Studies on Fatty Acid Composition of Siberian Marmot (*Marmota Sibirica* Radde, 1862) Fat

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Abstract

Fatty acid composition of Siberian marmot fat (*Marmota Sibirica*, tarbagan) has been studied; the basic physicochemical parameters have been determined. 36 fatty acids have been identified, about 90 % among those being represented by palmitic, oleic, linoleic and linolenic acids. A comparative analysis of the composition of tarbagan's hypodermic, abdominal and brown fat was carried out. It has been established that for the kinds of fat under investigation the composition of acids is variable, and the greatest differences in the concentration of saturated acids are inherent in brown fat. An unusually high fat unsaturation level for land species of animals observed for a Siberian marmot might cause the fat biological activity.

Keywords: marmot, tarbagan, fatty acid composition, brown fat, hypodermic fat (blubber), abdominal fat, polyunsaturated acids, iodine number, peroxide number, biologically active product

INTRODUCTION

Marmots *(Marmota)* represent big rodents of squirrel family *(*Rodentia: Sciuridae*)*. The tarbagan *(Marmota Sibirica* Radde, 1862*)* represents one of the species of marmots whose natural habitat is mainly concentrated over the territory of Mongolia and partly covers China, Transbaikalia and Tuva. The commercial hunting of marmot in Mongolia and Transbaikalia increased owing to a demand for marmot fells in the beginning of 20th century has topped out in 1910 when 5.7 million fells of this animal had been prepared in the aggregate [1, 2]. The tarbagan's fur was exported, and meat of this animal was used by local population for food.

In the traditional folk medicine of Mongolian and Siberian peoples the marmot fat was used for the treatment and prophylaxis of pulmonary tuberculosis, chronic obstructive diseases of a respiratory apparatus, for the treatment of burns and festering wounds, which indicates biological activity of this product.

The fat of a marmot is characterized by unusually high content of unsaturated acids as compared to other land species of animals, which may be caused by a seasonally occurring hibernation of marmots. A high content of natural antioxidants resulting in the fact that the marmot's fat is second only to fish oil and is superior with respect to all the other animal fats, determines its resistance to oxidation [3].

Among the fatty tissue varieties inherent in a marmot one can distinguish so called brown adipose tissue (brown fat) that is mainly located in axillary crease and interscapular region of a body and adjoins to the basic viscera (for example, to a heart). The functional destination of the brown adipose tissue that is abundantly supplied with mitochondria consists in a significant heat production [4]. The studies on brown fat of the Siberian marmot were not carried out until now.

The present work is aimed at the studies on physicochemical properties and fatty acid composition of tarbagan's fat.

EXPERIMENTAL

In the present work we investigated hypodermic, abdominal and brown fats of tarbagan. The animals were caught during the autumn period of 2003–2005 in the territory of the Buryatia. The choice of animals was carried out according to dimensional, mass and age criteria those are considered to determine the amount of fatty reserves in marmots [5].

The basic physicochemical parameters such as the iodine number (according to the Kaufman method [6],) peroxide number, acidity index and saponification number [7] were determined for various kinds of fat.

The fatty acid composition of the samples was determined using a Hewlett-Packard 5890-2 gas chromatograph with an HP 5971 quadrupole mass spectrometry detector. The separation was carried out using an HP-5 quartz column (packed with a 5 % diphenylsiloxane–95 % dimethylsiloxane copolymer) 30 m length, with an internal diameter of 0.25 mm. The thickness of the stationary phase film amounted to 0.25 μm. The samples of fatty acids (Supelco) were used as reference substances.

The procedure of sample preparation for the chromatographic analysis included obtaining methyl esters of fatty acids through the saponification of triacylglycerols using a 2 M HCl solution in methyl alcohol at the temperature of 90 °C [8].

RESULTS AND DISCUSSION

Physicochemical parameters of various kinds of tarbagan's fatty tissue (hypodermic, abdominal and brown fat) are presented in Table 1. High values of the iodine number of the samples under investigation indicate a high unsaturation level of the marmot fat, whereas low values of the acidity index and peroxide number could be considered as an evidence of a high fat quality. A lower iodine number value for brown fat as compared to the other kinds of fat inndicate a low level of its nonsaturation. The comparative analysis of fat parameters demonstrated no significant differences to be revealed for individual animals of different sexes.

The differences in the fat composition for the marmots choosen during different years could be, to all appearance, connected with a variation in the using by the animals for food certain species of plants.

With the use of the chromatography/mass spectrometry technique, a fatty acid composition of the fat under investigation was established. 36 high molecular mass fatty acids have been identified, with the maximum content of

TABLE 1

Physicochemical parameters of tarbagan *(Marmota Sibirica)* fat

Parameter	Fat (hypodermic/abdominal/brown)	
	male	female
Colour	Light yellow/light yellow/brown	Light yellow/light yellow/brown
Smell	Slight, specific	Weak, specific
Iodine number, g/100 g	110/108/72	112/109/75
Peroxide number, g/100 g	0.04/0.09/0.19	0.03/0.07/0.15
Acidity index	0.5	0.5
Saponification number	188.85	188.35

TABLE 2

Fatty acid composition for hypodermic, abdominal and brown tarbagan *(Marmota Sibirica)* fat , %

Acids	2003 (n = 10)			2004 (n = 14)			2005 (n = 5)		
	Hypodermic	Abdominal	Brown	Hypodermic	Abdominal	Brown	Hypodermic	Abdominal	Brown
c12:0	0.03±0.01	0.03±0.01	0.07±0.06	0.03±0.01	0.03±0.01	0.02±0.01	0.03±0.00	0.03±0.01	0.02±0.01
c14:0	0.99±0.19	0.96±0.15	0.96±0.15	0.89±0.16	0.78±0.09	0.59±0.10	0.81±0.02	0.89±0.20	0.88±0.04
c14:1	0.03±0.01	0.02±0.01	0.04±0.02	0.02±0.01	0.02±0.01	0.03±0.02	0.03±0.01	0.02±0.01	0.03±0.01
c15:0	0.24±0.04	0.21±0.03	0.72±0.62	0.25±0.01	0.24±0.03	0.14±0.05	0.20±0.02	0.23±0.02	0.13±0.01
c16:0	15.57±0.29	15.84±0.75	18.74±1.83	16.02±0.62	16.27±0.57	16.97±0.57	15.34±0.66	15.52±0.28	19.45±0.15
c16:1n9	0.50±0.05	0.47±0.07	0.49±0.15	0.45±0.02	0.45±0.02	0.34±0.09	0.52±0.08	0.52±0.01	0.37±0.07
c16:1n7	1.92±0.20	1.52±0.21	1.43±0.27	1.80±0.07	1.40±0.07	1.19±0.20	1.86±0.26	1.31±0.16	1.33±0.10
iso17:0	0.05±0.01	0.04±0.01	0.13±0.10	0.03±0.00	0.05±0.03	0.14±0.07	0.04±0.01	0.04±0.01	0.03±0.01
aiso17:0	0.22±0.09	0.15±0.05	0.16±0.06	0.16±0.01	0.14±0.01	0.19±0.03	0.11±0.03	0.13±0.03	0.14±0.01
c17:0	0.72±0.07	0.72±0.12	0.69±0.09	0.80±0.03	0.80±0.04	0.78±0.05	0.63±0.05	0.77±0.04	0.59±0.03
c17:1n9	0.71±0.17	0.67±0.14	0.52±0.08	0.82±0.06	0.69±0.03	0.43±0.06	0.76±0.10	0.73±0.05	0.42±0.02
c16:3n4	0.30±0.15	0.23±0.14	0.19±0.11	0.17±0.02	0.17±0.02	0.06±0.03	0.05±0.01	0.06±0.01	0.03±0.01
c18:0	0.02±0.01	0.03±0.02	0.11±0.10	0.03±0.03	0.03±0.02	0.03±0.03	0.03±0.02	0.04±0.01	0.06±0.01
c18:1n11	1.70±0.20	2.11±0.25	2.76±0.83	1.87±0.19	2.13±0.27	3.73±0.30	1.45±0..13	1.77±0.11	3.05±0.13
c18:1n9	46.41±3.69	47.22±2.04	45.14±1.54	47.79±1.99	46.72±0.78	55.85±1.00	58.63±1.02	57.75±2.16	55.03±2.04
c18:1n7	0.68±0.06	0.69±0.04	0.64±0.05	0.73±0.03	0.72±0.02	0.69±0.20	0.76±0.04	0.75±0.02	0.67±0.20
c18:2n6	8.35±1.03	7.83±0.82	8.03±1.12	9.02±0.44	9.52±0.45	8.32±0.48	5.42±0.58	6.00±0.63	5.30±0.78
c18:3n6	0.02±0.01	0.05±0.04	0.12±0.05	0.02±0.01	0.03±0.01	0.21±0.13	0.13±0.08	0.29±0.01	0.07±0.01
c19:0	0.25±0.08	0.17±0.11	0.13±0.09	0.28±0.13	0.13±0.10	0.08±0.02	0.12±0.05	0.12±0.01	0.16±0.02
c18:3n3	18.79±2.01	18.73±1.26	16.44±3.42	16.09±1.57	17.37±0.69	8.65±0.39	11.35±0.79	11.59±0.88	11.05±0.98
c18:3n4	0.20±0.15	0.11±0.10	0.12±0.08	0.07±0.02	0.06±0.01	0.04±0.01	0.04±0.01	0.03±0.00	0.05±0.01
c20:0	0.04±0.03	0.04±0.02	0.12±0.12	0.19±0.12	0.15±0.14	0.03±0.01	0.02±0.01	0.03±0.00	0.03±0.01
c20:1n11	0.51±0.05	0.49±0.07	0.35±0.11	0.58±0.02	0.48±0.06	0.29±0.09	0.62±0.04	0.34±0.20	0.34±0.10
c20:1n9	0.12±0.03	0.11±0.02	0.08±0.04	0.18±0.01	0.15±0.03	0.12±0.02	0.16±0.02	0.10±0.05	0.10±0.05
c20:2n6	0.06±0.02	0.05±0.02	0.04±0.02	0.08±0.01	0.07±0.01	0.10±0.03	0.02±0.00	0.03±0.01	0.02±0.01
c20:4n5	0.05±0.02	0.04±0.02	0.05±0.02	0.05±0.01	0.04±0.02	0.08±0.01	0.06±0.04	0.02±0.01	0.04±0.02
c20:3n11	0.21±0.04	0.19±0.03	0.14±0.05	0.24±0.03	0.22±0.01	0.09±0.01	0.07±0.01	0.08±0.04	0.08±0.03
c20:3n3	0.08±0.04	0.05±0.02	0.06±0.03	0.06±0.02	0.06±0.03	0.02±0.01	0.07±0.01	0.02±0.01	0.03±0.01
c20:5n3	0.10±0.02	0.08±0.01	0.09±0.05	0.12±0.02	0.10±0.01	0.04±0.01	0.06±0.03	0.06±0.02	0.07±0.02
c22:0	0.05±0.04	0.03±0.01	0.03±0.02	0.07±0.03	0.03±0.02	0.10±0.01	0.03±0.01	0.04±0.01	0.03±0.01
c22:1n13	0.02±0.01	0.02±0.01	0.06±0.05	0.02±0.01	0.08±0.04	0.01±0.01	0.16±0.11	0.24±0.12	0.02±0.01
c22:5n6	0.03±0.01	0.02±0.01	0.06±0.03	0.06±0.02	0.13±0.01	0.16±0.05	0.18±0.01	0.14±0.04	0.03±0.01
c22:5n3	0.05±0.04	0.04±0.01	0.06±0.03	0.01±0.00	0.01±0.01	0.03±0.02	0.05±0.02	0.03±0.02	0.01±0.01
c24:0	0.06±0.02	0.05±0.04	0.09±0.08	0.14±0.01	0.01±0.01	0.02±0.01	0.02±0.01	0.02±0.01	0.13±0.03
c22:6n3	0.06±0.06	0.03±0.02	0.10±0.10	0.01±0.01	0.01±0.01	0.01±0.01	0.01±0.01	0.03±0.01	0.03±0.01
c21:1	0.01±0.01	0.01±0.01	0.04±0.03	0.07±0.05	0.01±0.01	0.03±0.01	0.02±0.01	0.01±0.01	0.01±0.01
Σ saturated	18.24	18.27	21.95	18.89	18.66	19.09	17.38	17.86	21.65
Σ monounsaturated	52.61	53.33	51.55	54.33	52.85	62.71	64.97	63.54	61.37
Σ polyunsaturated	28.30	27.45	25.50	26.00	27.79	17.81	17.51	18.38	16.81
Not determined	0.85	0.95	1.00	0.78	0.70	0.39	0.14	0.22	0.17

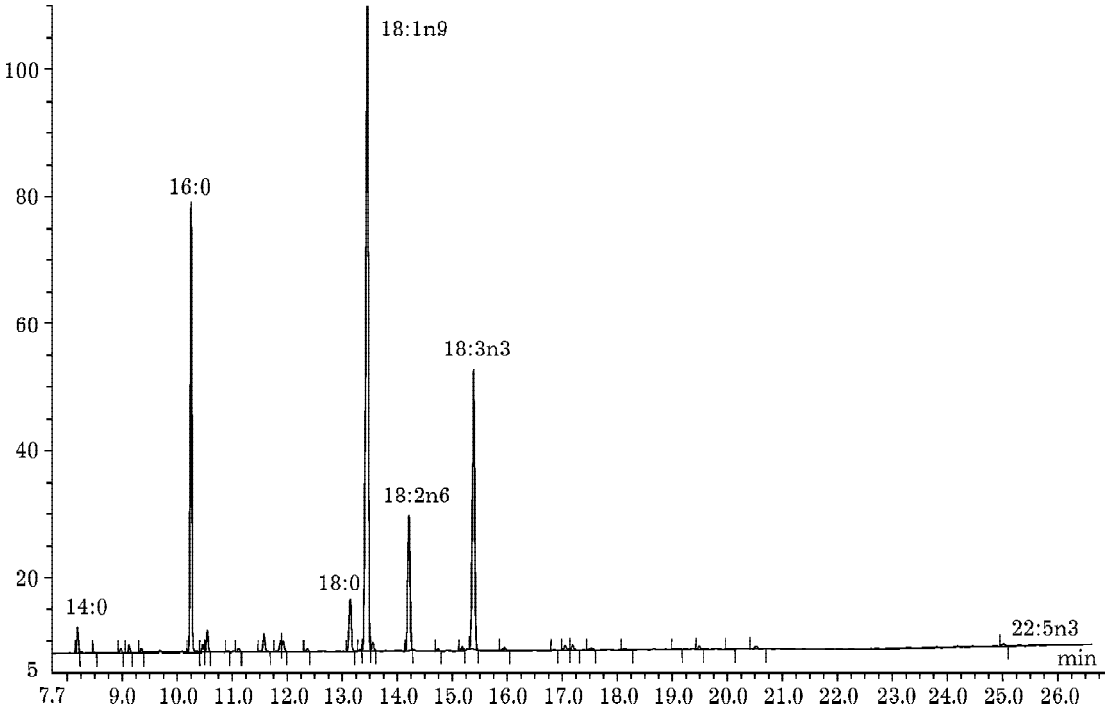

Fig. 1. Experimental chromatographic profile of tarbagan fat.

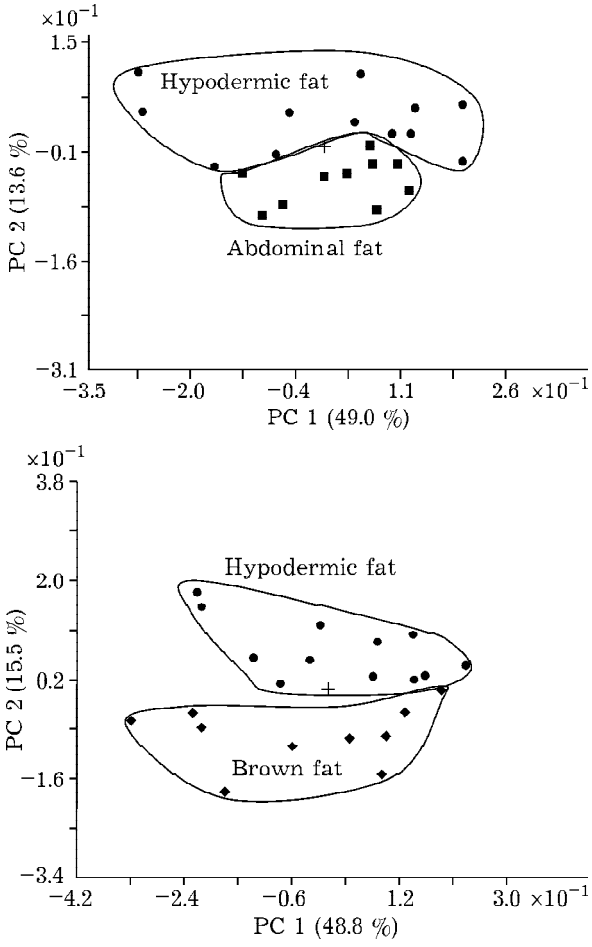

Fig. 2. Pots of the analysis of basic components of hypodermic, abdominal and brown tarbagan fat.

the fatty acids such as C16:0, C16:1n7, C18:1n9, C18:1n11, C18:2n6, C18:3n3 (Table 2, Fig. 1). An unusually high content of polyunsaturated fatty acids has been revealed non-inherent in the fat of the other land animals, which, to all appearance, could be caused by a seasonally occurring hibernation of marmots..

The data demonstrated in Table 2 were processed using a PC analysis method (the method of principle component analysis) that allows one to reveal the differences in the fatty acid composition of the fat kinds under investigation (Fig. 2, Table 2). It should be noted that the acid composition of brown fat distinctly differs from all the other fat varieties (see Fig. 2, Table 2) and exhibits a higher saturation level, which seems likely to be caused by its functioning as a basic mitochondrial "fuel" within the organisms of animals predisposed to hibernation [9].

CONCLUSION

The studies on a fatty acid composition of hypodermic, abdominal and brown fats of a marmot have revealed regular differences in the composition of the fats under investigation. A high unsaturation degree as well as the content

of irreplaceable acids indicates the tarbagan fat to be biologically active of and promising for its use as a medical product.

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