DYNAMICS OF GROWTH, BIOCHEMICAL BLOOD PARAMETERS, CARCASS AND MEAT CHARACTERISTICS OF FODDERING NUTRIA (*MYOCASTOR COYPUS*) INFLUENCED BY PROTEINS DIET

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Abstract. The main task of this work was to determine the influence of different dietary protein levels on wellness of nutrias (having in mind growth and food intake) and biochemical blood parameters in combination with meat composition. Forty five nutrias at two months of age after the end of lactating period were selected (thirty males and fifteen females) and randomly divided into three groups (ten males and five females in each). The amounts of proteins in the diet were 21 %, 25 %, 29 %, respectively. The dependence of the amount of the protein in the diet on the growth of nutria was characteristic both for females and males from the age of four months. The male nutrias of the 3rd experimental group reached the weight of 6.10 kg while the average weights of the nutrias of the 1st and the 2nd groups were 5.38 and 5.58 kg respectively. The weights of females of the 1st, 2nd and 3rd groups were 4.66, 4.98 and 5.20 kg respectively. The decrease of glucose, cholesterol and urea in the blood serum by increase of the protein content in the diet was observed. The carcass weights of males were higher comparing with females for each group. But the differences in weight between sexes in groups did not differ and the amount of protein in the diet produced no influence on this parameter. The amounts of proteins in meat samples were 23.58, 24.40 and 25.46 % for males and 22.34, 22.67 and 22.76 % for females for the 1st, 2nd and 3rd investigated groups, and the crude fat amount in meat varied from 1.83–2.01 % for males and 1.86–2.04 % for females of all groups.

Keywords: nutria, carcass yield, proximate composition, biochemical parameters

Introduction. Nutria (*Myocastor coypus*) is a medium-sized herbivore animal bread for fur and meat. Its fur quality is equivalent with mink and foxes and much more valuable than the rabbit fur. The taste, nutritional and dietary characteristics of nutria's meat is similar to that of rabbit (Migdal et al., 2013). The meat composition, especially low fat content, is attractive for human diet (Tulley, 2000). Nutrias offer meat and other edible slaughter by-products such as liver, heart and kidneys.

The diet of fur animals is based on plant-based feed, but must be enriched with animal origin proteins, which affect the better development of muscle tissue (Szymeczko and Skrede, 2001). Extensive nutrition systems are typical for nutria growing in East Europe as distinct from South American specialized farms with an intensive production system (Glagowsi and Panas, 2009). Improvement of the yield of carcass and the biochemical composition of meat by combining the protein diet and different supplements have recently become an issue of high interest (Cabrera et al., 2007; Glogowski et al., 2009; Glogowski and Panas, 2009; Glogowski and Czauderna, 2012). Unfortunately, the investigations concerning wellness or influence of diet on biochemical parameters for nutria and others fur animals are pour (Ahamefule et al., 2008; Damgaard et al., 1998; Martino et al., 2012).

The main task of this work was to determine the influence of different dietary protein levels on wellness of nutrias (having in mind growth and food intake) and biochemical blood parameters in combination with meat composition.

Material and methods

Animals and diet. The investigations were conducted in accordance with the law of the Republic of Lithuania (2012-10-03) for animal welfare and handling, Law No. IX-2271 (Valstybės žinios, 1997, No. 108-2728; 2012, No. 122-6126) and a sub-statutory act by the State Food and Veterinary Service of Lithuanian Republic regarding the confirmation of the order on the animals for experiments, research, storage, maintenance and operating requirements (Valstybės žinios, 2012, No. 130-6595).

The animals were bred in one of the fur farms of Lithuania. Forty five nutria at two months of age after the end of lactating period were selected (thirty males and fifteen females) and randomly divided into three groups (ten males and five females in each). The animals were kept in indoor pens. They were fed three times per day and had free access to drinking water.

The uniform diets were based on coarsely ground barley and wheat flour mixture (3:1 ratio), soybean, sunflower meal, meat meal, calcium carbonate, salt, vitamin and mineral supplement (Table 1). The composition of the diet remained unchanged for the same group adjusting the amount of feed to the age throughout the experimental period. The amounts of proteins in the diet were 21 % (the 1st group), 25 % (the 2nd group) and 29 % (the 3rd group). The proximate compositions (moisture, fibre, ash, crude fats, proteins and nitrogen free extractives (NFE)) of the feed samples were determined using the methods described by Pearson (1976). The moisture and ash of the samples were determined using weight difference methods. The crude proteins were

analysed according the Kjeldahl method, crude fats were determined by the Soxhlet extraction and fibre were established by the method of Kürschner-Hanack. The content of NFE was calculated by the difference.

Table 1. **Ingredients and chemical composition of the feed for nutria**

Ingredients	The 1st group (21 % of proteins)	The 2nd group (25 % of proteins)	The 3rd group (29 % of proteins)
Barley and wheat (3:1), g/kg	748.0	648.0	548.0
Soybean meal, g/kg	133.0	233.0	333.0
Sunflower meal, g/kg	100.8	100.8	100.8
Meat meal, g/kg	10.0	10.0	10.0
$CaCO_3$, g/kg	2.2	2.2	2.2
Salt, g/kg	5.0	5.0	5.0
Vitamin/mineral supplement, g/kg	1.0	1.0	1.0
Crude protein, %	21.6	25.2	28.8
Crude fat, %	2.9	3.1	3.5
Crude fiber, %	4.2	5.2	5.2
Carbohydrates, %	52.8	48.6	44.4
Metabolisable energy, MJ/kg	14.0	16.8	17.1

Carcass yield and chemical meat composition. The weight of animals was registered monthly during the experimental period. At 8 months of age, 6 nutrias (3 males and 3 females) of each group were selected randomly and slaughtered in a commercial slaughterhouse.

The furs were withdrawn and the carcasses were prepared to the subsequent analysis. The final weight of nutria, the weight of carcass with head, the yield of carcass, the viscera (heart, lung, kidneys and liver) weights and the yield of meat were determined.

Meat samples (approx. 50 g) were collected from the thigh of the right hind leg. The chemical composition of meat expressed as moisture, fibre, ash, crude fats, protein and NFE were investigated by the same methods as proximate composition of feed.

Biochemical blood parameters. Blood samples of three animals from each group for analysis of biochemical parameters were taken from the forelegs *v. Saphena* at the 9th week of investigations. Blood serum was analyzed for glucose, cholesterol, urea, bilirubin, calcium, phosphorus and total protein. Blood biochemical parameters were investigated with the biochemical analyzer DIALAB Autolyzer 20010D-2009 (USA).

Statistical analyses. The results are presented with their means, standard deviation and standard error (Juozaitienė, Kerzienė, 2001; Sakalauskas, 1998).

Results and Discussion

Growth and food intake. The nutria showed no differences in body weight between the two sexes at age of 2 month at the beginning of experiment (Table 2). The consistent increase of weight was characteristic for females and males in all investigated groups. The increase in weight was lower for males and females of the 2nd and 3rd investigated groups comparing with females and males of the 1st group from the sixth month of age.

Table 2. **The influence of protein amount in the diet on the body weight** (kg) **of nutria**

Age, month	The body weight					
	The 1st group (21 % of proteins)		The 2nd group (25 % of proteins)		The 3rd group (29 % of proteins)	
	male (n=10)	female (n=5)	male (n=10)	female (n=5)	male (n=10)	female (n=5)
2	1.48±0.11	1.28±0.06	1.50±0.15	1.34±0.16	1.59±0.11	1.68±0.09***
3	2.34±0.08	1.95±0.16	2.14±0.13	2.10±0.14	2.43±0.09	2.20±0.06
4	3.24±0.11	2.63±0.11	3.32±0.12	3.12±0.12**	3.48±0.13	3.00±0.05**
5	4.18±0.17	3.37±0.08	4.16±0.21	3.64±0.04**	4.59±0.12	3.88±0.10***
6	4.96±0.19	3.78±0.06	4.81±0.22	4.10±0.11*	5.14±0.08	4.48±0.08***
7	5.16±0.26	4.31±0.08	5.22±0.18	4.52±0.06	5.64±0.14	4.72±0.11**
8	5.38±0.16	4.66±0.06	5.58±0.24	4.98±0.20	6.10±0.17	5.20±0.07***
*P<0.05; **P<0.01; ***P<0.001						

The dependence of the amount of the protein in diet on the growth of nutria was characteristic both for females and males from the age of four month. The male nutrias of the 3rd experimental group reached the weight of 6.10 kg while the average weights of the nutria of the 1st and 2nd groups were 5.38 and 5.58 kg, respectively or this weight was lower by 11.8 % and 9.32 % than that of the males from the 3rd group. The weights of females of

the 1st, 2nd and 3rd groups were 4.66, 4.98 and 5.20 kg respectively; thus the increase of weight in the 3rd group was 11.59 % and 4.23 % comparing with the 1st and 2nd experimental groups. Cabrera et al. (2007) indicates that the animals receiving 19 % of proteins showed significant differences between males and females only at fifth month of age, while no differences in food intake depending on protein level was found.

Biochemical blood parameters. The biochemical blood parameters (Table 3) (total protein, glucose, cholesterol, urea, bilirubin and mineral elements: calcium and phosphorus) were determined with the aim to indicate the health status of the animals according to the valuable feeding. The biochemical blood parameters are discussed in comparison to those reported by Martino et al. (2012) for free-ranging nutrias and Damgaard et al. (1998) for mink (*Mustel vision*).

Table 3. **The biochemical blood parameters of nutrias**

Parameters	The 1st group (n=3) (21 % of proteins)	The 2nd group (n=3) (25 % of proteins)	The 3rd group (n=3) (29 % of proteins)
Total protein, g/l	48.12±0.11	48.54±0.09*	48.86±0.10**
Glucose, mg/dl	134.24±0.21	132.56±0.18**	128.64±0.16***
Cholesterol, mmol/l	2.62±0.04	2.54±0.04	2.46±0.02*
Urea, mmol/l	6.28±0.14	6.10±0.12	5.48±0.12**
Bilirubin, µmol/l	5.62±0.08	5.86±0.06***	6.24±0.08***
Calcium, mmol/l	2.84±0.04	3.12±0.02***	3.46±0.02***
Phosphorus, mmol/l	2.41±0.01	2.56±0.02***	2.83±0.01***
*P<0.05; **P<0.01; ***P<0.001			

The total protein content was determined within the range of 48.12–48.86 g/l for all three investigated groups. The plasma concentration of total protein decreased from 69 mmol/l for 31 % protein diet to 57 mmol/l for 16 % protein diets for mink (*Mustela vision)* (Damgaard et al., 1998). The amount of glucose decrease by increasing the protein content in the diet was observed in blood serum. The amount of glucose was 134.24 mg/dl for nutrias with 21 % of proteins in the diet while the amounts of glucose were 1.27 (P <0.01) and 4.35 % (P<0.001) lower for the nutrias with 25 % and 29 % proteins in the diet respectively. This contributes to the values of the comprehensive reference intervals of 120.2–180.6 mg/dl for both sexes combined (Martino et al., 2012). The correlation between the concentration decrease and the increase of the protein amount in the diet was noticeable for the amount of cholesterol (from 2.62 to 2.46 mmol/l) and urea (from 6.28 to 5.48 mmol/l) in blood. The plasma concentration of urea of mink (*Mustela vision*) was of 6.6 mmol/l in the control group (31 % of proteins in diet) while the concentration in group with 16 % proteins diet was 5.8 mmol/l (Damgaard et al., 1998). The values of calcium and of phosphorous contribute with the given values: calcium: 1.74–2.79 mmol/l and phosphorus 2.00–3.05 mmol/l (Martino et al., 2012). The lower plasma concentration of total protein, urea and creatinine when protein diet was low (16 % or 20 %) in mink diet have been associated with the hypothesis, that those parameters are indicators of the metabolism of amino acids (Damgard et al., 1998).

Carcass yield. The mean slaughtering parameters are presented in Table 4. The carcass weights of males were higher comparing with female for each group. But the differences in weight between sexes in groups did not differ and the amount of protein in the diet had no influence on this parameter as also has been reported by other authors (Cabrera et al., 2007). The carcass weights of the males of the 1st, the 2nd and the 3rd groups were 3.035, 3.081 and 3.355 kg, respectively, while the means of female were 2.601, 2.746 and 2.850 kg. So, the average differences between weights depending on the amount of proteins in diets were 434, 335 and 505 g, respectively.

The weight of the nutria and the carcass yield of the muscle depended on the ratio of nutrients in the diet (Mertin et al., 2003). The carcass yield of 54.8–56.4 % was calculated for all dietary protein levels and this is similar to Cabrera et al. (2007) but differs from Glagowski and Panas (2009) as well as Mertin et al. (2003).

The yield of nutria carcass in the rage of 55.00 to 55.80 % was equivalent to rabbit carcass yield which was in the range of 51.48 to 55.67 % (Hemandez et al., 2006; Pla et al., 1998). The weight of viscera including head varied from 513.51–583.10 g for males and 461.71–493.74 g for females. The weight of meat for males of different proteins level varied from 1733 to 1927 g and for females from 1441 to 1529 g, which was of 29.4–32.2 % of the whole weight. So protein diets do not influence the ratio of the weight of meat with whole weight.

Meat composition. Table 5 summarizes the investigations of chemical composition of nutria's meat. The increase of the amount of proteins and fats were not significant comparing different groups or sexes. The amounts of proteins were 23.58, 24.40 and 25.46 % for males and 22.34, 22.67 and 22.76 % for females for the 1st, 2nd and 3rd investigated group, respectively, while revealed the protein content in meat was in the range of 19 % to 23 % (Cabrera et al., 2007; Migdal et al., 2013; Saadoun et al., 2006). The crude fat amount varied from 1.83–2.01 % for males and 1.86–2.04 % for females and this amount was significantly lower comparing with 4.4 % in males and 6.0 % in females (Glagowski and Panas,

2009) and 7.83 % in females (Migdal et al., 2013), but were in agreement with the values reported by others authors. The fat content in nutria meat was found within the range of 1.4 to 2.5 % (Cabrera et al., 2007; Saadoun et al., 2006).

Table 4. **The mean slaughtering parameters**

Parameters	The 1st group (21 % of proteins)		The 2nd group (25 % of proteins)		The 3rd group (29 % of proteins)	
	male (n=3)	female (n=3)	male (n=3)	female (n=3)	male (n=3)	female (n=3)
The final weight of nutria, g	5383±0.16	4662±0.06	5582±0.24	4984±0.20	6100±0.17	5201±0.07***
The weight of carcass with head, g	3035±0.26	2601±0.18	3081±0.21***	2746±0.20***	3355±0.13***	2850±0.14***
The yield of carcass (calculated by live weight), %	56.4±0.60	55.8±70.06	55.2±0.51	55.1±0.04***	55.0±0.72	54.8±0.05***
The weight of viscera with head, g	513.51	468.71	547.53	475.34	583.10	493.74
The yield of viscera with head, %	9.54	10.05	9.81	9.54	9.56	9.49
The yield of meat, g	1733±28.4	1441±34.2	1786±20.6	1435±24.8	1927±40.3	1529±47.1
The yield of meat (calculated by live weight), %	32.2±0.45	30.9±0.29	32.0±0.54	28.8±0.27**	31.6±0.38	29.4±0.47
**P<0.01; ***P<0.001						

Table 5. **The chemical composition of nutria's meat**

Parameters	The 1st group (21 % of proteins)		The 2nd group (25 % of proteins)		The 3rd group (29 % of proteins)	
	male (n=3)	female (n=3)	male (n=3)	female (n=3)	male (n=3)	female (n=3)
Dry matter, g/kg	29.21±0.51	28.46±0.32	30.14±0.62	28.89±0.18	31.43±0.60*	29.12±0.22
Organic matter, g/kg	25.41±0.47	24.20±0.24	26.32±0.41	24.61±0.16	27.47±0.32**	24.80±0.21
Crude protein, g/kg	23.58±0.23	22.34±0.18	24.40±0.20*	22.67±0.11	25.46±0.12***	22.76±0.08
Crude fat, g/kg	1.83±0.06	1.86±0.04	1.92±0.04	1.94±0.03	2.01±0.02***	2.04±0.08
Crude ash, g/kg	3.80±0.22	4.26±0.24	3.82±0.24	4.28±0.32	3.96±0.33	4.32±0.18
Metabolizable energy, MJ/kg	6.36	6.08	6.60	6.19	6.87	6.25
*P<0.05; **P<0.01; ***P<0.001						

Conclusions

The different amounts of proteins (21, 25, and 29 %) support adequate growth and food intake of nutria. The carcass weights of males are higher compared with females in each group indicating no influnce of protein diet. The male nutrias of the 3rd experimental group reached the weight of 6.10 kg while the average weights of the nutria of the 1st and 2nd groups were 5.38 and 5.58 kg, respectively. The weights of females of the 1st, 2nd and 3rd groups were 4.66, 4.98 and 5.20 kg respectively. The amounts of total protein, calcium and phosphorus contribute to the comprehensive reference intervals, while the decrease of glucose (from 134.24 to 128.64 mg/dl), cholesterol (from 2.62 to 2.46 mmol/l) and urea (from 6.28 to 5.48 mmol/l) in blood serum by increase of the protein content in the diet was characteristic of the investigated nutrias. The carcass yield of 54.8–56.4 % was calculated for all dietary protein levels. The amounts of proteins in meat samples were 23.58, 24.40 and 25.46 % for males and 22.34, 22.67 and 22.76 % for females for the 1st, 2nd and 3rd investigated groups, and the crude fat amount in meat varied from 1.83–2.01 % for males and 1.86–2.04 % for females of all groups.

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