was not significant. In this study only results for the effect of group are presented since this effect was the main objective of our research.

The mortality rate was 8.3 % (4 rabbits: two in the OAK and one rabbit in the LIME and in the SPRUCE group), which is in intensive breeding systems within usual limits.

## RESULTS AND DISCUSSION

There are only few carcass traits which are influenced by environmental enrichment with gnawing stick (Table 1). Differences between CONTROL and three enriched groups were not significant, what is in accordance with the results of Luzi *et al.* (2003b), Jordan *et al.* (2002) and Maertens and Van Oeckel (2001). On the contrary Luzi *et al.* (2003a) found higher slaughter, warm and chilled carcass weights when gnawing sticks were added to cages with 8 animals.

Table 1. The influence of environmental enrichment on carcass characteristics

	GROUP								
	CONTROL		OAK		LIME		SPRUCE		
	LSM	SE	LSM	SE	LSM	SE	LSM	SE	
Slaughter weight (SW), g	3551.60	103.91	3368.33	113.56	3348.20	106.67	3406.97	112.22	
Carcass weight, g	1911.29	26.40	1949.05	27.98	1872.72	26.41	1897.44	27.56	
Dressing percentage, %	55.91 <sup>ab</sup>	0.80	57.10 <sup>a</sup>	0.85	54.65 <sup>b</sup>	0.80	55.36 <sup>ab</sup>	0.84	
Chilling carcass weight, g	1779.73	27.09	1816.53	28.71	1744.72	27.1	1773.31	28.28	
Drip loss, %	6.89	0.27	6.78	0.29	6.85	0.27	6.61	0.28	
Kidneys fat	g	53.44	4.32	59.72	4.58	50.58	4.32	52.43	4.51
	%/SW	1.63	0.13	1.72	0.15	1.39	0.14	1.49	0.14
Liver	g	91.04	3.17	93.11	3.36	93.33	3.17	85.28	3.31
	%/SW	2.63	0.10	2.74	0.11	2.75	0.10	2.52	0.11
Kidneys	g	18.73	0.53	18.47	0.56	18.48	0.53	18.68	0.55
	%/SW	0.54	0.02	0.55	0.02	0.55	0.02	0.56	0.02

<sup>a, b</sup> values with different superscripts differ significantly ( $P \leq 0.05$ )

Dressing percentage was higher than established by Žarn (1997), Kermauner and Štruklec (1999) and Kermauner and Žgur (2002) in rabbits of SIKa male line and much lower than found by Dal Bosco *et al.* (2002), who reported 60.1 % dressing percentage (with head).

The proportions of liver in our experiment were lower than reported by Maertens and Van Oeckel (2001) and also lower than in our previous experiments with SIKa male line (Kermauner

and Štruklec, 1999; Kermauner and Žgur, 2002); they were much lower from the results of Dal Bosco *et al.* (2002), who measured 5.29 % of liver. The proportions of kidneys were comparable with the results of Kermauner and Štruklec (1999) and Kermauner and Žgur (2002) for SIKa male line and lower than found by Dal Bosco *et al.* (2002). The proportion of kidneys fat was comparable with Luzi *et al.* (2003b) and lower than found by Dal Bosco *et al.* (2002) and Kermauner and Žgur (2002), although their rabbits were younger (85 and 90 days of age).

Comparison of different types of wood used for gnawing stick shows that despite regression on slaughter weight rabbits from OAK group had higher dressing percentage than rabbits from LIME group. In SPRUCE group the weight of liver was in tendency higher than in OAK and LIME groups, while proportions of liver did not differ among groups.

Enrichment of cages and different types of wooden sticks had no significant influence on weights and proportions of separate digestive organs.

Table 2. The influence of environmental enrichment on meat characteristics

	GROUP								
	CONTROL		OAK		LIME		SPRUCE		
	LSM	SE	LSM	SE	LSM	SE	LSM	SE	
pH <sub>24</sub>	5.58	0.04	5.53	0.04	5.63	0.04	5.62	0.04	
CIE <sup>1</sup>	L*	57.76 <sup>ab</sup>	0.78	59.40 <sup>ac</sup>	0.85	59.71 <sup>c</sup>	0.79	57.05 <sup>b</sup>	0.84
	a*	4.65 <sup>a</sup>	0.37	4.66 <sup>a</sup>	0.39	4.02 <sup>ab</sup>	0.38	3.73 <sup>b</sup>	0.39
	b*	1.56	0.21	1.96	0.23	1.57	0.21	1.10	0.22

<sup>a, b</sup> values with different superscripts differ significantly ( $P \leq 0.05$ )

<sup>1)</sup> Difference between LIME and CONTROL is only important ( $P = 0.0950$ )

Enrichment of cages with wooden sticks influenced the characteristics of meat: meat from CONTROL group had a less pale colour than LIME group and it was redder (a\*) then from SPRUCE group. This is in accordance with Luzi *et al.* (2003b), who also found higher redness of rabbits' meat of in conventional pens in comparison with pens enriched with wooden sticks.

The lightness of meat in our study is comparable then in SIKa male line (Kermauner and Žgur, 2002), while Dal Bosco *et al.* (2002) and Luzi *et al.* (2003b) observed darker colour of meat. The redness and yellowness of meat in our experiment differ from our previous studies on SIKa male line, where less red and more yellow colours were observed (Kermauner and Žgur, 2002). Similarly Luzi *et al.* (2003b) established different colour as well (less red and yellow colour than in our experiment), while Dal Bosco *et al.* (2002) found comparable a\* and b\* values.

pH<sub>24</sub> value of meat was not influenced by environmental enrichment, what confirms the results from Luzi *et al.* (2003b), although they found higher pH value (about 5.80). pH<sub>24</sub> values of meat in our experiment are comparable with SIKa rabbits (Kermauner and Žgur, 2002) and Dal Bosco *et al.* (2002).

Comparison of different types of wood used for gnawing stick shows some differences in meat characteristics between three enriched groups: pH<sub>24</sub> of meat from OAK group was in tendency lower than in LIME group. The colour of meat from SPRUCE group deviate from other enriched groups: it was darker than from OAK and LIME groups and less red and in tendency less yellow than meat from OAK group.

In the first part of our study Jordan *et al.* (2004) found the highest frequency and duration of wood gnawing in SPRUCE group. Also the amount of gnawed material tended to be higher in SPRUCE group in comparison with other two enriched groups (OAK 4.39, LIME 5.12, SPRUCE 6.30 g,  $P \leq 0.10$ ). We presume that intensive gnawing of spruce wood probably affect the colour of rabbit meat, but further studies are required to specify this effect.

## CONCLUSIONS

The addition of wooden stick to wire cages had no important influence on carcass characteristics. Among three enriched groups with different kind of wood only meat of rabbits with spruce stick partly exhibited different colour: meat from SPRUCE group was darker than from OAK and LIME groups and less red and in tendency less yellow than meat from OAK group.

## ACKNOWLEDGEMENT

This study was a part of a research project funded by research grants from 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.*, 1999, 8, 149–157.
- 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.*, 2002, 75, 149–156.
- Gunn, D./ Morton, D.B. Inventory of the behaviour of New Zealand White rabbits in laboratory cages. *Appl. Anim. Behav. Sci.*, 1995, 45, 277–292.
- Jordan, D./ Štuhec, I. The influence of environment enrichment (gnawing stick) on some performance and carcass traits of male rabbits. In: *Proceedings of the 10<sup>th</sup> International Symposium: Animal Science Days: Environmental friendly and EU conform animal husbandry, Peccs, 2002-10-16/18. Acta Agraria Kaposvariensis*, 6(2002)2, 195–200.
- Jordan, D./ Varga, A./ Kermauner, A./ Gorjanc, G./ Štuhec, I. The influence of environmental enrichment with different kind of wood on some behavioural and fattening traits of rabbits housed in individual wire cages. In: *Proceedings of the 12<sup>th</sup> International Symposium: Animal Science Days: Animal Production According to Ecological, Ethological and Ethical Norms, Bled, 2004-09-2/4. Zb. Biotehniške fak. Univ. v Ljubljani, Kmetijstvo. Supplement (in print)*
- Kermauner, A./ Štruklec, M. The effect of increased zinc (Zn) supply on weights of certain organs and on growth of rabbits. In: *Matthes, S. (Ed.) 11. Arbeitstagung über Haltung und Krankheiten der Kaninchen, Pelztier und Heimtiere, Celle, 1999-05-19/20. Gießen, DVG, 1999, 79–88.*
- 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 10<sup>th</sup> International Symposium: Animal Science Days: Environmental friendly and EU conform animal husbandry, Peccs, 2002-10-16/18. Acta Agraria Kaposvariensis*, 2002, 6, 2, 201–207.
- Koritnik M./ Banožić S. 1974. Uzgoj kuniča. Zagreb: 74–75.
- Lidfors, L. Behavioural effects of environmental enrichment for individually caged rabbits. *Appl. Anim. Behav. Sci.*, 1997, 52, 157–169.
- Luzi F., Ferrante V., Heinzl E., Verga M. Effect of environmental enrichment on productive performance and welfare aspects in fattening rabbits. *Italian Journal Animal Science*, 2003a, 2, 1: 438–440.
- 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 54<sup>th</sup> Annual Meeting of the European Association for Animal Production, Rome, Italy, 31. Aug.-3. Sept. 2003. Honing Y. (Ed.). Wageningen, Wageningen Pers, 2003b, 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: *12th Symposium on housing and diseases of rabbits, furbearing animals and pet animals, Celle (Germany), 2001-5-9/10, Gießen, DVG, 2001, 156–161.*
- Mirabito, L./ Galliot, P./ Souchet, C. Effect of different ways of cage enrichment on the productive traits and mortality of fattening rabbits. *Proc. 7<sup>th</sup> World Rabbit Congress, Valencia. In: World Rabbit Sc.*, 8 (suppl. 1), 2000. Vol. B, 447–452.
- SAS system for Windows. Release 8.02. Cary, NC, SAS Institute, 2001.

Žarn, D. Učinki nekaterih probiotikov na proizvodne in fiziološke kazalce ter na viskoznost črevesne vsebine pri rastočih kuncih. (Influence of some probiotics on production and physiological traits and on viscosity of intestinal content in growing rabbits.) Graduation Thesis. Domžale, Biotech. Fac., Zootech. Dept., 1997, 78 p.