International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

The Chemical Composition and the Content of Macro- and Microelements in the Subproducts of Domesticated Reindeer in Yakutia

Nikolay Spiridonovich Robbek, Nikolay Vasilievich Vinokurov, Alexandra Innokentievna Pavlova, Lena Prokopyevna Koryakina, Natalya Nikolaevna Grigoryeva

Abstract*: *For the indigenous minorities of the far North, venison is the main environmentally safe food product. The study was aimed at determining the chemical composition, the weight, and the content of macro- and microelements in the subproducts of domesticated reindeer in Yakutia for further production of composite and functional food products, following the current ecological situation in the region. The subproducts of domesticated reindeer of the Chukchi and Evenki breeds are distinguished by the weight of the liver, the kidneys, the stomach, and the intestines; with that, the weight of subproducts in males was higher than in females. The comparatively high relative weight of internal organs in the reindeer of the Chukchi breed is associated with the better development of viability in the adverse conditions of the tundra habitat. Differences are observed within the content of nutrients in the subproducts in various age groups (females, males, and calves); this difference in the content of protein and fat is associated with the age-related feeding habits and the accumulation of nutrients in the organism of the deer. For instance, calves in this period feed on mother's milk; besides, the growing organism of a calf accumulates additional nutrients. The heart and the spleen of calves contain more macroelements (Ca, P, Mg, K, Na, and Cl) than those of male and female deer, while the kidneys, on the contrary, contain less macroelements. The content of microelements (Se, Fe, Mn, Cu, Zn, and F) in the heart and the spleen of calves is higher, and in the liver and the kidneys, it is lower.

Keywords*: *North, Yakutia, domesticated deer, chemical composition, subproducts, live weight, microelements, macroelements.

Manuscript published on November 30, 2019.
* Correspondence Author
Nikolay Spiridonovich Robbek*, Federal State Budgetary Scientific Institution "Yakut Research Institute of Agriculture named after M.G. Safronov", Yakutsk, Russian Federation.
Nikolay Vasilievich Vinokurov, Federal State-Funded Educational Institution of Higher Education "Yakut State Agricultural Academy", Yakutsk, Russian Federation.
Alexandra Innokentievna Pavlova, Federal State-Funded Educational Institution of Higher Education "Yakut State Agricultural Academy", Yakutsk, Russian Federation.
Lena Prokopyevna Koryakina, Federal State-Funded Educational Institution of Higher Education "Yakut State Agricultural Academy", Yakutsk, Russian Federation.
Natalya Nikolaevna Grigoryeva, Federal State-Funded Educational Institution of Higher Education "Yakut State Agricultural Academy", Yakutsk, Russian Federation.

I. INTRODUCTION

Reindeer have inhabited the Earth for about a million years. It is assumed that as a species, they evolved in the early ice age in the southern and temperate parts of North America. After that, their representatives widely spread in the North of North America, Asia, and Europe.

In the Russian Federation, the population of domesticated reindeer is 1.3 million animals, and the population of wild reindeer is 1.5 million animals. The population of reindeer is ranked first in the world's population of domesticated reindeer (more than half of the world's population). Reindeer are reared in the tundra, the forest-tundra, the mountain-taiga, and the taiga zones. Yakutia is one of the major reindeer-herding regions of Russia. Reindeer herding here has always featured high culture with the preserved system of keeping these animals in herds; the reindeer herders continuously roam with the herds throughout the year in the search for food [1 – 9].

This work was aimed at studying the content, the weight, the chemical composition, and the content of macro- and microelements in the subproducts of domesticated reindeer in Yakutia in the context of the gender and age groups for determining their nutritional value.

II. PROPOSED METHODOLOGY

A. General Description

The materials for studying the weight content, the chemical composition, and the content of macro- and microelements in the subproducts of domesticated reindeer by gender and age groups were obtained from the results of studying the averaged samples of the meat of the reindeer slaughtered in early December 2011 in the Oimyakon district of Yakutia.

B. Algorithm

Three deer of the best fatness were slaughtered in each age and gender group during the autumn deer recounting. The reindeer were kept in the natural climatic conditions of the mountain taiga zone, without additional nutrition. Samples were taken from each carcass, the content of micro- and macroelements was determined at the Laboratory of Biochemistry and Mass Analysis of the Yakut Research Institute of Agriculture on the SKANNER model 4250 IR analyzer. The weight of subproducts was determined on the SW-1 electronic weigher.

III. RESULT ANALYSIS

Reindeer subproducts as a food product take a significant place in the diet of the indigenous population. However, to date, their nutritional value has been insufficiently studied; therefore, the article presents the data about the nutritive value of the subproducts of Yakutia domesticated reindeer obtained in course of the authors' research.

The weight of subproducts. Table 1 shows the yield of subproducts of the Chukchi and Evenki reindeer according to A. P. Kokorin.

Table 1: The yield of Chukchi and Evenki reindeer subproducts, %

Gender	Age, years	n	Lungs	Heart	Liver	Kidneys	Stomach	Intestines	
								small	large
1. The yield of subproducts from calves									
Chukchi breed									
Males	0.5	24	0.91	0.91	1.31	0.31	2.22	0.85	0.75
	1.5	22	1.10	1.10	1.18	0.24	2.43	0.80	0.95
	0.5	25	0.76	0.76	1.17	0.23	2.10	0.79	0.65
Females	1.5	24	1.06	1.06	1.07	0.23	2.46	0.70	0.78
Evenki breed									
Males	0.5	27	1.12	1.12	1.22	0.28	2.15	0.85	0.69
	1.5	25	1.25	1.25	1.21	0.24	2.47	0.77	0.85
	0.5	26	0.89	0.89	1.11	1.21	1.98	0.81	0.60
Females	1.5	26	1.22	1.22	1.02	0.21	2.35	0.67	0.73
2. The yield of subproducts from adult reindeer									
Chukchi breed									
Males	2.5	32	1.51	1.00	1.46	0.21	2.73	0.72	0.86
	3.5	21	1.37	0.94	1.34	0.23	2.62	0.74	0.78
	2.5	24	1.52	0.91	1.49	0.23	2.83	0.78	0.77
Females	3.5	20	1.48	1.02	1.58	0.25	2.86	0.84	0.80
Evenki breed									
Males	2.5	23	1.57	0.88	1.38	0.19	2.49	0.67	0.78
	3.5	21	1.35	0.78	1.21	0.19	2.24	0.63	0.73
	2.5	22	1.55	0.82	1.29	0.21	2.63	0.70	0.72
Females	3.5	20	1.63	0.86	1.39	0.22	2.64	0.74	0.78

The subproducts from domesticated Chukchi and Evenki reindeer were studied. According to the A. P. Kokorin (1988), the calves of the Chukchi reindeer featured higher relative weight of the liver, the kidneys, the stomach, and the intestines, compared to the calves of the Evenki breed. With that, the weight of subproducts from males was higher than that from females (Table 2).

This regularity of the relative weight of subproducts was preserved until 1.5 and 2.5 years of age [3]. Such a comparatively high relative weight of internal organs in the reindeer of the Chukchi breed was associated with the better development of the viability in the adverse conditions of the tundra habitat. These peculiarities, in turn, improved the productive qualities of Chukchi reindeer.

From the subproducts of the Evenki breed, the authors studied the weight and the nutritional value of the heart, the liver, the spleen, and the kidneys.

Table 2 shows that the weight of the heart, the liver, the spleen, and the kidneys in females and males did not differ significantly, but in calves, the weight of these organs was lower due to the age difference.

Table 2: The weight of domesticated reindeer subproducts, kg

Group	Heart	Liver	Spleen	Kidneys
Female reindeer, n=3	0.90 ± 0.07	1.35 ± 0.04	0.18 ± 0.01	0.21 ± 0.01
Male reindeer, n=3	1.03 ± 0.04	1.37 ± 0.11	0.19 ± 0.01	0.21 ± 0.01
Calves, n=3	0.65 ± 0.04*	1.07 ± 0.04*	0.12 ± 0.01*	0.19 ± 0.01

** $P \leq 0.05$.*

The findings of the authors correspond to the results of the studies performed by A. D. Mukhachev et al. [3].

Chemical composition and energy value of the subproducts. Table 3 shows that the heart, the liver, the spleen, the kidneys of the reindeer are rich in proteins, fats, and carbohydrates. However, there are significant differences within the nutrient content in various age groups. For instance, the heart and the spleen of calves are richer in proteins, fats, and carbohydrates than the heart and the spleen of female and male deer, and are far superior to those organs in terms of energy value.

Table 3: The chemical composition and the energy value of domesticated reindeer subproducts by the gender and the age groups (wet weight)

Components	Unit of measurement	Heart	Liver	Spleen	Kidneys
Female reindeer, n=3					
Moisture	%	66.75 ± 3.67	59.81 ± 1.73	57.27 ± 6.24	58.61 ± 8.62
Protein	%	17.32 ± 0.87	19.31 ± 0.34	19.85 ± 1.62	19.52 ± 2.23
Fat	%	13.30 ± 2.19	18.27 ± 0.84	19.66 ± 4.04	19.12 ± 5.44
Carbohydrates	%	1.20 ± 0.26	1.79 ± 0.10	1.96 ± 0.49	1.85 ± 0.67
Ash	%	1.10 ± 0.05	1.22 ± 0.02	1.26 ± 0.09	1.23 ± 0.13
Energy value	kcal	222.82 ± 3.48	230.68 ± 4.70	264.21 ± 4.79	246.21 ± 6.26
Male reindeer, n=3					
Moisture	%	60.17 ± 3.83	58.10 ± 1.86	61.48 ± 3.26*	62.11 ± 2.67
Protein	%	18.95 ± 1.02	19.65 ± 0.48	18.77 ± 0.85	18.61 ± 0.69
Fat	%	17.36 ± 2.56	19.12 ± 1.21	16.93 ± 2.11	16.52 ± 1.73
Carbohydrates	%	1.68 ± 0.31	1.90 ± 0.14	1.63 ± 0.25	1.58 ± 0.21
Ash	%	1.20 ± 0.06	1.24 ± 0.03	1.19 ± 0.05	1.18 ± 0.04
Energy value	kcal	238.76 ± 1.02	258.28 ± 0.48	233.97 ± 0.85	229.44 ± 0.69
Calves, n=3					
Moisture	%	60.49 ± 0.50	59.07 ± 1.85	53.32 ± 6.66	65.64 ± 1.96
Protein	%	19.03 ± 0.13*	19.42 ± 0.45	20.88 ± 1.72*	17.54 ± 0.41
Fat	%	17.57 ± 0.32*	18.49 ± 1.20	22.22 ± 4.32*	13.84 ± 1.03
Carbohydrates	%	1.71 ± 0.04*	1.82 ± 0.14	2.26 ± 0.52*	1.26 ± 0.13
Ash	%	1.20 ± 0.01	1.22 ± 0.03	1.31 ± 0.10	1.11 ± 0.03
Energy value	kcal	241.09 ± 0.13*	251.37 ± 0.45*	292.54 ± 1.72*	199.76 ± 0.41*

** $P \leq 0.05$.*

The content of nutrients in the liver and the energy value of the liver do not significantly differ between the age groups.

The kidneys of calves are much poorer in nutrients, compared to the kidneys of female and male deer.

This difference in the content of protein and fat was determined by the age peculiarities of feeding and accumulation of nutrients in the organism of the deer. For instance, calves in this period are additionally fed with the mother's milk; besides the growing organism of a calf needs time to save up proteins, fats, and carbohydrates for the winter, which are the reserve nutrients, in the heart, the liver, and the spleen, since these organs serve as "depots" for reserve nutrients.

The content of macroelements. The results of studying the content of macroelements in reindeer subproducts are shown in Table 4.

Table 4: The content of macroelements in domesticated reindeer subproducts by the gender and age groups, mg/100 g

Components	Heart	Liver	Spleen	Kidneys
Female reindeer, n=3				
Calcium	11.98 ± 1.05	14.37 ± 0.40	15.03 ± 1.94	14.62 ± 2.68
Phosphorus	216.42 ± 17.49	256.15 ± 6.71	267.28 ± 32.33	260.33 ± 44.64
Magnesium	19.98 ± 1.31	22.96 ± 0.50	23.79 ± 2.43	23.27 ± 3.35
Potassium	266.44 ± 17.47	306.15 ± 6.71	317.30 ± 32.33	310.33 ± 44.64
Sodium	99.82 ± 13.12	129.61 ± 5.03	137.96 ± 24.25	132.75 ± 33.48
Chlorine	126.35 ± 22.74	177.99 ± 8.72	192.46 ± 42.03	183.43 ± 58.03
Male reindeer, n=3				
Calcium	13.93 ± 1.23	14.77 ± 0.58	13.72 ± 1.01	13.53 ± 0.83
Phosphorus	248.92 ± 20.48	262.96 ± 9.66	245.42 ± 16.89	257.34 ± 5.06
Magnesium	22.42 ± 1.54	23.47 ± 0.73	22.15 ± 1.27	21.91 ± 1.04
Potassium	298.92 ± 20.48	312.96 ± 9.65	295.42 ± 16.89	292.18 ± 13.86
Sodium	124.19 ± 15.36	134.71 ± 7.25	121.57 ± 12.67	119.14 ± 10.39
Chlorine	168.59 ± 26.62	186.83 ± 9.56	164.05 ± 21.96	160.83 ± 18.53
Calves, n=3				
Calcium	14.00 ± 0.15*	14.47 ± 0.57	16.26 ± 2.07*	12.25 ± 0.49*
Phosphorus	250.54 ± 2.59*	257.86 ± 9.53	287.73 ± 34.51*	220.74 ± 8.24*
Magnesium	22.54 ± 0.19*	23.09 ± 0.71	25.33 ± 2.59	22.74 ± 1.09*
Potassium	300.54 ± 2.59*	307.86 ± 9.53	304.40 ± 48.59	270.75 ± 8.24*
Sodium	125.40 ± 1.94*	130.90 ± 7.15	153.30 ± 25.89*	103.06 ± 6.18*
Chlorine	170.70 ± 3.37*	180.22 ± 12.39	219.06 ± 44.87	131.97 ± 10.72*

** $P \leq 0.05$.*

These data show that the calves' heart was richer in Ca — 14.00 mg/100 g, P — 250.54 mg/100 g, Mg — 22.54 mg/100 g, K — 300.54 mg/100 g, Na — 125.40 mg/100 g, Cl — 170.70 mg/100 g; and the spleen was richer in Ca — 16.26 mg/100 g, P — 287.73 mg/100 g, Na — 153.30 mg/100 g, Cl — 219.06 mg/100 g than the heart of female and male reindeer.

By the content of macroelements in the liver, there was no significant difference between the gender and age groups.

The kidneys of calves were poorer in Ca — 12.25 mg/100 g, P — 220.74 mg/100 g, Mg — 22.74 mg/100 g, K — 270.75 mg/100 g, Na — 103.06 mg/100 g, Cl — 131.97 mg/100 g than

those of female and male reindeer.

The content of microelements. The data in Table 5 show that

– the heart of calves was poorer in Se — 30.18 mg/100 g than the heart of female and male deer;

– the liver of calves was poorer in Fe — 13.05 mg/100 g, Mn — 66.83 mg/100 g, Cu — 333.56 mg/100 g, Zn — 12.85 mg/100 g, F — 207.53 mg/100 g, and richer in Co — 16.92 mg/100 g than the liver of female and male deer;

– the spleen of calves was richer in Fe — 16.50 mg/100 g, Mn — 83.12 mg/100 g, Cu — 414.98 mg/100 g, Zn — 16.40 mg/100 g, F — 252.68 mg/100 g, Se — 40.95 mg/100 g, and poorer in I — 94.28 mg/100 g, Co — 11.04 mg/100 g than the spleen of female and male deer;

– the kidneys of calves were poorer in microelements than the kidneys of female and male deer;

– in terms of the heavy metals in the spleen of calves, the content of Cd was 16.49 µg/100 g, and that of Hg was 7.25 µg/100 g, which was more than their content in the spleen of female and male deer;

– the kidneys of calves contained much less Hg — 3.72 mg/100 g, Pb — 15.26 mg/100 g than the kidneys of female and male deer;

– the content of microelements and heavy metals in the internal organs had no significant difference.

Table 5: The content of microelements in domesticated reindeer subproducts by the gender and age groups, 100 g (N. S. Robbek, 2011)

Components	Heart	Liver	Spleen	Kidneys
Female reindeer, n=3				
Iron, mg	12.07 ± 1.35	14.69 ± 1.38	14.63 ± 3.89	13.82 ± 4.31*
Manganese, µg	59.84 ± 4.12	74.59 ± 6.52	74.29 ± 1.83	70.47 ± 20.33
Copper, µg	298.79 ± 20.69	372.24 ± 32.52	370.74 ± 91.42	374.70 ± 98.48
Zinc, µg	11.77 ± 1.30	14.54 ± 1.42	14.47 ± 3.98	13.65 ± 4.42
Fluoride µg	184.51 ± 9.33	229.02 ± 18.07	228.19 ± 50.79	217.62 ± 56.35
Iodine, µg	110.47 ± 9.91	121.61 ± 7.23	121.28 ± 20.31	129.96 ± 15.75
Cobalt, µg	14.29 ± 1.91	15.53 ± 1.06	15.48 ± 2.99*	14.86 ± 3.31
Selenium, µg	31.44 ± 5.21	36.40 ± 3.47	36.24 ± 9.76	34.21 ± 9.83
Cadmium, µg	12.07 ± 1.35	14.69 ± 1.38	14.62 ± 3.89	13.82 ± 4.31
Mercury, µg	5.00 ± 0.43	6.42 ± 0.64	6.39 ± 1.79	6.01 ± 1.99
Lead, µg	18.45 ± 0.93	22.90 ± 1.81	27.10 ± 1.42	18.16 ± 1.83
Male reindeer, n=3				
Iron, mg	12.94 ± 2.99	15.07 ± 1.26	12.04 ± 1.97	10.88 ± 0.91
Manganese, µg	66.35 ± 14.12	76.39 ± 5.94	62.06 ± 9.30	56.61 ± 4.31
Copper, µg	331.11 ± 70.46	381.22 ± 29.65	309.76 ± 46.38	282.52 ± 21.48
Zinc, µg	12.75 ± 3.07	14.93 ± 1.29	11.82 ± 2.02	10.63 ± 0.94
Fluoride µg	206.18 ± 39.15	234.01 ± 16.47	194.31 ± 25.77	179.18 ± 11.94
Iodine, µg	112.47 ± 15.66	123.60 ± 6.59	107.73 ± 10.31	101.67 ± 4.77
Cobalt, µg	14.19 ± 2.30	15.83 ± 0.97	13.49 ± 1.51	12.60 ± 0.70
Selenium, µg	32.01 ± 7.52	37.36 ± 3.16	29.73 ± 4.95	26.82 ± 2.29
Cadmium, µg	12.94 ± 2.99	15.07 ± 1.26	12.03 ± 1.97	10.88 ± 0.91
Mercury, µg	5.61 ± 1.38	6.59 ± 0.58	5.19 ± 0.91	4.66 ± 0.42
Lead, µg	20.26 ± 3.91	23.40 ± 1.65	19.43 ± 2.58	17.92 ± 1.03
Calves, n=3				
Iron, mg	12.90 ± 1.08	13.05 ± 0.77*	16.50 ± 4.60*	8.85 ± 1.42*
Manganese, µg	66.13 ± 5.07	66.83 ± 3.63*	83.12 ± 2.68*	47.03 ± 6.68*
Copper, µg	330.01 ± 25.28	333.56 ± 18.11*	414.98 ± 10.96*	234.73 ± 23.34*

Zinc, µg	12.70 ± 1.10	12.85 ± 0.79*	16.40 ± 4.71*	8.55 ± 1.45*
Fluoride µg	205.56 ± 14.05*	207.53 ± 10.06*	252.68 ± 60.09*	152.63 ± 18.52*
Iodine, µg	90.47 ± 8.92	111.64 ± 5.23*	94.28 ± 10.31	97.05 ± 10.54*
Cobalt, µg	14.27 ± 0.59	16.92 ± 3.53*	11.04 ± 1.09	14.51 ± 2.01
Selenium, µg	30.18 ± 0.61	32.27 ± 1.93*	40.95 ± 1.55*	21.72 ± 3.56*
Cadmium, µg	12.89 ± 1.07*	13.04 ± 0.77*	16.49 ± 4.60*	8.85 ± 1.41*
Mercury, µg	5.59 ± 0.49*	5.66 ± 0.35*	7.25 ± 2.12*	3.72 ± 0.65*
Lead, µg	20.56 ± 1.40*	20.75 ± 1.01*	25.27 ± 5.01*	15.26 ± 1.85*

*$P \leq 0.05$.

IV. CONCLUSION

Differences are observed within the content of nutrients in the subproducts in various age groups (females, males, and calves); this difference in the content of protein and fat is associated with the age-related feeding habits and accumulation of nutrients in the organism of the deer. The heart and the spleen of calves contain more macroelements (Ca, P, Mg, K, Na, and Cl) than those of male and female deer, while the kidneys, on the contrary, contain less macroelements. The content of microelements (Se, Fe, Mn, Cu, Zn, and F) in the heart and the spleen of calves is higher, and in the liver and the kidneys, it is lower.

REFERENCES

1. A. F. Abramov, M. P. Neustroev, K. M. Stepanov, N. S. Robbek, “Myasnaya produktivnost i pishchevaya tsennost myasa domashnikh severnykh olenei Yakutii” [Meat productivity and the nutritional value of the meat of domesticated reindeer in Yakutia]: Handbook.Moscow: FSBEI SPES RAA AC, 2011.
2. A. F. Abramov, N. S. Robbek, G. N. Osipova, “Pishchevaya tsennost myasa olenei evenskoi porody Yakutii” [Nutritional value of the reindeer of the Evenki meat breed in Yakutia], Achievement of the science and technology in agriculture, vil. 10, 2010, pp. 51 – 52.
3. A. D. Mukhachev, L. A. Klopashikov, K. A. Layshev, Myasnaya produktivnost severnykh olenei [Reindeer meat productivity], Novosibirsk, 2001.
4. N. S. Robbek, “The content of macro- and microelements in the meat of domesticated reindeer on the example of the Yuchugeyskoye experimental production farm”, News of the Buryat State Academy of Agriculture, vil. 2, 2010, pp. 123 – 125.
5. N. S. Robbek, A. F. Abramov, Evenskaya poroda olenei Yakutii: myasnaya produktivnost, biologicheskaya i pishchevaya tsennost [Evenki reindeer in Yakutia: meat productivity, biological and nutritional value]: monograph, Novosibirsk: ANS Sibak Publishing House, 2017.
6. V. R. Kharzinova, A. A. Sermyagin, E. A. Gladyr, G. Brem, N.A. Zinovieva, I.M. Okhlopkov, “A study of applicability of snp chips developed for bovine and ovine species to whole-genome analysis of reindeer rangifer tarandus”, Journal of heredity, vol. 6 (106), 2015, pp. 758-761.
7. V.R. Kharzinova, A.V. Dotsev, I.M. Okhlopkov, K.A. Laishev, V.I. Fedorov, L.D.O. Shimit, G.G. Brem, K. Wimmers, H. Reyer, N.A. Zinoveva, “Genetic characteristics of semi-domesticated reindeer populations from different regions of Russia based on SNP analysis”, Journal of Dairy Science, vol. 1 (99), 2016, p. 162.
8. V.R. Kharzinova, A.V. Dotsev, I.M. Okhlopkov, E.A. Gladyr, V.I. Fedorov, G.G. Brem, N.A. Zinoveva, “Genetic diversity and population structure of wild and semi-domesticated reindeer (rangifer tarandus) inhabited in northeastern siberia based on single nucleotide polymorphism markers”, Journal of Animal Science, vol. 4 (94), 2016, pp. 110-111.
9. V.R. Kharzinova, T.V. Karpushkina, A.V. Dotsev, A.D. Soloveva, T.M. Romanenko, G.G. Brem, N.A. Zinoveva, “Association of microsatellite profile with phenotypic traits of semi-domesticated reindeer”, Journal of Animal Science, vol. 4 (95), 2017, pp. 105 – 106.