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COMPARISON OF MEAT QUALITY BETWEEN EUROPEAN BROWN HARE AND DOMESTIC RABBIT

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ABSTRACT

The objective of this work was to assess meat quality in European brown hare and domestic rabbit. The research was focused on nutritive value, chemical composition and physical characteristics of meat. We investigated the qualitative parameters in *Musculus longissimus thoracis et lumborum*. Meat samples from brown hares were taken during hunts from selected hunting-grounds in south-west Slovakia. Meat samples of rabbits were from animals slaughtered at the experimental slaughter house. All samples were stored at identical conditions. The qualitative parameters were assessed after 48 hours. The content of total water, content of total proteins, total fats, value of pH_{48}, meat colour and water holding capacity were determined. The results were processed statistically using the programme Excel and SAS 9.1 by one-way variance analysis, and the significance of arithmetical differences was tested by the Bonferroni test.

Average content of total water in hare meat was 72.83 g.100 g^{-1} and was not found to be influenced by sex or age of animals. Higher content of total water ($P \leq 0.01$) was noted in rabbit meat (74.25 g.100g^{-1}). Average content of total proteins in hare meat was 24.70 g.100 g^{-1}. We observed higher content of total proteins in hare meat compared with rabbit meat 22.20 g.100g^{-1} ($P \leq 0.01$). The average content of total fats in brown hare meat was 1.48 g.100 g^{-1}. Content of total fats in rabbit meat (2.55 g.100g^{-1}) was higher as compared with hare meat ($P \leq 0.01$). The value of pH_{48} varied from 5.69 to 6.38. Average pH_{48} value hare meat was higher compared with rabbit meat (6.17 and 5.95 respectively), ($P \leq 0.01$). Higher L-value of meat colour was noted in rabbit meat (47.33). This value shows that the meat is lighter. Lower L-value (29.52) with hare meat shows that the meat is markedly darker. Average content of loosely bound water in brown hare meat was 29.70 g.100 g^{-1}. Significantly higher ($P \leq 0.01$) content of loosely bound water was also noted in hare meat compared with rabbit meat (24.72 g.100 g^{-1}). Brown hare meat is dietetically a very valuable raw material and it can be recommended as a component of modern human diet.

Key words: European brown hare; domestic rabbit; meat quality

INTRODUCTION

In Slovakia venison belongs among important products of hunting and it is considered to be biologically more valuable than the meat of farm animals.

A number of authors have been engaged in study of venison (Uherová *et al*., 1982; Souci *et al*.,1994; Bandick, Ring, 1996; Slamečka *et al*.,1997; Winkelmayer, 2000a, b, 2004). Škrivanko *et al*. (2008) investigated 71 meat samples of hares shot in the eastern region of Croatia. Chemical tests showed the following average content in meat of hares: water 75.34 %, protein 23.19 %, fat 1.12 %, ash 1.16 %.

From the nutritional point of view consumption of venison is a positive contribution particularly for its relatively high content of protein and low content of fat, with favourable index of nutritive value of fat, i.e. proportion of essential amino acids and saturated fatty acids. Venison is full-value meat, easily digestible with typical aroma for the given species, and has finer muscle fibres than the meat of slaughter animals (Herzog, 1993).

Thanks to its relatively low fat content venison ranks among the richest proteinaceous meat along with fish meat. Its protein content is even higher

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than in our farm animals. Besides, the proteins in venison are of extraordinary value, it means they show digestibility in favour of the protein construction in man. Venison contains more colouring matters and therefore it is of more intensive colour than the meat of farm animals. Dark colour of meat is encountered in animals, which were shot and not slaughtered and insufficiently exsanguinated (Winkelmayer *et al*., 2004).

Rafay *et al*. (1999) were engaged in characteristics of broiler rabbits' meat. They reported 74.37 g total water, 23.58 g total proteins, 0.88 g total fats, 426.79 kJ energy value and 87.66 mg cholesterol in 100 g rabbit meat. According to Lambertini *et al*. (1996) and Hernández *et al.* (1998), differences in meat quality parameters are constant among the rabbit genotypes. In general, the qualitative parameters in meat improve with growth intensity, while fat content increases with decreasing water content (Parigi-Bini *et al.*, 1992). Barrón *et al*. (2004) were also engaged in study of qualitative meat parameters in different rabbit genotypes. The authors noticed statistically significant differences in values of pH_{24} in meat samples from *M. longissimus dorsi* and from *M. biceps femoris*. Researchers also studied the influence of age on some chemical parameters in rabbits (Hulot and Ouhayoun, 1999; Dalle Zotte *et al*., 1996; Dalle Zotte and Ouhayoun, 1995). The authors reported that with the age of animals pH value decreases, while myoglobin concentration and glycolytical metabolism increases. Rafay *et al.* (2008) compared the meat quality in transgenic rabbits with the control (non-transgenic) ones. Content of total water in transgenic rabbits was 74.03 and in control ones 74.84 g.100 g^{-1}, total proteins 21.45 and 22.12g.100 g^{-1}, total fats 3.67 and 2.32g.100g^{-1}, energy value 495.43 and 458.07 kJ. 100 g^{-1}, pH value 5.79 and 5.48, meat colour 20.94 and 25.44, content of loosely bound water 31.66 and 35.63 g.100 g^{-1}, respectively. Chrenek *et al* (2012) were engaged in similar study; they reported that content of total water in transgenic and non-transgenic rabbits were 74.00 and 71.50 g.100 g^{-1}, content of total proteins 21.55 and 21.12 g.100 g^{-1}, total fats 3.50 and 3.35 g.100 g^{-1}, energy value 495.55 and 456.00 kJ. 100 g^{-1}, pH value 5.80 and 5.50, meat colour 20.55 and 21.40, content of loosely bound water 33.85 and 35.65g.100 g^{-1}, respectively.

MATERIAL AND METHODS

The objective of this study was to assess meat quality in brown hare and domestic rabbit. The work was also aimed at assessment of nutritive value, chemical composition and physical parameters of meat.

We studied the selected parameters in 33 brown hares shot in southwest Slovakia and in 22 male domestic rabbits of meat hybrid P91, sexually mature at the age of eight months, from the experimental rabbit herd in the Animal Production Research Centre Nitra, Slovakia.

All rabbits were housed in one-step flat-deck-batteries in a partially air conditioned hall. Requisite breeding conditions were kept in the whole building.

The longest breast and hip muscle (*Musculus longissimus thoracis et lumborum*) were selected as representative sample from the studied animal species to assess the meat quality. Meat samples were taken from hares on the day of shooting, they were stored in a cooling box at 4 ºC and after 48 hours meat quality was assessed on the basis of chemical composition and selected physical parameters. Rabbits were slaughtered in the experimental slaughter house and samples were stored under the same conditions as meat of hares.

Basic meat composition was studied by INFRATEC 1265 apparatus (Germany). We evaluated the following parameters: content of total water (g.100 g^{-1}), total proteins (g.100 g^{-1}), total fats (g.100 g^{-1}) and energy value (kJ . 100 g^{-1}). Energy value of meat was calculated using the following regression equation:

Energy value (kJ . 100 g^{-1}) = (16.75 x total content of proteins) + (37.68 x total fat content).

The following physical parameters of meat quality were also studied: pH_{48}, colour and content of loosely bound water (g.100 g^{-1}). We determined pH_{48} value by the stub electrode and portable pH meter RADELKIS OP-109.

Water holding capacity was determined by pressing method as described by Grau - Hamm in a modified apparatus at constant pressure (Hašek – Palanská, 1976). It was expressed with the content of loosely bound water. The colour of muscles was measured using the apparatus Mini Scan x E Plus (Hunter, USA).

Obtained results were statistically processed using the programmes Excel and SAS 9.1. Arithmetic mean ($\bar{x}$), standard deviation (s) and variation coefficients (V %) were calculated, and the obtained results were evaluated by 1-way variance analysis. The significance of arithmetic differences were tested by Bonferroni test at the level of significance $P \leq 0.05$ and $P \leq 0.01$.

RESULTS AND DISCUSSION

Content of total water in brown hare meat, in dependence on sex and age, was almost the same – from 72.48 to 72.98 g. 100 g^{-1} (tab. 1). Winkelmayer (2004) reported values from 69.2 g .100 g^{-1} and Slamečka *et al.* (1997) up to 73.14 g .100 g^{-1}, which correspond also with our results that were 72.83 g .100 g^{-1} on average. Slamečka *et al.* (1997) noted significant differences between sexes in content of total water in meat of males

73.14 g.100 g^{-1}, compared with females 72.36 g .100 g^{-1}. We did not notice marked differences between sexes; the content of total water was almost the same for males (72.48 g .100 g^{-1}) and females (72.98 g .100 g^{-1}). Content of total water in dependence of age of animals was almost at the same level: juvenile individuals had 72.85 g .100 g^{-1} and the adult ones 72.80 g .100 g^{-1}. Similar results were reported also by Slamečka *et al*. (1997), with the content of total water in meat of juvenile hares being 72.70 g .100 g^{-1}, and 72.80 g .100 g^{-1} in adult animals.

Significantly higher water content was noted for meat of rabbit 74.25 g .100 g^{-1} ($P \leq 0.01$), which corresponds with the value 74.00 g .100 g^{-1} as noted previously by Chrenek *et al*. (2012), 71.50 g .100 g^{-1} by Rafay *et al.* (2008) and 74.84 g .100 g^{-1} also by Rafay *et al.* (1999). On the contrary, Winkelmayer (2004) reported lower content of total water in rabbits (69.60 g .100 g^{-1}).

Schwark *et al.* (1990) reported that content of total proteins in venison ranges from 23.20 g .100 g^{-1} to 24.14 g .100 g^{-1}. In our work we found average content of total proteins in hare meat 24.70 g .100 g^{-1} (tab. 2), which corresponds with the results of the above mentioned authors as well as with that of Winkelmayer (2004) (24.35g.100g^{-1}) and Slamečka *et al.* (1997) (23.87g.100g^{-1} to 24.53g.100 g^{-1}). Content of total proteins in dependence of sex was significantly higher ($P \leq 0.01$) in meat of males (25.30g.100 g^{-1}) compared with meat of females (24.43g.100g^{-1}); in dependence of age it was 24.69 g.100 g^{-1} for juvenile and 24.71g.100g^{-1} for adult hares. Our results correspond with values reported by Slamečka *et al*. (1997); the content of total proteins in hare meat according to sex was 23.95g.100g^{-1} for males and 24.53 g .100 g^{-1} for females; and in dependence of age it was 24.30 g .100 g^{-1} for young and 23.87 g .100 g^{-1} for adult animals.

Content of total proteins was higher in hare meat (24.70g.100g^{-1}) compared with rabbit meat (22.20 g.100 g^{-1}). Detected differences were statistically highly significant ($P \leq 0.01$). Winkelmayer *et al*. (2004) reported 20.80 g.100 g^{-1} total proteins in rabbit meat, while Rafay *et al*. (1999) noted 23.58 g.100 g^{-1}. Our results showed 22.20 g.100 g^{-1} of total proteins in rabbit meat, which is a higher content than reported

Table 1: Content of total water in brown hare and domestic rabbit in *Musculus longissimus thoracis et lumborum* (g .100 g^{-1})

Species	Number of animals n	$\bar{x}$	SE	CV (%)
Brown hare male a	10	72.48	1.04	1.44
Brown hare female b	23	72.98	0.57	0.78
Brown hare old c	16	72.80	0.72	0.10
Brown hare young d	17	72.85	0.82	1.13
Brown hare total e	33	72.83 f ++	0.76	1.04
Domestic rabbit f	22	74.25 e ++	0.47	0.63

+P≤0.05, ++P≤0.01; $\bar{x}$ = mean; SE = standard mean error; CV (%) = coefficient of variation

Table 2: Content of total protein in brown hare and domestic rabbit in *Musculus longissimus thoracis et lumborum* (g .100 g^{-1})

Species	Number of animals n	$\bar{x}$	SE	CV (%)
Brown hare male a	10	25.30 b ++	0.99	3.91
Brown hare female b	23	24.43 a ++	0.63	2.59
Brown hare old c	16	24.71	0.95	3.84
Brown hare young d	17	24.69	0.76	3.08
Brown hare total e	33	24.70 f ++	0.33	1.33
Domestic rabbit f	22	22.20 e ++	0.84	3.78

+P≤0.05, ++P≤0.01; $\bar{x}$ = mean; SE = standard mean error; CV (%) = coefficient of variation

by Winkelmayer *et al.* (2004) and Chrenek *at al*. (2012) but lower than the content mentioned by Rafay *et al*. (1999).

Content of total fats in meat of brown hare reported by Slamečka *et al.* (1997) ranged from 1.80 g.100 g^{-1} to 2.16 g.100 g^{-1} and by Winkelmayer (2004) from 5.45 g.100 g^{-1}. The average content of total fats in meat of brown hare in our study was 1.48 g.100 g^{-1}. This content was higher in females (1.59 g.100 g^{-1}) compared with males (1.23 g.100 g^{-1}), which corresponds also with results of Slamečka *et al*. (1997) who found higher content of total fats in meat of females compared with the meat of males (1.59 g.100 g^{-1} and 1.23 g.100 g^{-1}, respectively). The age of hares did not affect the content of total fats (1.46 g.100 g^{-1} or 1.49 g.100 g^{-1}), which is in line with the results of the cited work. It is supposed that the content of total fats in meat of animals is connected to a great extent with the carrying capacity of the environment, which is lower in our conditions than in Austria.

When we compared between the species, we found higher content of total fats in meat of rabbit (2.55g.100g^{-1}) than hare meat (1.48g.100g^{-1}). The detected differences were statistically significant (P≤0.01). McNitt *et al.* (2000) reported total content of fats in domestic rabbit as 7.40g.100g^{-1}, Rafay *et al*. (2008) 2.32g.100g^{-1} and Chrenek *et al*. (2012) 3.35 g.100 g^{-1}.

Energy value (tab. 4) of hare meat varied from 468.70 to 470.12 kJ. 100 g^{-1} in dependence of sex and age, and it is comparable with the results (from 474.72 to 487.63 kJ. 100 g^{-1}) as reported by Slamečka *et al*. (1997). Energy value of rabbit meat was more or less at the same level of 468.01 kJ. 100 g^{-1}, and it may be compared with the results reported by Rafay *et al*. (2008) (458.07 kJ.100 g^{-1}) and Chrenek *et al*. (2012) (456.00 kJ.100 g^{-1}).

The detected average pH values (tab. 5) in meat of brown hare were 6.17, and varied from 5.69 to 6.38 in individual categories. We found significant differences in dependence of sex. If we compare our results with results obtained by Slamečka *et al.* (1997), who noted the pH value in a very narrow span from 5.65 to 5.66, it is evident that the pH value detected by us is high (with the exception of males), and it indicates pre-mortal exhaustion of muscle glycogen. The most possible cause for it can be the stressful conditions at slaughter

Table 3: Content of total fat in brown hare and domestic rabbit in *Musculus longissimus thoracis et lumborum* (g.100 g^{-1})

Species	Number of animals n	$\bar{x}$	SE	CV (%)
Brown hare male a	10	1.23 b +	0.42	34.29
Brown hare female b	23	1.59 a +	0.32	20.13
Brown hare old c	16	1.49	0.44	29.53
Brown hare young d	17	1.46	0.34	23.28
Brown hare total e	33	1.48 f ++	0.38	25.68
Domestic rabbit f	22	2.55 e ++	0.53	20.78

+P≤0.05, ++P≤0.01; $\bar{x}$ = mean; SE = standard mean error; CV (%) = coefficient of variation

Table 4: The energy value in brown hare and domestic rabbit in *Musculus longissimus thoracis et lumborum* (kJ.100 g^{-1})

Species	Number of animals n	$\bar{x}$	SE	CV (%)
Brown hare male a	10	470.12	21.83	4.64
Brown hare female b	23	469.06	11.91	2.54
Brown hare old c	16	470.12	12.67	2.69
Brown hare young d	17	468.70	17.66	3.77
Brown hare total e	33	469.39	15.23	3.24
Domestic rabbit f	22	468.01	17.93	3.83

+P≤0.05, ++P≤0.01; $\bar{x}$ = mean; SE = standard mean error; CV (%) = coefficient of variation

and mainly greater physical activity before the hares are shot.

At the comparison between sexes we must state that the higher pH value was noticed in hare meat (6.17) compared with rabbit meat (5.95). The detected differences were statistically significant (P≤0.05).

L-value indicates colour of meat (tab. 6); it was significantly higher (P≤0.05) in meat of male brown hares (30.61) compared with the meat of females (29.05). The age of hares did not affect the meat colour, which was almost at the same level for juvenile individuals (29.66) and adult ones (29.38).

It can be stated that significantly higher (P≤0.01) L-value was noted for the rabbit meat; it means that this meat is lighter in colour (47.33), and lower L-value was observed for hare meat (29.52), which is markedly darker

Table 5: The pH_{48} value in brown hare and domestic rabbit in *Musculus longissimus thoracis et lumborum*

Species	Number of animals n	$\bar{x}$	SE	CV (%)
Brown hare male a	10	5.69 b ++	0.35	6.14
Brown hare female b	23	6.38 a ++	0.35	5.51
Brown hare old c	16	6.24	0.56	8.97
Brown hare young d	17	6.10	0.37	6.07
Brown hare total e	33	6.17 f +	0.48	7.78
Domestic rabbit f	22	5.95 e+	0.06	1.01

+P≤0.05, ++P≤0.01; $\bar{x}$ = mean; SE = standard mean error; CV (%) = coefficient of variation

Table 6: The colour in brown hare and domestic rabbit in *Musculus longissimus thoracis et lumborum* (L-value)

Species	Number of animals n	$\bar{x}$	SE	CV (%)
Brown hare male a	10	30.61 b +	2.71	8.85
Brown hare female b	23	29.05 a +	1.28	4.42
Brown hare old c	16	29.38	1.81	6.16
Brown hare young d	17	29.66	2.08	7.01
Brown hare total e	33	29.52 f ++	1.93	6.54
Domestic rabbit f	22	47.33 e ++	3.09	6.53

+P≤0.05, ++P≤0.01; $\bar{x}$ = mean; SE = standard mean error; CV (%) = coefficient of variation

Table 7: Content of loosely bound water in brown hare and domestic rabbit in *Musculus longissimus thoracis et lumborum* (g.100 g^{-1})

Species	Number of animals n	$\bar{x}$	SE	CV (%)
Brown hare male a	10	27.95 b +	3.14	11.22
Brown hare female b	23	30.47 a +	2.30	7.55
Brown hare old c	16	29.79	2.05	6.88
Brown hare young d	17	29.62	3.41	11.51
Brown hare total e	33	29.70 f ++	2.79	9.39
Domestic rabbit f	22	24.72 e ++	4.31	17.44

+P≤0.05, ++P≤0.01; $\bar{x}$ = mean; SE = standard mean error; CV (%) = coefficient of variation

as noted by Slamečka *et al*. (1997), and Winkelmayer (2004).

Content of loosely bound water in the meat of brown hare was significant (P≤0.05) in dependence of sex (tab. 7). The content was higher in females (30.47 g.100 g^{-1}) compared with males (27.95 g.100 g^{-1}). The age of hares did not influence the content of loosely bound water in meat and had almost the same values (29.62 g.100 g^{-1} and/or 29.79 g.100 g^{-1}). The average content (29.70 g.100 g^{-1}) corresponded with the results (28.99 – 30.22 g.100 g^{-1}) obtained by Slamečka *et al.* (1997). In contrast, we noticed a significant difference between sexes in the content of loosely bound water (2.52 g.100 g^{-1} higher in meat of females compared with males).

Comparison between both the species showed that the content of loosely bound water (29.70 g.100 g^{-1}) was significantly higher (P≤0.01) in meat of brown hare compared with rabbit meat (24.72 g.100 g^{-1}).

CONCLUSION

On the basis of obtained results it can stated that the meat of brown hare and domestic rabbit is of high quality and it is a healthy component of human nutrition. The meat of brown hare is characterized by high content of protein and very low content of fats. It would be suitable to replace the meat of farm animals by venison and rabbit meat in human nutrition. Venison and rabbit meat is suitable also for dietary cuisine mainly for their favourable content of fats and proteins.

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