doi: 10.17221/8556-CJAS

Carcass composition and meat quality of Czech genetic resources of nutrias (*Myocastor coypus*)

E. Tůmová[1], D. Chodová[1], J. Svobodová[1], L. Uhlířová[1,2], Z. Volek[2]

[1]Department of Animal Husbandry, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Prague, Czech Republic
[2]Institute of Animal Science, Prague-Uhříněves, Czech Republic

ABSTRACT: The effects of sex and colour type on carcass composition, nutrients content, and muscle fibre characteristics of hind leg meat of nutrias raised under intensive conditions were the focus of this study. Thirty-six eight-month-old nutrias of both sexes with three colour types (Standard nutria, ST; Moravian Silver, MS; and Prestice Multicolour, PM) were studied. Live weight was affected by colour type ($P < 0.05$) and sex ($P < 0.001$); however, no effects of these variables were found for the dressing out percentage. Crude protein content was significantly higher in males than in females, whereas crude fat content was higher in females. A significant interaction between colour type and sex was found for hydroxyproline and ash contents. Fatty acids were affected primarily by the sex of nutrias. No effect of colour type on the distribution of muscle fibres in the *Biceps femoris* muscle was found. However, females had fewer βR ($P < 0.05$) and more αR fibres ($P < 0.001$) than males.

Keywords: nutria; colour type; slaughter traits; meat nutritional value; muscle fibre

INTRODUCTION

The general aim of genetic conservation is to maintain within and across breed diversity, where within breed diversity refers to the genetic management of one population and the across breed diversity implies the genetic management of many populations (Meuwisen 2009). Local populations are typically defined by a standard and diversity of adult size, coat colour, and fur type, but little is known about the potential diversity in zootechnical performance. For nutrias, the genetic resource stocks are registered in the Czech Republic, Poland, and the Slovak Republic; however, a few data on performance or meat quality are available. The knowledge of performance and meat quality of nutrias can be used for the management of genetic resources and as the basis for further research.

The nutria is indigenous to the southern part of South America, and both wild and captive-raised animals are used for fur and meat. Historically, nutrias were raised in captivity in Europe, Russia, and China primarily for the quality and other properties of the fur. However, the fur market changed, and nutria meat is the main product of farmed animals. According to Hoffman and Cawthorn (2013), for microlivestock (e.g. nutria) to be competitive with domestic livestock in commercial production, several traits are required. In meat science, more research on the nutritional composition of nutria meat is required, as well as on the value-added nutria meat products.

Little is known regarding the quality of nutria meat or the factors that influence its characteristics. Relatively more is known about nutria slaughter traits and carcass composition, as described by Faverin et al. (2002), Mertin et al. (2003), Cabrera et al. (2007), and Glogowski and Panas (2009). Tulley et al. (2000), Saadoun et al. (2006), Cabrera et al. (2007), Glogowski and Panas (2009), Glogowski et al. (2010), and Migdal et al. (2013) have all recently determined the nutritional value of nutria meat.

Supported by the Ministry of Agriculture of the Czech Republic (Project NAAR No. QI101A164).

doi: 10.17221/8556-CJAS

Additionally, some data on physical measurements are available (Alt et al. 2006; Beutling et al. 2008; Cholewa et al. 2009; Migdal et al. 2013). However, these measures of various meat quality traits varied because of study differences in age of animals, feeding practices, rearing conditions, and other factors. Nutria farmed under intensive conditions were evaluated for the effects of colour type (Faverin et al. 2002) and sex (Faverin et al. 2002; Saadoun et al. 2006; Cabrera et al. 2007) on carcass composition and meat quality. Therefore, the present study focused on the effects of sex and colour type on the carcass composition, nutrient content, and muscle fibre characteristics in hind leg meat of nutria raised under intensive farming conditions.

MATERIAL AND METHODS

Animals and experimental design. A total of 36 nutrias were used for the trial. Three colour types of nutrias were investigated: Standard (ST), Moravian Silver (MS), and Prestice Multicolour (PM). The nutrias were randomly selected from 120 individuals housed in six indoor pens with hard, slated floor (1.0 m^2 per animal). The nutrias were fattened from weaning at two months until eight months of age. A 12 h lighting regime was used. The nutrias were fed a pelleted feed mixture throughout the experiment that consisted of 19.04% crude protein, 14.70% crude fibre, 41.22% neutral detergent fibre, 2.04% ether extract, 1.13% Ca, and 0.7% P. Feed and water were available *ad libitum*. At the end of the fattening, all animals were fasted for 12 h. At eight months old, when nutrias are typically slaughtered for meat production, six nutrias of each colour type were selected and the following parameters were analyzed: slaughter traits, meat nutritional values, and muscle characteristics. The experiment was approved by the Ethics Committee of the Central Commission for Animal Welfare at the Ministry of Agriculture of the Czech Republic. The nutrias were slaughtered in an experimental slaughterhouse with electric stunning and bleeding.

Carcass analyses. A protocol for carcass analysis of nutrias was not available; therefore, the method for rabbits of Blasco and Ouhayoun (1996) was modified. The hot carcass weight was determined within 30 min of slaughter. The carcass did not include the skin, genitals, bladder, gastrointestinal tract, thoracic cage organs, liver, kidneys, perirenal fat, or distal portions of the legs. The hot carcass weight without the head was used to calculate the dressing out percentage. The head was cut between the occiput and atlas vertebra. The dressing out percentage was calculated as the hot carcass weight without the head divided by the live weight at eight months of age, multiplied by 100. Afterwards, the hot carcass was cut to separate the hind part, loin, and hind legs, following Blasco and Ouhayoun (1996). The percentage of these parts and the hind leg meat from the hot carcass without the head were calculated. The perirenal fat was identified, and the percentage calculated following Blasco and Ouhayoun (1996).

Chemical analyses. The chemical composition of the meat was analyzed using the left thigh. The samples were stored until analyses in plastic bags at –20°C. The dry matter of the meat was determined by oven drying at 105°C, and the ether extract content was obtained by extraction with petroleum ether in a Soxtec 1043 apparatus (Foss Tecator AB, Höganäs, Sweden). The determination of ether extract was performed as described in ISO 1444 (1996) (http://csnonlinefirmy.unmz.cz/html_nahledy/57/50218/50218_nahled.htm). The protein content of the meat was determined using a Kjeltec Auto 1030 Analyser (Foss Tecator AB). The ash content was determined according to 920.153 method of AOAC (2005). Hydroxyproline (HPR) was analyzed by acid hydrolysis according to Diemar (1963).

The fatty acid (FA) composition of the diet and the hind leg meat was determined as described by Volek and Marounek (2011). Briefly, the FA composition was determined after chloroform-methanol extraction of total lipids (Folch et al. 1957). Nonadecanoic acid (C19:0) was used as an internal marker to quantify the FA in the samples. The alkaline trans-methylation of the FA was performed as described by Raes et al. (2003). The gas chromatography of the methyl esters was performed using an HP 6890 chromatograph (Agilent Technologies, Inc., Santa Clara, USA) with a programmed 60 m DB-23 capillary column (150–230°C) and a flame-ionisation detector; the split injections were performed using an Agilent autosampler. 1-µl samples of FAME in hexane were injected at a 1 : 40 split ratio. The separation was achieved using the following column temperature program: initially, the column was

doi: 10.17221/8556-CJAS

operated at 60°C for 7 min, and then the temperature was programmed at 20°C/min to 110°C, and held for 4 min, programmed at 10°C/min to 120°C, and held for 4 min, programmed at 15°C/min to 170°C, programmed at 2°C/min to 210°C, and held for 13.5 min, and finally programmed at 40°C/min to 230°C, and held for 7 min. The fatty acids were identified by retention times compared with standards. The PUFA 1, PUFA 2, PUFA 3, and 37 Component FAME Mixes (Supelco, Bellefonte, USA) were used as standards.

The AOAC (2005) 954.01 method was used to determine the crude protein levels in the feed mixtures. The ether extract was determined according to the AOAC (1995) 920.39 method. Crude fibre levels were measured as described by Van Soest and Wine (1967). Ca and P were determined by the method of Englmaierova et al. (2014).

Oxidative stability was measured with the TBARS test in the right hind leg meat, using the method described by Piette and Raymond (1999). The results are expressed in mg of malondialdehyde (MDA) per kg of meat. The meat samples were vacuum-packed and stored at 4°C for zero, three or six days.

Muscle fibre determination. Muscle fibre characteristics of the *Biceps femoris* (BF) muscle were measured in six nutrias of each colour type and sex. Two samples sizing 1 cm^2 were collected from the central part of the BF. The serial cross sections (12 μm) of both muscle types were obtained using a cryostat at –20°C. The sections were treated with myofibrillar ATPase staining after successive preincubations in alkaline buffer, as recommended by Brooke and Kaiser (1970). The fibres were classified as βR (red, slow oxidative), αR (red, fast oxido-glycolytic), and αW (white, fast glycolytic) according to the nomenclature of Ashmore and Doerr (1971). For each muscle fibre type, the percentage and mean cross-sectional area (CSA; μm^2) were determined using NIS Elements AR software (Version 3.1, 1991).

Statistical analyses. The data were analyzed using SAS software (Statistical Analysis System, Version 9.1.3., 2003). All measurements were processed with two-way ANOVA, which included the interaction of colour type and sex. The individual nutria was used as the experimental unit. Statistically significant differences ($P < 0.05$) were indicated by different superscripts.

RESULTS AND DISCUSSION

The descriptive statistics of the composition of the carcasses are provided in Table 1. The mean weight of nutrias of each colour type at the age of eight months was the live weight of slaughtered nutrias. The live weight was affected by colour

Table 1. Effect of nutria colour type and sex on carcass composition

Characteristic	Standard nutria		Moravian Silver		Prestice Multicolour		RMSE	Significance		
	male	female	male	female	male	female		colour type	sex	colour type × sex
Live weight (g)	5967	4477	5823	3729	6120	4687	569	*	***	ns
HCW (g)	3465	2510	3417	2123	3590	2673	316	*	***	ns
HCWH (g)	3003	2168	2935	1822	3082	2252	265	*	***	ns
DOP (%)	50.3	48.7	50.4	49.2	50.5	48.1	2.4	ns	*	ns
Parts from the hot carcass weight without head										
Hind part (%)	43.4^{b}	42.3^{c}	42.3^{c}	45.6^{a}	41.9^{c}	46.1^{a}	2.2	ns	***	***
Loin (%)	19.6^{a}	19.3^{a}	19.4^{a}	14.6^{b}	19.2^{a}	14.2^{b}	1.8	***	***	***
Hind leg (%)	23.0^{b}	22.5^{b}	22.9^{b}	26.3^{a}	21.4^{c}	26.3^{a}	1.4	***	***	***
Hind leg meat (%)	17.9^{c}	18.4^{b}	18.5^{b}	16.5^{d}	17.7^{c}	20.0^{a}	1.7	ns	ns	*
Perirenal fat (%)	1.37	1.18	2.12	1.22	0.85	0.94	0.57	***	ns	ns

HCW = hot carcass weight with head, HCWH = hot carcass weight without head, DOP = dressing out percentage, ns = not significant, RMSE = root mean square error

$^{a–d}$means in the same row with different superscripts are significantly different

*$P < 0.05$, ***$P < 0.001$

doi: 10.17221/8556-CJAS

type ($P < 0.05$) and sex ($P < 0.001$). The highest live weight was observed in the PM males, and the lowest live weight was observed in the MS females. The effect of colour type on live weight was consistent with the Faverin et al. (2002) study of the Greenland and Silver nutrias and with the Beutling et al. (2008) study of the Standard and Greenland nutria. Additionally, sexual dimorphism in growth was described in nutrias. In the present study, the greatest differences in live weight by sex at eight months of age were in the MS nutria, in which the weight of the sexes differed by 36%, whereas in the ST and PM nutria, the difference was approximately 25%. Faverin et al. (2002) found that males were by 29% heavier than females at 14–15 months, and Alt et al. (2006) observed a 15% difference between the sexes at 7.5 months. Moreover, Mertin et al. (2003) and Cabrera et al. (2007) also described sex differences in live weights. However, the nutrias in our experiment were heavier than those of Mertin et al. (2003) and Beutling et al. (2008) at the same age.

For carcass production in the Czech Republic, as in Poland, Germany and South America, the carcass weight without the head is more important than the carcass weight with the head. The hot carcass weight without head was significantly affected by colour type (Table 1). The PM nutrias had the heaviest carcasses of the three colour types. Faverin et al. (2002) found a higher carcass weight of the Greenland nutrias than of the Silver ones, and Beutling et al. (2008) observed higher carcass weights of the Standard nutrias than of the Greenland ones. As observed for live weights, carcass weight also differed between males and females ($P < 0.001$). The percentage differences for this trait were 28% in the ST nutrias, 38% in the MS nutrias, and 27% in the PM nutrias, which were similar to the percentage differences in live weight for the sexes. Alt et al. (2006) and Beutling et al. (2008) found that male carcasses were approximately by 15% heavier than those of females. Relative to previous studies, the larger differences in hot carcass weight between the sexes were likely because of the relatively higher live weights at slaughter in the present study. However, sex differences in weight also depended on the colour type.

The dressing out percentage is an important economic variable in the nutria market. The slaughter yield typically increases in the heavier animals. Despite the significant differences in live weight among the colour types, the dressing out percentage was not affected by colour (Table 1), which was consistent with the findings of Faverin et al. (2002). Similarly, Beutling et al. (2008) observed that the dressing out percentages of the Greenland nutrias were higher than of the Standard nutrias at 12 months of age; however, between 18 and 24 months of age, the dressing out percentage of the Standard nutrias exceeded that of the Greenland nutrias. The authors stated that the maximum dressing out percentage of nutrias occurred between 8 and 18 months. The dressing out percentage was higher ($P < 0.05$) in males than in females. Faverin et al. (2002), Cabrera et al. (2007), and Beutling et al. (2008) also found a higher dressing out percentage in males; however, Glogowski and Panas (2009) did not find differences between the sexes. By contrast, Mertin et al. (2003) found a significantly higher dressing out percentage in males at eight months of age, but by three years of age, no sex differences were found for this trait. The differences in dressing out percentage were likely more strongly affected by age than by live weight.

Before the present study, little was known about the composition of the nutria carcass. Similarly to rabbits, the hind part of nutrias has a high nutritional value. A significant interaction between colour type and sex on the proportion of the hind part was found (Table 1). The highest percentages of hind parts ($P < 0.05$) were in the PM and MS females, and the lowest percentage was in the PM males. The significant interaction indicated differences in the hind part percentage between males and females in all three colour types. The percentages of loin ($P < 0.001$) and of the hind leg ($P < 0.001$) were also affected by the interaction of colour type and sex. The highest percentages of hind leg ($P < 0.001$) were in the PM and MS females, and the lowest percentages were in males of the same colour types. The significant interaction revealed large differences between colour types in the proportion of the carcass that depended on sex of the nutria. The lowest percentages of loin ($P < 0.001$) were in the PM and MS females, whereas those of the other groups did not differ. Similarly, the percentage of hind leg meat was more constant in the ST nutrias. No significant effects of colour type or sex were observed for percentage of hind leg meat; however, a significant interaction revealed that the highest percentage of hind leg meat ($P < 0.05$) was in the PM females and that the lowest

doi: 10.17221/8556-CJAS

Table 2. Chemical composition of nutria hind leg meat

Characteristic (g/kg)	Standard nutria		Moravian Silver		Prestice Multicolour		RMSE	Significance		
	male	female	male	female	male	female		colour type	sex	colour type × sex
DM	243.2	245.5	243.3	251.3	247.1	247.6	5.91	ns	ns	ns
CP	211.1	210.7	214.9	208.1	213.8	210.1	3.12	ns	***	ns
CF	18.3	21.3	15.4	26.9	20.1	21.1	6.82	ns	*	ns
HPR	0.82[a]	0.82[a]	0.76[b]	0.78[b]	0.83[a]	0.69[c]	0.07	ns	ns	*
Ash	11.7[a]	11.6[b]	11.3[c]	10.6[d]	11.3[c]	10.8[d]	0.28	***	***	*
EV (Kj/kg)	4.22	4.33	4.18	4.50	4.34	4.31	0.23	ns	ns	ns

DM = dry matter, CP = crude protein, CF = crude fat, HPR = hydroxyproline, EV = energetic value, ns = not significant, RMSE = root mean square error

[a–d]means in the same row with different superscripts are significantly different

*$P < 0.05$, ***$P < 0.001$

percentage was in the MS females. Thus, carcass parts had different patterns of growth depending on the colour type, which might reflect the length and intensity of selection on each colour type. In the present study, a comparison of the disproportions in nutria carcass composition among colour types was not possible because of insufficient data. However, in rabbits, differences in carcass composition among breeds were described (Hernandez et al. 2006; Metzger et al. 2006; Szendro et al. 2010; Tumova et al. 2013, 2014).

Relative to live weight, perirenal fat is a late maturing tissue. The perirenal fat was affected only by colour type ($P < 0.001$), with the lowest values in the PM nutrias (Table 1). Generally, perirenal fat increases with live weight; however, in the present study, perirenal fat was the lowest in the heaviest colour type. This type had higher growth intensity and a longer growth period than the other types, and thus might mature relatively late. No data on perirenal fat related to colour type in nutrias are available in the literature. Consistent with the results of Cabrera et al. (2007), the percentage of perirenal fat in the present study was unaffected by sex.

For the chemical composition of the meat (Table 2), dry matter and energetic values were not affected by the colour type or sex of nutrias. The crude protein content was higher ($P < 0.001$) in males than in females. Similarly, a significant effect of sex was observed for crude fat. However, these results disagreed with those of Saadoun et al. (2006), Cabrera et al. (2007), and Glogowski and Panas (2009) who did not find an effect of sex on the composition of nutria meat. The inconsistent results were likely related to the different ages

Table 3. Main groups of fatty acids of nutria hind leg meat

Characteristic	Standard nutria		Moravian Silver		Prestice Multicolour		RMSE	Significance		
	male	female	male	female	male	female		colour type	sex	colour type × sex
SFA (%)	34.5	35.5	34.7	33.8	35.6	35.8	1.40	ns	ns	ns
MUFA (%)	33.5	35.8	32.8	35.9	33.8	34.5	2.28	ns	*	ns
PUFA (%)	31.6	28.4	32.2	30.0	30.3	29.4	2.31	ns	*	ns
PUFA/SFA	0.92	0.80	0.93	0.89	0.85	0.82	0.08	ns	*	ns
PUFA n-3 (%)	4.17	3.63	4.11	4.14	4.07	3.86	0.29	ns	*	ns
PUFA n-6 (%)	27.4	24.7	28.1	25.8	26.2	25.6	2.19	ns	*	ns
PUFA n-6/n-3	6.59	6.82	6.84	6.27	6.47	6.66	0.59	ns	ns	ns

SFA = saturated fatty acids, MUFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids, ns = not significant, RMSE = root mean square error

*$P < 0.05$

doi: 10.17221/8556-CJAS

Table 4. Oxidative stability of nutria hind leg meat

TBARS[1]	Standard nutria		Moravian Silver		Prestice Multicolour		RMSE	Significance		
	male	female	male	female	male	female		colour type	sex	colour type × sex
Day 0	0.13	0.15	0.19	0.14	0.15	0.11	0.074	ns	ns	ns
Day 3	0.47^{c}	0.54^{bc}	0.62^{b}	1.51^{a}	0.76^{b}	1.76^{a}	0.292	***	***	***
Day 6	0.74	0.75	1.36	1.65	1.29	1.54	0.489	***	ns	ns

RMSE = root mean square error, ns = not significant, TBARS = thiobarbituric acid-reactive substances

[1]values are presented in malondialdehyde/100 g of meat

[a–c]means in the same row with different superscripts are significantly different

***$P < 0.001$

and rearing conditions used in these studies. The HPR is an indicator of collagen content in meat, and the collagen content was influenced by the interaction between colour type and sex ($P < 0.05$). The lowest HPR value was in the PM females, and the highest HPR values were in the ST and PM males and the ST females. The differences among colour types and sexes might be due to the genetic origin because all animals were kept under the same conditions and slaughtered at the same age. Similar results were described for rabbits by Arino et al. (2006). The collagen content was similar to that ascertained by Migdal et al. (2013). The ash content was affected by both factors, including the interaction ($P < 0.05$). The lowest ash content was in the MS and PM females, and the highest content was in the ST males. However, Tulley et al. (2000) found similar ash contents for wild male and female nutrias.

The fatty acid contents in the hind leg meat are presented in Table 3. The colour type of nutria had no effect on the fatty acid content; however, the fatty acid groups were most affected by sex of the nutria. In all colour types, the saturated fatty acids (SFA) had the highest content followed by monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA). The SFA contents were similar to those described by Glogowski et al. (2010). However, we do not agree with the assumption of these authors that intensively fed animals had a higher total proportion of SFA. In our study, the concentration of SFA was 35.8–38.3%, which was similar to the results of Glogowski et al. (2010) who reported 33% in females and 35.1% in males with forage-based feeding. The MUFA contents were significantly higher in females than in males, which corresponded with the findings of Saadoun et al. (2006) and Glogowski et al. (2010). However, PUFA contents were higher ($P < 0.05$) in males like in the study of Saadoun et al. (2006) and Glogowski et al. (2010). The PUFA quality depended on n-3 fatty acid content, which was higher in males ($P < 0.05$). The PUFA n-3 contents and the effects of sex were similar to those of Saadoun et al. (2006); however, Glogowski et al. (2010) observed lower contents of PUFA n-3

Table 5. Muscle fibre characteristics of nutria *Biceps femoris*

Characteristic	Type of fibre	Standard nutria		Moravian Silver		Prestice Multicolour		RMSE	Significance		
		male	female	male	female	male	female		colour type	sex	colour type × sex
Percentage of total fibres	βR	22.3	11.3	16.9	8.6	14.4	14.0	8.6	ns	*	ns
	αR	4.8	9.7	8.1	9.3	6.6	13.5	3.6	ns	***	ns
	αW	72.9	79.0	74.9	82.2	79.0	72.6	9.5	ns	ns	ns
CSA (μm)	βR	2173	1621	2345	1975	2607	2026	1156	ns	***	ns
	αR	2366	2053	1978	1793	3001	1833	1065	ns	***	ns
	αW	4031	3700	4185	3065	4229	3791	1938	ns	***	ns

RMSE = root mean square error, CSA = cross-section area, ns = not significant

*$P < 0.05$, ***$P < 0.001$

doi: 10.17221/8556-CJAS

than in our results. The fatty acid composition is primarily dependent on feed composition, but the effect of sex in this study was most likely related to metabolism rather than feed consumption as hypothesized by Glogowski et al. (2010).

The quality of fat was also expressed by oxidation stability as measured with the MDA concentration. No differences among groups were found on the day of slaughter (Table 4). However, by the third day of storage, the MDA concentration was highly significantly affected by colour type, sex, and the interaction of the two. The highest MDA concentrations ($P < 0.001$) were in the MS and PM females, and the lowest were in the ST males. By the sixth day of storage, the MDA was lower in the ST nutrias ($P < 0.001$) than in the PM and MS nutrias. There are no comparative data on oxidative stability in nutrias; however, in rabbits, the effect of the breed was observed (Tumova et al. 2014). Zomeno et al. (2010) in rabbits described the effect of the genetic lines on lipogenic, lipolytic, and oxidative enzyme activities. Based on these results and the fatty acid composition, we assumed that lipid metabolism in nutrias was more likely affected by genetic differences in metabolism of colour types and sexes.

The data on BF muscle fibre characteristics are summarized in Table 5. The BF consisted of 72–82% αW fibres, 8–22% βR fibres, and 4–13% αR fibres. The composition of fibres varies among animal species (Fuentes et al. 1998) and is affected by many factors, such as breed, sex, and age. However, in the present study, the muscle fibre distribution was not affected by colour type. Similarly, as reported by Chodova et al. (2014) for rabbits, the breed did not affect the proportions of muscle fibres in the BF. By contrast, in the present study, the proportion of βR fibres ($P < 0.05$) and αR fibres ($P < 0.001$) was affected by sex. The percentage of βR fibres was higher in males, whereas that of αR fibres was higher in females. The fibres with glycolytic metabolism (αW) had a higher CSA than the βR and αR fibres. Dalle Zotte et al. (2005) described similar results for rabbits. In CSA, nutrias had twice as many αW fibres as rabbits. With the exception of the percentage of αW fibres, all muscle fibre measurements were significantly affected by sex. The higher CSA values in males likely reflected the higher live weight.

The composition of the carcass was affected by colour type and sex of nutrias, as well as the interaction between colour type and sex. These interactions were presumably related to the genetic origin of each colour type. The nutritional value of the meat was primarily affected by the sex of nutrias as well as muscle fibre characteristics. This study provided the first data on the muscle fibre characteristics of nutrias, which are related to physical properties. Therefore, further research is needed to better understand the factors that determine meat quality in nutrias.

REFERENCES

Alt M., Fuhsy D., Beutling D. (2006): Quality parameters of nutria meat. Fleischwirtschaft, 86, 126–128. (in German)

AOAC (1995): Official Methods of Analysis. 16th Ed. Association of Official Analytical Chemists, Arlington, USA.

AOAC (2005): Official Methods of Analysis. 18th Ed. Association of Official Analytical Chemists, Gaithersburg, USA.

Arino B., Hernandez P., Blasco A. (2006): Comparison of texture and biochemical characteristics of three rabbit lines selected for litter size or growth rate. Meat Science, 73, 687–692.

Ashmore C.R., Doerr L. (1971): Comparative aspects of muscle fiber types in different species. Experimental Neurology, 31, 408–418.

Beutling D., Cholewa R., Miarka K. (2008): The nutria as a meat and fleece producer. Fleischwirtschaft, 88, 106–110. (in German)

Blasco A., Ouhayoun J. (1996): Harmonisation of criteria and terminology in rabbit meat research. World Rabbit Science, 4, 93–99.

Brooke M.H., Kaiser K.K. (1970): Muscle fiber types: How many and what kind? Archives of Neurology, 23, 369–379.

Cabrera M.C., del Puerto M., Olivero R., Otero E., Saadoun A. (2007): Growth, yield of carcass and biochemical composition of meat and fat in nutria (Myocastor coypus) reared in an intensive production system. Meat Science, 76, 366–376.

Chodova D., Tumova E., Martinec M., Bizkova Z., Skrivanova V., Volek Z., Zita L. (2014): The effect of housing system and genotype on rabbit meat quality. Czech Journal of Animal Science, 59, 190–199.

Cholewa R., Pietrzak M., Beutling D. (2009): Meat quality of nutria. Fleischwirtschaft, 10, 112–116. (in German)

Dalle Zotte A., Remignon H., Ouhayoun J. (2005): Effect of feed rationing during post-weaning growth on meat quality, muscle energy metabolism and fibre properties of Biceps femoris muscle in the rabbit. Meat Science, 70, 301–306.

doi: 10.17221/8556-CJAS

Diemar W. (1963): Laboratory Manual for Food Chemists. Theodor Steinkopf Verlag, Dresden, Germany. (in German)

Englmaierova M., Skrivanova V., Skrivan M. (2014): The effect of non-phytate phosphorus and phytase levels on performance, egg and tibia quality, and pH of the digestive tract in hens fed higher-calcium-content diet. Czech Journal of Animal Science, 59, 107–115.

Faverin C., Corva P.M., Hozbor F.A. (2002): Slaughter traits of adult coypus grown in captivity. Journal of Agricultural Science, 138, 115–120.

Folch J.M., Lees M., Sloane-Stanley G.H. (1957): A simple method for the isolation and purification of total lipids from animal tissues. Journal of Biological Chemistry, 226, 497–509.

Fuentes I., Cobos A.R., Segade A.G. (1998): Muscle fibre types and their distribution in the biceps and triceps brachii of the rat and rabbit. Journal of Anatomy, 192, 203–210.

Glogowski R., Panas M. (2009): Efficiency and proximate composition of meat in male and female nutria (Myocastor coypus). Meat Science, 81, 752–754.

Glogowski R., Czauderna M., Rozbicka A., Krajewska K.A., Clauss M. (2010): Fatty acid profile of hind leg muscle in female and male nutria (Myocastor coypus Mol.), fed green forage diet. Meat Science, 85, 577–579.

Hernandez P., Arino B., Grimal A., Blasco A. (2006): Comparison of carcass and meat characteristics of three rabbit lines selected for litter size or growth rate. Meat Science, 73, 645–650.

Hoffman J.J., Cawthorn D. (2013): Exotic protein sources to meet all needs. Meat Science, 95, 764–771.

Mertin D., Hanusova J., Flak P. (2003): Assessment of meat efficiency in nutria (Myocastor coypus). Czech Journal of Animal Science, 48, 35–45.

Metzger S.Z., Odermatt M., Szendro Z.S., Mohaupt M., Romvari R., Makai A., Biro-Nemeth E., Sipos L., Radnai I., Horn P. (2006): A study of the carcass traits of different rabbit genotypes. World Rabbit Science, 14, 107–114.

Meuwissen T. (2009): Genetic management of small populations: A review. Acta Agriculturae Scandinavica Section A – Animal Science, 59, 71–79.

Migdal L., Barabasz B., Niedbala P., Lapinski S., Pustkowiak H., Zivkovic B., Migdal W. (2013): A comparison of selected biochemical characteristics of meat from nutrias (Myocastor coypus Mol.) and rabbits (Oryctolagus cuniculus). Annals of Animal Science, 13, 387–400.

Piette G., Raymond Y. (1999): A comparative evaluation of various methods used to determine rancidity in meat products. Fleischwirtschaft, 79, 69–73. (in German)

Raes K., De Smet S., Balcaen A., Claeys E., Demeyer D. (2003): Effect of diets rich in N-3 polyunsatured fatty acids on muscle lipids and fatty acids in Belgian Blue double-muscled young bulls. Reproduction Nutrition Development, 43, 331–345.

Saadoun A., Cabrera M.C., Castellucio P. (2006): Fatty acids, cholesterol and protein content of nutria (Myocastor coypus) meat from an intensive production system in Uruguay. Meat Science, 72, 778–784.

Szendro Z., Matics Z., Gerencser Z., Nagy I., Lengyel M., Horn P., Dalle Zotte A. (2010): Effect of dam and sire genotypes on productive and carcass traits of rabbits. Journal of Animal Science, 88, 533–543.

Tulley R.T., Malekian F.M., Rood J.J., Lamb M.B., Champagne C.M., Redmann S.M., Patrick R., Kinler N., Raby C.T. (2000): Analysis of the nutritional content of Myocastor coypus. Journal of Food Composition and Analysis, 13, 117–125.

Tumova E., Martinec M., Volek Z., Hartlova H., Chodova D., Bizkova Z. (2013): A study of growth and some blood parameters of Czech rabbits. World Rabbit Science, 21, 251–256.

Tumova E., Bizkova Z., Skrivanova V., Chodova D., Martinec M., Volek Z. (2014): Comparisons of carcass and meat quality among rabbit breeds of different sizes, and hybrid rabbits. Livestock Science, 165, 8–14.

Van Soest P.J., Wine R.H. (1967): Use of detergents in the analysis of fibrous feeds. 4. Determination of plant cell-wall constituents. Journal of the Association of Official Analytical Chemists, 50, 50–55.

Volek Z., Marounek M. (2011): Effect of feeding growing-fattening rabbits a diet supplemented with whole white lupin (Lupinus albus cv. Amiga) seeds on fatty acid composition and indexes related to human health in hind leg meat and perirenal fat. Meat Science, 87, 40–45.

Zomeno C., Blasco A., Hernandez P. (2010): Influence of genetic line on lipid metabolism traits of rabbit muscle. Journal of Animal Science, 88, 3419–3427.

Received: 2015–02–02
Accepted after corrections: 2015–05–25

Corresponding Author

Prof. Ing. Eva Tůmová, CSc., Czech University of Life Sciences Prague, Faculty of Agrobiology, Food and Natural Resources, Department of Animal Husbandry, Kamýcká 129, 165 21 Prague 6-Suchdol, Czech Republic
Phone: +420 224 383 048, e-mail: tumova@af.czu.cz