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Content and apparent ileal digestibility of protein and amino acids in diets fed to parent stock of farm-raised polar foxes (*Alopex lagopus* L.)

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Abstract: This study aimed to compare content and apparent ileal digestibility of protein and amino acids in diets used over 1 year (4 feeding periods) on 2 farms of reproductive polar foxes (A and B). Two diets (1 from farm A, 1 from farm B) from the same feeding period were tested in succession (4 eight-day digestibility experiments) on 5 polar foxes with 'end-to-end' ileorectal anastomosis. The main protein sources were poultry, fish, and beef offal in diets A and beef offal in diets B. In diets A, considerably higher content of protein and total essential and nonessential amino acids was found. In each feeding period, diets B had higher ($P < 0.05$) digestibility of protein and amino acids including sulfur-containing amino acids. Methionine was the amino acid of the highest digestibility in diets A and arginine in diets B. In the diets from both farms, high digestibility was noted for histidine, lysine, phenylalanine, glutamic acid, and proline. The lowest digestibility was recorded for cystine. Too high a content of ash in diets A reduced ($P < 0.05$) digestibility of protein and amino acids. Diversified composition of feeds for polar foxes provides a definitely higher supply of digestible protein and amino acids.

Key words: Polar fox, farm feeding, ileal digestibility, amino acids

1. Introduction

Diets adequate for carnivorous fur-bearing animals should supply highly digestible protein in order to meet the physiological requirements of maintenance and other biological functions such as reproduction, lactation, growth and development, and fur production (1). Fur animals show a particularly high requirement for sulfur-containing amino acids (AA) such as methionine and cystine, which, for them, are the first limiting AAs conditioning all the above-mentioned processes (2,3). Furthermore, according to current knowledge, histidine, threonine, tryptophan, and lysine are the AAs of great importance for polar foxes; therefore, their shortage can result in severe reductions in performance (3).

It is generally known that total amounts of protein and AAs in most feedstuffs are not equal to the amounts that are available for the animals. Although digestibility does not mean the same as availability, digestibility studies have become the most favorite technique for estimating AA availability in different animal species (4). The previous research on polar foxes and mink revealed that, depending on the source of dietary protein, the apparent digestibility of nitrogen and AAs determined in digesta from the terminal part of the small intestine was lower (even by several percentage units) compared to the apparent digestibility measured in feces (5,6). According to Szymeczko et al. (6), the total tract digestibility method informs only about the final effect of protein digestion; it does not give a view on the changes of AAs that occur in the large intestine as a result of its bacterial microflora activity and, therefore, may overestimate the amounts of AA absorbed from the digestive tract in dogs, mink, and foxes. It was documented that the lower the digestibility of dietary protein is in the small intestine, the more protein is available for fermentation in the hind-gut and, thus, a larger difference between ileal and total tract digestibility will occur (7). Since low-quality protein is often used as a basic component of feeds for farm-raised polar foxes, the ileal digestibility method should be applied for determining the digestibility of protein and AAs in this species (7,8).

The aim of the present study was to compare the content and apparent ileal digestibility of protein and AAs

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in diets used in a 1-year-long feeding period of parent stock of polar foxes on 2 domestic farms.

2. Materials and methods

2.1. Experimental animals

The digestibility experiments included 5 one-year-old male polar foxes from the same litter and of a similar body weight (6.18 ± 0.15 kg). After veterinary examination, 'end-to-end' ileorectal anastomosis (IRA method) was surgically applied following the method previously described by Szymeczko (8). Foxes were housed individually in metabolic cages in a thermally controlled room (16–18 °C). The experiment was carried out with permission from the local ethics committee in Bydgoszcz and experimental procedures followed the Polish protocols of ethical standards for the use of live animals.

2.2. Experimental diets and sampling procedures

In the digestibility experiments, diets from 2 domestic reproductive farms of polar foxes were tested: farm A (diets A1, A2, A3, A4) and B (B1, B2, B3, B4). These farms differed with reproduction results in the seasons preceding the digestibility experiment: farm A with 8.1 kits per female and farm B with 1.0 kit per female. Four series of digestibility experiments were carried out in the terms corresponding to 4 farm-feeding periods: regeneration after reproduction (15 July–15 September, diets: A1, B1), winter fur development (15 September–1 December, diets: A2, B2), gestation (1 December–15 May, diets: A3, B3), and lactation (15 May–15 July, diets: A4, B4). The ready-made diets were transported frozen from the farms, mixed with 5 g kg^{-1} of chromic oxide (Cr_2O_3) used as an inert marker for digestibility calculations, homogenized, divided into daily rations (376.81 kJ metabolizable energy (ME) kg^{-1} of the body weight) (1) and kept frozen (–25 °C) until the start of the digestibility experiments (8). During the investigations, the animals were fed once a day at 0800 hours and had free access to water at all times.

In each experimental period, 2 diets (1 from farm A and 1 from farm B) from the same feeding period were tested in succession. In total, 4 digestibility experiments were carried out, each on 5 polar foxes. The examination of each diet lasted for 8 days, a 4-day adaptation period, and a 4-day period with the total collection of ileal digesta. During the collection period, all the experimental digesta from each fox was immediately collected after excretion and stored at –25 °C before analysis. After the termination of the experiment, frozen experimental diets and digesta were weighted, freeze-dried, ground, and sifted for removal of hair before chemical analysis.

2.3. Chemical analyses

Diets and freeze-dried samples of digesta were analyzed for dry matter (DM) (95–100 °C for 5 h), crude protein (Kjeldahl - N × 6.25), ash (600 °C for 2 h), and crude fiber according to the methods of the AOAC (9). The crude fat content was determined (after HCl hydrolysis by TECATOR Soxtec Hydrolyzing Unit) with the use of the Soxhlet method, according to the application notes for the Soxtec System HT6 apparatus. The content of AAs in the hydrolyzed samples of diets and ileal digesta was determined with the use of the AA analyzer Beckman 6300 with integration according to the "GOLD" system. The samples were hydrolyzed in 6 N HCl for 22 h at 110 °C. To protect methionine and cystine during hydrolysis, the samples were oxidized with performic acid and afterwards determined according to the modified method of Moore (10). Tryptophan was analyzed after alkaline hydrolysis with barium hydroxide according to the method of Buraczewska and Buraczewski (11). Cr_2O_3 in feed and digesta samples was estimated by the method described by Kimura and Miller (12).

2.4. Calculations and statistical analysis

The content of N-free extractives was calculated by difference: dry matter – (crude protein + crude fat + crude fiber + crude ash). ME of diets was calculated with the use of factors of 18.8 kJ g^{-1} digestible protein, 39.8 kJ g^{-1} digestible fat, and 17.6 kJ g^{-1} digestible carbohydrate (13). The results obtained were verified statistically with Student's t-test for dependent samples with the use of the Statistica software. The level of significance was set at $P < 0.05$.

3. Results

The diets used on farm A in every feeding period contained different animal offal (poultry, fish, beef) and extruded cereals, while those on farm B contained only fatty beef offal (65%–78%) and ground barley (22%–35%) (Table 1). Over the nonmating period, the main component of diets A was poultry offal (42%–44%), while over the reproduction period fish offal predominated (43%–50%).

The chemical composition of the experimental farm feeds is reported in Table 2. In all feeding periods, the diets used on farm A had a higher level of DM, which was especially marked in the nonmating period. Diets A also had higher contents of crude protein (diets A: 124–129 and B: 77–107 g kg^{-1}) and N-free extractives. The content of crude fat was on a comparable level in diets from the nonmating period on both farms, while in the reproduction period the fat content was 2 times higher in diets B (diets B: 79.1–103 and A: 43.9–48.4 g kg^{-1}). Despite the differences in dietary fiber content, its level in diets A and B did not exceed the recommended amounts (2). The most pronounced differences were found in ash content, which was about 2.9-fold (gestation) to 4.9-fold (regeneration after reproduction) higher in diets A than in diets B. In each feeding period, the total essential amino

Table 1. Composition of diets fed to polar foxes on farm A and B over respective feeding periods (g kg^{-1} as fed basis).

Ingredients	Feeding period							
	Nonmating period				Reproduction period			
	Regeneration after reproduction		Winter fur development		Gestation		Lactation	
	A1	B1	A2	B2	A3	B3	A4	B4
Beef offal	-	699	-	783	165	700	143	650
Poultry offal	420	-	440	-	165	-	214	-
Fish offal	299	-	294	-	496	-	428	-
Meat meal	70	-	74	-	-	-	-	-
Fish meal	-	-	-	-	33	-	43	-
Blood and feathers meal	-	-	29	-	-	-	-	-
Milk powder	20	-	10	-	17	-	29	-
Rapeseed oil	-	-	12	-	-	-	-	-
Extruded cereals	150	-	89	-	122.5	-	141.5	-
Precooked barley	-	300	-	216	-	298.5	-	348.5
Fiber additive (lucerne meal, wheat bran)	40	-	22	-	-	-	-	-
Vegetables	-	-	29	-	-	-	-	-
Vit.-min. mix.[1]	1	0.5	1	0.5	1	1	1	1
Iron preparation[2]	-	0.5	-	0.5	0.5	0.5	0.5	0.5

[1]Concentration per 1 g: vit. A 3500 IU; D_3 500 IU; E 28 mg; K_3 0.2 mg; B_1 1.5 mg; B_2 2.8 mg; B_6 2.8 mg; B_{12} 0.02 mg; H 0.2 mg; folic acid 0.2 mg; PP 10 mg; calcium pantothenate 7 mg; methionine 200 mg; choline chloride 50 mg; Fe 17 mg; Zn 2 mg; Cu 1 mg; Mn 1 mg; Co 1 mg; J 0.1 mg; Se 0.6 mg.
[2]Concentration in 1 mL of preparation: liver extract 543 mg; ferrous sulfate 75 mg; manganese sulfate 3.5 mg; cupric sulfate 3.5 mg; cobalt chloride 1.5 mg.

acid (TEAA) and total nonessential amino acid (TNEAA) contents were higher in diets used on farm A. Among the essential AAs, arginine, leucine, and lysine predominated (46%–49% TEAA) in the diets used on both farms. Diets from farm A were considerably higher in methionine content (diets A: 2.0–2.8 and B: 1.1–1.7 g kg^{-1}). Among the dietary nonessential AAs, glutamic acid, glycine, aspartic acid, and proline predominated (72%–74% TNEAA) in all diets.

In every feeding period, the diets used on farm B had a significantly ($P < 0.05$) higher digestibility of protein, TEAA, and TNEAA (Table 3). The AA of the highest ileal digestibility was methionine in diets A (86.4%–91.6%) and arginine in diets B (93.4%–95.9%). Among the essential AAs, histidine, lysine, and phenylalanine had high digestibility coefficients in diets used on both farms. Among the nonessential AAs, the highest digestibilities were noted for tyrosine, glutamic acid, alanine, and proline in diets A and for glycine, proline, and glutamic acid in diets B. The definitely lowest ileal digestibility was recorded for cystine (diets A: 60.5%–77.4% and B: 69.1%–79.3%). Threonine and tryptophan also had low ileal digestibility coefficients for all the experimental diets. In every feeding period, TEAA had higher ileal digestibility compared to TNEAA (81.5%–92.1% and 76.0%–90.9%, respectively) regardless of the diet used.

4. Discussion

Polar fox, as a canine carnivore, needs diets with a high concentration of energy and nutrients. To meet its nutritional requirements, as well as to achieve high-quality fur and satisfactory reproduction results, it is

Table 2. Chemical composition (g kg^{-1} as fed basis) and metabolizable energy (ME) (kJ g^{-1}) content in diets fed to polar foxes on farm A and B over respective feeding periods.

Nutrients	Feeding period							
	Nonmating period				Reproduction period			
	Regeneration after reproduction		Winter fur development		Gestation		Lactation	
	A1	B1	A2	B2	A3	B3	A4	B4
Dry matter	333	218	327	244	288	243	287	279
Crude protein	124	76.9	129	105	124	98.0	128	107
Crude fat	73.9	52.7	72.7	75.5	43.9	79.1	48.4	103
Crude fiber	5.1	9.0	5.7	4.5	5.0	6.0	4.0	8.3
N-free extractives	72.0	67.3	64.8	45.1	79.3	47.9	47.4	42.6
Ash	57.9	11.7	52.1	13.7	35.6	12.1	59.1	17.0
ME	5.44	4.02	5.30	5.23	4.69	5.21	4.41	6.35
ME distribution (%) from								
Protein	34	31	34	34	43	31	46	29
Fat	50	50	51	56	35	59	42	63
Carbohydrates	16	19	15	10	22	10	12	8
Essential AAs								
Arginine	7.4	4.9	8.6	6.9	8.0	6.6	8.5	6.8
Histidine	2.9	1.8	3.0	2.5	2.7	1.9	2.5	2.1
Isoleucine	4.2	2.6	4.7	3.5	4.7	3.0	4.3	3.3
Leucine	8.1	5.2	9.2	7.3	8.8	6.3	7.8	6.9
Lysine	6.2	4.1	6.4	6.0	7.4	5.6	7.7	6.1
Methionine	2.0	1.1	2.1	1.6	2.6	1.7	2.8	1.7
Phenylalanine	4.8	3.1	5.6	4.2	4.7	3.6	4.4	3.8
Threonine	4.6	2.8	5.1	3.9	4.8	3.5	4.5	3.8
Tryptophan	0.9	0.6	1.0	0.8	1.1	0.9	1.0	0.9
Valine	5.7	3.7	6.9	5.1	5.7	4.4	5.2	5.0
Nonessential AAs								
Alanine	9.0	5.4	9.3	7.6	8.8	7.0	8.6	7.6
Aspartic acid	10.6	6.6	11.5	9.2	11.1	8.5	11.1	9.0
Cystine	1.1	0.9	1.9	1.2	1.2	1.2	1.2	1.1
Glutamic acid	16.9	10.9	18.6	14.3	17.4	12.7	17.5	13.3
Glycine	13.5	8.6	14.5	12.5	12.8	12.1	14.1	12.2
Proline	9.0	6.1	10.7	8.2	8.6	8.0	8.6	7.7
Serine	4.8	3.2	6.7	4.4	5.8	4.1	5.3	4.2
Tyrosine	2.8	2.0	3.2	2.7	3.1	2.5	3.1	2.7
TEAA[1]	46.8	29.9	52.6	41.8	50.5	37.5	48.7	40.4
TNEAA[2]	67.7	43.7	76.4	60.1	68.8	56.1	69.5	57.8
TAA[3]	114.5	73.6	129.0	101.9	119.3	93.6	118.2	98.2

[1]TEAA = total essential amino acids; [2]TNEAA = total nonessential amino acids; [3]TAA = total amino acids.

Table 3. Apparent ileal digestibility (mean ± SD, %) of protein and amino acids in diets fed to polar foxes on farms A and B over respective feeding periods.

Nutrients	Feeding period							
	Nonmating period				Reproduction period			
	Regeneration after reproduction		Winter fur development		Gestation		Lactation	
	A1	B1	A2	B2	A3	B3	A4	B4
Protein	78.3^{a} ± 1.2	86.4^{b} ± 0.5	74.6^{a} ± 2.2	90.6^{b} ± 0.7	85.0^{a} ± 1.4	88.8^{b} ± 0.7	83.6^{a} ± 1.2	90.8^{b} ± 0.7
Essential AAs								
Arginine	85.2^{a} ± 2.2	93.4^{b} ± 0.6	86.0^{a} ± 2.5	95.9^{b} ± 0.5	89.6^{a} ± 1.4	95.0^{b} ± 0.3	86.9^{a} ± 1.0	95.1^{b} ± 0.6
Histidine	87.1^{a} ± 1.3	90.8^{b} ± 0.8	84.4^{a} ± 0.7	94.2^{b} ± 0.6	89.9 ± 1.1	89.3 ± 0.5	88.5^{a} ± 0.7	91.4^{b} ± 0.6
Isoleucine	84.0 ± 1.0	86.4 ± 1.1	82.2^{a} ± 1.0	91.3^{b} ± 1.0	90.1 ± 0.9	90.3 ± 0.2	88.8^{a} ± 0.7	91.1^{b} ± 0.6
Leucine	82.3^{a} ± 1.0	85.9^{b} ± 1.3	80.7^{a} ± 1.1	91.3^{b} ± 1.2	90.5^{a} ± 0.8	91.7^{b} ± 0.5	88.5^{a} ± 0.6	92.7^{b} ± 0.6
Lysine	81.9^{a} ± 1.5	89.6^{b} ± 1.1	79.9^{a} ± 1.5	94.2^{b} ± 0.6	90.3^{a} ± 0.7	93.2^{b} ± 0.2	89.1^{a} ± 0.8	93.4^{b} ± 0.4
Methionine	88.1 ± 2.0	89.5 ± 0.5	86.4^{a} ± 1.8	93.3^{b} ± 0.8	91.6^{a} ± 0.5	92.7^{b} ± 0.4	90.8^{a} ± 0.6	93.2^{b} ± 1.3
Phenylalanine	82.9^{a} ± 1.0	88.6^{b} ± 1.0	82.3^{a} ± 1.4	92.8^{b} ± 0.8	90.4^{a} ± 0.8	92.7^{b} ± 0.2	88.4^{a} ± 0.6	93.4^{b} ± 0.5
Threonine	78.8 ± 1.1	81.8 ± 1.8	77.4^{a} ± 0.9	88.9^{b} ± 1.6	86.2 ± 1.6	85.7 ± 1.1	84.3^{a} ± 1.0	88.3^{b} ± 1.3
Tryptophan	77.2^{a} ± 1.2	81.8^{b} ± 1.5	75.5^{a} ± 2.6	87.2^{b} ± 1.3	87.2 ± 1.7	88.7 ± 1.6	86.1^{a} ± 1.1	90.7^{b} ± 0.6
Valine	82.9^{a} ± 0.9	87.2^{b} ± 1.1	80.0^{a} ± 1.6	91.5^{b} ± 1.1	88.9^{a} ± 0.9	90.1^{b} ± 0.4	87.0^{a} ± 0.6	91.2^{b} ± 0.8
Nonessential AAs								
Alanine	82.4^{a} ± 1.8	89.4^{b} ± 0.8	79.4^{a} ± 2.7	93.1^{b} ± 0.8	87.5^{a} ± 1.6	91.9^{b} ± 0.4	83.8^{a} ± 1.2	91.9^{b} ± 0.7
Aspartic acid	76.8^{a} ± 1.6	87.3^{b} ± 1.1	71.1^{a} ± 1.3	91.7^{b} ± 0.9	86.4^{a} ± 1.3	90.2^{b} ± 0.5	83.4^{a} ± 0.9	91.3^{b} ± 0.7
Cystine	60.5^{a} ± 3.9	69.1^{b} ± 2.3	62.6^{a} ± 3.2	79.3^{b} ± 2.8	76.3 ± 2.9	76.8 ± 1.5	77.4 ± 2.1	76.0 ± 7.8
Glutamic acid	82.1^{a} ± 1.1	90.0^{b} ± 0.9	78.7^{a} ± 1.1	93.4^{b} ± 0.7	89.4^{a} ± 1.0	92.1^{b} ± 0.5	87.0^{a} ± 0.9	92.6^{b} ± 0.7
Glycine	77.9^{a} ± 2.7	92.2^{b} ± 0.6	78.0^{a} ± 3.4	95.0^{b} ± 0.8	85.2^{a} ± 2.5	93.9^{b} ± 0.4	80.6^{a} ± 1.7	94.2^{b} ± 0.7
Proline	79.4^{a} ± 2.3	90.7^{b} ± 0.7	79.7^{a} ± 2.6	94.0^{b} ± 0.9	86.2^{a} ± 2.4	92.7^{b} ± 0.4	81.3^{a} ± 1.3	93.2^{b} ± 0.7
Serine	77.6^{a} ± 1.0	84.7^{b} ± 1.4	77.4^{a} ± 1.2	90.3^{b} ± 1.3	86.6 ± 1.2	88.1 ± 0.8	84.9^{a} ± 1.0	89.2^{b} ± 1.2
Tyrosine	83.1^{a} ± 1.0	88.4^{b} ± 1.0	81.5^{a} ± 1.7	91.9^{b} ± 1.0	87.4 ± 1.0	87.8 ± 0.4	86.7^{a} ± 0.7	89.3^{b} ± 0.7
TEAA[1]	83.0^{a} ± 1.0	87.5^{b} ± 1.0	81.5^{a} ± 1.4	92.1^{b} ± 0.9	89.5^{a} ± 0.9	90.9^{b} ± 0.4	87.8^{a} ± 0.7	92.0^{b} ± 0.6
TNEAA[2]	77.5^{a} ± 1.5	86.5^{b} ± 1.0	76.0^{a} ± 1.9	90.9^{b} ± 1.2	85.6^{a} ± 1.4	89.2^{b} ± 0.6	83.1^{a} ± 1.0	89.7^{b} ± 1.5
TAA[3]	80.6^{a} ± 1.2	87.0^{b} ± 1.0	79.1^{a} ± 1.6	91.6^{b} ± 1.0	87.8^{a} ± 1.1	90.3^{b} ± 0.5	85.7^{a} ± 0.9	91.0^{b} ± 1.0

$^{a, b}$: Mean values in the same feeding period and in the same row with different superscripts are significantly different ($P < 0.05$).
[1]TEAA = total essential amino acids; [2]TNEAA = total nonessential amino acids; [3]TAA = total amino acids.

necessary to provide properly balanced diets containing highly digestible protein and available AAs, mainly sulfur containing AAs (1,2,13). Farm-raised polar foxes are usually fed conventional wet diets composed of raw animal by-products, the nutritive value of which differs greatly on different farms depending on the ingredients used for diets' formulations. In the present study, the diets used on 2 domestic breeding farms during the whole year (1 breeding cycle) were compared. The composition of diets used on farm A was diversified and their content of nutrients (except for ash) and energy met the requirements of reproductive polar foxes. The diets used on farm B were completely unbalanced in terms of ME (excessive concentration of ME from fat and insufficient in its level from protein and carbohydrates) and nutrient concentrations and, especially in the gestation and lactation periods, did not cover nutrient requirements of polar foxes parent stock (1,13), which could be one of the reasons for poor reproductive results observed on this farm.

Different content and quality of dietary protein used in the feeds on the experimental farms were clearly reflected in the level and composition of dietary AAs. It must be stressed that the knowledge of AA requirements for polar foxes is very limited. According to Jarosz (2), diets A fully covered nutritional requirements of polar foxes for methionine, cystine, and tryptophan, whereas diets B turned out to be seriously deficient in sulfur-containing AA and tryptophan, which was especially marked in the reproduction period. It is documented that the deficiency of these AAs negatively influences metabolic processes, proper growth and health of animals, formation of winter fur, and reproduction performance (3).

In the present study, in spite of the recommended levels of protein and variety of protein sources in diets A, significantly higher protein digestibility coefficients in all feeding periods were determined for the diets used on farm B. It may have been caused by the 2.9- to 4.9-fold higher content of crude ash in diets A than in diets B. Overly high contents of ash in feed, exceeding nutritional requirements, decreases the digestibility of organic substances, protein, fat, and fatty acids, negatively influencing the concentration of ME in the diets for carnivorous fur animals (14,15). Digestibility coefficients for protein were the lowest for the diets used on farm A during the nonmating period, which could be attributed not only to the high level of ash in these diets but also to the processing temperature used to prepare the protein source (animal meals) (6,16,17).

A nutritive value of dietary protein depends on the availability of its AAs. In the present experiment, both essential and nonessential AAs had significantly lower digestibility in the diets used on farm A, which was, like in case of protein, most probably caused by an overly high content of dietary ash. It should be mentioned that in spite of significantly lower digestibility coefficients in diets with different animal offal, the calculated content of digestible protein and digestible AAs was considerably higher than in diets in which beef offal was the only source of protein (data not presented). To the end of the small intestine, high digestibility was found for arginine and methionine, as well as for histidine, lysine, phenylalanine, glutamic acid, and proline, which is in agreement with earlier investigations on ileally cannulated dogs and polar foxes (6–8,16,18,19). In the present research, the lowest availability in the small intestine was detected for cystine. Moreover, threonine and tryptophan also had relatively low digestibility coefficients to the end of the small intestine regardless of the diet. Similar results were also noted previously in experiments on foxes (6–8,18), mink (5), and dogs (19,20). In all the diets examined in the present study, TEAA had higher ileal digestibility coefficients compared to TNEAA, which confirms results obtained earlier in foxes (7,8) and dogs (19,20). This could result from the fact that protein of endogenous origin is not digested as rapidly as dietary protein (5,8). Since apparent digestibility was measured in the present study, the low digestibility coefficients for cystine and threonine could have resulted from large amounts of these AAs in the endogenous secretions, as was demonstrated previously in polar foxes (18) and mink (5).

The results of this study clearly show that the feeds used on farms of reproductive polar foxes vary considerably with regard to their nutritional value. It has been confirmed that an excessively high content of dietary ash significantly reduces the apparent ileal digestibility of dietary protein and AA. Moreover, diversified composition of feeds used in polar fox feeding provides a higher supply of digestible protein and AAs, including limiting AAs. It can be assumed that too low a content of digestible protein and essential AAs in diets used on farm B could be one of the reasons for the unsatisfactory reproductive results obtained on this farm.

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