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Biochemical Composition, Amino Acid and Fatty Acid Contents of Muskrat *(Ondatra zibethicus)* Meat

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ABSTRACT
We have defined the biochemical composition of the carcass meat of muskrat, including the content of the amino acids, lipids, and saturated and unsaturated fatty acids. The moisture, crude proteins, fatty acid, and ash were 74.6, 23.2, 1.2, and 0.92%, respectively. The average amount of calories was 478 kJ per 100 g meat. We separated 17 amino acids using reversed-phase high-performance liquid chromatography (RP-HPLC) analysis. The fat content was low in both male and female invasive muskrats. The aliphatic tails of the fatty acids range from 16 to 18 carbons. The saturated palmitic (C16:0) and stearic acids (C18:0), and unsaturated oleic (C18:1) and linoleic (C18:2), and linolenic acids (C18:3) were extracted. Even though some of the western provinces in Mongolia applied the carcass meat of the muskrats for treatment against kidney disease in traditional medicine, the scientific proof is still unclear.

Keywords: *Carcass meat, Muskrat, Fatty acids, Amino acids, Biochemistry*

1. INTRODUCTION

Muskrats *Ondatra zibethicus* (Linnaeus, 1766), like most rodents, are prolific breeders and very important as marsh managers, removing extra plants and making sure waterways are clear [1]. Naturally, the muskrats spread into Mongolia from Russia in the 1940's. The current population of mature muskrats in the Khar-Us lake is approximately 80000 individuals [2, 3].

The carcass meat of the muskrats has been applied for food and traditional medicine in the western provinces of Mongolia. In Mongolian traditional medicine, muskrat meat was considered therapeutic for kidney diseases. However, the scientific evidence of the treatment has not yet been published. Therefore, the studies on biochemical composition are essential to understand the effect of muskrat meat.

The natural forage of wild animals rich in herbs, minerals, and other components has biological activity. Biochemical compositions are important to determine the activities of meat against diseases. The muskrat has white fat (white adipose tissue) and brown fat (brown adipose tissue). The adipose tissues are in different locations of the body. The effects of different diets on the biochemical composition, fatty acids, amino acids, and nutrition of meat in various semiaquatic rodents have been studied widely. Previously, Kakela and Hyvärinen examined the fatty acid compositions of the adipose tissues and liver of the beaver and muskrat [4]. We couldn't have found any Mongolian scientific papers about the chemical study of muskrat meat.

Therefore, the objective of this study was to determine the biochemical composition, amino acids, saturated and unsaturated fatty acids composition of carcass meat of Muskrat (*Ondatra zibethicus*).

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2. EXPERIMENTAL

2.1. Materials

The animals were harvested in the Tes river of Uvs province (N 50°32′ 902, E 93°51′ 085) in 2013. In Mongolia, muskrat hunting is allowed from the fifth of November until the first of February since 1971. Of five harvested animals, five adults (three male and two female) were selected for further investigations. Culled muskrats were weighted after bled, skinned and eviscerated. The mean body weight averaged 636±202 g. The mean carcass meat of muskrat was 303.5±59 g and the dressing percentage was 47.7%. The *Ondatra zibethicus* were stored frozen at -20°C.

2.2. Methods

2.2.1. Biochemical Analysis

Moisture content was determined by drying the carcass meat for 8 h at 105°C repeatedly. We also determined dry substances, fat, and ash in meat. Total lipids were isolated from the tissues using a chloroform:methanol (2:1 v/v) mixture as described by Folch [5]. The protein content was quantified by the Kjeldahl procedure.

2.2.2. Fatty Acid Composition

After alkaline hydrolysis, fatty acids were esterified by N-Ethyldiisopropylamine and 2-Bromoacetophenone. Analyses were carried out using a reversed-phase HPLC (JASCO, FP-2020 Plus) equipped with a UV detector measuring absorbance at 254 nm [6] and a mass spectrometer as the detector under electrospray ionization (ESI) conditions in positive mode (AccuTOF LC-Plus positive MS: Sodium, 22.9 *m/z*, injection: 15 µL). In HPLC analysis, the C-18 column (6.0 x 250 mm) was used as a standard for 3 fatty acids (palmitic acid, oleic acid, and stearic acid). Acetonitrile:water served as the eluent and was programmed from 90:10 to 100:0. The flow rate was set at 2 mL/min.

2.2.3. Amino Acid Analysis

The content of amino acids after hydrolysis with 6 M HCl was carried out using a reverse-phase HPLC system (Shimadzu), equipped with an LC-20AD pump, DGU-20A3R, autosampler, and RF-10Axl, 350-450 nm fluorescence detector. The samples were submitted to automatic pre-column fluorescence derivatization detection method using o-phthalaldehyde (OPA)/N-acetylcysteine as a reaction reagent by programming the autosampler. After derivatization, an amount equivalent to 1.0 µL of each sample was injected on a C18 (ODS) column. Solutions of 17 amino acids standard (Amino Acids Mixture Standard Solution, Type H, solution in 0.1 mol/L HCI, Wako, Japan) in four concentrations (0 mmol/L, 0.05 mmol/L, 0.1 mmol/L, and 0.15 mmol/L) were obtained for calibration curves. 10 µL was poured into a conical insert, capped immediately and refrigerated (4°C). Amino acids were separated all at once using an amino acid mobile phase kit and an OPA reagent kit (Shimadzu). The concentration of the different amino acids was calculated from the standard curves of the pure amino acids prepared and derivatized simultaneously with the samples and run under identical conditions.

2.2.4. Statistical Analysis

All values are reported as the mean and standard deviation for 5 measurements on the sample. We analyzed data were treated using JMP 5.1 software.

3. RESULTS AND DISCUSSION

3.1. Biochemical Composition

The descriptive statistics of the Biochemical composition of carcass meat are reported in Table 1 and Table 2. The moisture, protein, fat, and ash content were determined only in meat and results showed similar values for the male and the female. There were no significant differences ($p>0.05$) between the male and the female.

Table 1. Biochemical composition of Ondatra zibethicus (n=5)

Sex	Moisture, %	Dry substance, %	Protein, %	Fat, %	Ash, %	Energy, kJ
1. Female (n=2)	74.6	25.4	23.3	1.43	0.88	479.0
2. Male (n=3)	74.7	25.3	23.1	1.09	0.95	477.4
Mean	74.6	25.4	23.2	1.22	0.92	478.0
Standard deviation	0.25	0.29	0.24	0.21	0.05	3.86
Min.	74.3	25.0	22.8	1.02	0.84	474.1
Max.	74.9	25.7	23.5	1.62	1.00	483.9

Table 2. Comparison of the biochemical composition of other meats

Animals	Moisture	Protein	Fat	Ash	Energy	References
	%				kJ	
Nutria (*Myocastor coypus*)	-	16.0	3.0	-	1459.0	[8]
European beaver (*Castor fiber* L.)	76.1	21.6	1.1	1.2	404.0	[7]
Muskrat (*Ondatra zibethicus* L.)	74.6	23.2	1.2	0.9	478.0	present research

The moisture, protein, fat, and ash content in the present research were close to European beaver by Mariusz [7]. The fat content in the present study was lower compared to European beaver and Nutria. In this study, the energy value was between 474.1 and 483.9 kJ in 100 g.

3.2. Amino Acids Composition

The composition of the amino acids profile of muskrat meat is shown in Table 3. The amino acids at the highest content were aspartic acid (13.8±0.05%), glutamine acid (11.6±0.45%), glycine (10.6±0.3%), and alanine (11.1±0.15%) within the essential amino acid leucine (8.0±0.05%). The average percentage of essential amino acids was 34.2%. Values of amino acids concentration were higher in the present study compared to results found by Mariusz [7].

Table 3. Amino acids composition of muskrat meat

Amino acid		**%**
Aspartic acid	Asp	13.8±0.05
Arginine	Arg	5.8±0.4
Serine	Ser	6.1±0
Glutamine acid	Glu	11.6±0.45
Proline	Pro	4.6±0.05
Glycine	Gly	10.6±0.3
Alanine	Ala	11.1±0.15
Cysteine	Cys	0.3±0
Tyrosine	Tyr	2.3±0
Essential amino acid		**%**
Valine	Val	2.9±0
Methionine	Met	2.4±0
Isoleucine	Ile	2.2±0
Leucine	Leu	8.0±0.05
Threonine	Thr	4.6±0
Phenylalanine	Phe	3.4±0.15
Histidine	His	3.1±0.05
Lysine	Lys	7.6±0.2
Total		100

3.3. Fatty Acids Composition

In HPLC analysis, the retention time of fatty acid may be predicted by semi-empirical means. Figure 1 shows the chromatogram obtained from the separation of three fatty acids standards (palmitic acid C16:0, oleic acid C18:1, and stearic acid C18:0) and fatty acids samples. The five unknown peaks were detected at about 15, 21, 28, 29, and 42 min and characterized by ESI-MS. The early eluting peak at a retention time of about 15 min Figure 1 gave *m/z* of 278.43 in ESI-MS. Thus, the linoleic acid is represented in Figure 1 by peak 2 gave *m/z* of 280.45.

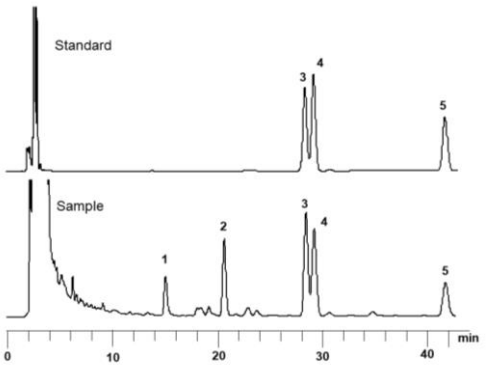

Figure 1. HPLC profiles of fatty acids. Standard: Palmitic acid (3), Oleic acid (4), Stearic acid (5). Sample: Linolenic acid (1), Linoleic acid (2), Palmitic acid (3), Oleic acid (4), Stearic acid (5)

From the published reports, Käkeläand Hyvärinen have been examined the fatty acid compositions of the adipose tissue in the extremities, trunk, and liver in muskrats and beaver. In adipose tissue analyzed by Käkelä and Hyvärinen, linolenic acid (2.7-13%), linoleic acid (16.7-21.9%), palmitic acid (12.8-21%), oleic acid (7.3-39.1%) and stearic acid (1.9-20.5%), respectively, were found predominant [4]. In the present study, detected linolenic acid, linoleic acid, palmitic acid, oleic acid, and stearic acid were in agreement with reported data by [4].

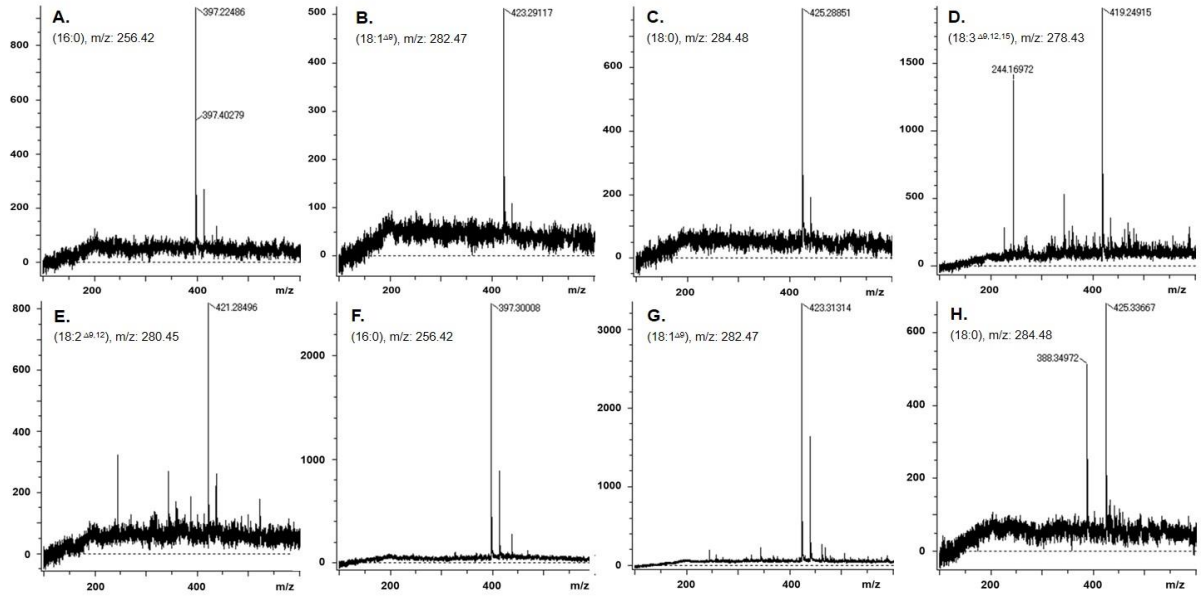

Figure 2. Mass spectrometer profiles of fatty acids. **A.** Standard: Palmitic acid, **B.** Oleic acid, **C.** Stearic acid. **D.** Sample: Linolenic acid, **E.** Linoleic acid, **F.** Palmitic acid, **G.** Oleic acid, **H.** Stearic acid

Table 4. Detected mass details of fatty acids

	Fatty acids	*m/z*	2-Bromoacetophenone	Na	H^+	Detected mass
Std	**Palmitic acid**	256.42	119.04	22.9	1.007	397.36
	Oleic acid	282.47	119.04	22.9	1.007	423.51
	Stearic acid	284.48	119.04	22.9	1.007	425.42
Sample	**Linolenic acid**	278.43	119.04	22.9	1.007	419.36
	Linoleic acid	280.45	119.04	22.9	1.007	421.39
	Palmitic acid	256.42	119.04	22.9	1.007	397.36
	Oleic acid	282.47	119.04	22.9	1.007	423.51
	Stearic acid	284.48	119.04	22.9	1.007	425.42

A mass spectrometer analysis of fatty acids in meat tissue of muskrat revealed the presence of fatty acids ranging in chain length from 16 to 18 carbon atoms and molecular mass from 256.42 to 284.48 Figure 2.

4. CONCLUSION

The introduced muskrats are widely distributed in Mongolia. A high population of muskrats often destructs local habitat caused by burrowing and reduces aquatic vegetation for food and building materials. Therefore, in order to reduce the negative effect of muskrat, restrict the population density and growth rate.

In the present study, the carcass of wild muskrat was found as a good nutritional meat source with amino acids composition (essential amino acids averaged 34.2%), chemical composition, fatty acid composition (omega-3, omega-6, and omega-9), and a low energy value. All these characteristics help to consider muskrat meat as useful in many medicinal preparations. In addition, further research should determine the content of the macro- and microelements in the carcass meat of muskrat.

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