Characteristics of fatty acid composition of non-traditional feeds used in modern diets of young mink and its effect on the growth of young

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Abstract. From 2010 to 2015, a short-haired mink from Denmark and Poland was imported to the Savvatievo Animal Farm, which is larger in size compared to the domestic one. To preserve and further increase the size of the mink, in addition to breeding work, the feeding standards were revised. Since 2010, new non-traditional feeds have been introduced into the diet of animals, the nutritional value of which is not known yet, the caloric content in 2015-2017 was increased to 165-170 kcal and by 2018-2021 it was brought to 180 kcal per 100 g of feed while at the same time gradually reducing the amount of protein: in 2015-2017 to 7.5 g and in 2018-2021 to 6.5-7.0 g per 100 kcal of feed for young animals during the growth period (July-October). Feed with a high fat content is introduced. In this regard, it was decided to conduct a detailed analysis of some non-traditional feeds by fatty acid composition and determine the effect of the introduction of these feeds on the growth of young animals.

1 Introduction

One of the most important conditions for improving the productive qualities of farm animals is scientifically based feeding. The main nutrients are protein, fat, and carbohydrates. An exceptional role in feeding fur-bearing animals belongs to fats, the sources of which are animal and vegetable feeds. When compiling diets for fur-bearing animals, fat is considered as a source of energy. Fats have long been judged by their amount in products, without taking into account the fatty acid composition and the effect of individual fatty acids on metabolism. Since the second half of the twentieth century, their role in the structure and function of biological membranes, in the formation of hormones, prostaglandins, and some other biologically active compounds has been revealed [1]. Diets enriched with fats are biologically and economically effective, they can reduce the deficient protein of animal origin. Their use as part of animal diets can significantly increase the intensity of growth, reduce feed costs per unit of production and, equally important for the consumer, improve the quality of the obtained products [2]. However, the biological role of fats is determined by the content of fatty acids in them, especially polyunsaturated ones. When studying the mechanism of action

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of polyunsaturated fatty acids, it was found that they act as precursors in the biosynthesis of fatty acids that are part of the structural lipids of the body. At the same time, it turned out that linoleic acid is actually indispensable for mammals. However, their ratio is more important rather than the content of fatty acids in the diet.

Over the last 20 years, the composition of diets for fur-bearing animals has changed, instead of muscle meat and whole fish, poultry and fisheries waste and many other non-traditional feeds are fed. The question of the fatty acid composition in non-traditional feeds used in modern mink diets has not been studied; therefore, this work is devoted to the study of the composition of fatty acids in new feeds.

Fats or lipids are organic substances that consist of triglycerides and lipoid substances. Triglycerides, in turn, consist of glycerol and fatty acids (FA), and lipoid substances from phospholipids, sterols, and other compounds of a lipid nature.

The carbon chain is the basis of the FA molecule. On one side of this chain is a carboxyl (acid) group (COOH), on the other a methyl group (CH3). In different fatty acids, the number of carbon atoms, as well as the presence of double bonds between them, is different.

All organic substances have biochemical names, but for brevity in FA it is customary to use numerical designations based on the number of carbon atoms in the chain, as well as the number and position of double bonds. For example, oleic acid is 18:1 because it has 18 carbon atoms and one double bond.

FAs are classified as saturated and unsaturated.

Saturated FAs are distinguished by the absence of double bonds between carbon atoms (palmitic, stearic, myristic, etc.).

FAs with double bonds are called unsaturated, while the presence of two or more bonds FAs are called polyunsaturated. Polyunsaturated fatty acids (PUFAs) are mainly found in: soybean oil, fatty fish and chicken fat [3].

In recent years, the physiological role of individual polyunsaturated fatty acids (PUFAs), including linolenic acid (18:3), which among the essential fatty acids in terms of relative biological activity, although inferior by 8-10 times to linoleic acid (18:2) and 14-15 times to arachidonic acid (20:4), has undergone serious revision. It is the ancestor of PUFAs with a long carbon chain such as eicosapentaenoic (20:5) and docosahexaenoic (22:6), which by their chemical structure are united in the Omega-3 family, and by their biological properties are acids that prevent the development of some lipid metabolism disorders in humans and animals, especially atherosclerosis and coronary heart disease [4]. They are the precursors of prostaglandins. Linoleic, γ-linolenic, and arachidonic acids are part of the Omega-6 family. The beneficial effect of Omega-3 family acids is most pronounced with an optimal ratio in the diet with Omega-6 family acids [5-7].

According to the Institute of Nutrition of the Russian Academy of Medical Sciences, the ratio of Omega-6/Omega-3 in the diet for a healthy person should be 10:1, for therapeutic nutrition — from 3: to 5:1. They are not synthesized in the body, they are obtained only from feed. For adult fur-bearing animals, according to Danish scientists, their ratio should be represented in the known ratio Omega-6/Omega-3 1.5-3.5 :1, and during the growth period 4-8:1 [8]. In China, when conducting a study of the effect of different ratios of Omega-6/Omega-3 fatty acids, it was revealed that during the hair-covering formation, the silver fox assimilates and uses feed fats best at a ratio of these PUFAs 18:1[5].

In addition, the lack of Omega-3 leads to disorders in the structure of the hair and skin pathologies, such as dullness and fragility of the hair, dryness and skin exfoliation, as well as liver dystrophy [9-11]. Since the main product of animal husbandry is a large and beautiful pelt, the question of the quality of hair and skin is one of the first places. In addition to getting a good pelt, the fur breeder needs to grow and maintain a clinically healthy breeding herd.

However, the rationing of fatty acids in animal husbandry is hampered by the lack of reliable data on their content in the feeds used today, since the composition of diets has changed a lot over the last 10-15 years: whole fish and muscle meat have been replaced by cheaper protein sources, such as fish, chicken waste and meat and bone by-products. At the same time, to maintain the intensity of growth of young animals, it is recommended to keep the caloric content of 100 g of feed at the level of 140-180 kcal due to the addition of fat in the summer and autumn periods [12-14]. To do this, in addition to protein feeds, whole fats of vegetable (sunflower oil) and animal (chicken, pork fat) origin and carbohydrate feeds (gluten, industrial waste, etc.) are added to the diets. The use of vegetable fats greatly increases the cost of production, so their use in diets is minimal. At the same time, the source of fat among meat-and-bone, fish and chicken by-products, the most saturated with polyunsaturated fatty acids, has not been identified in animal husbandry [15].

In this regard, we decided to analyze the fatty acid composition of feeds that are most often used in the preparation of diets. In addition, based on the obtained data, a scientific and economic experiment was conducted on feeding young mink to identify the influence of different sources of fat with different calorie portions on the increase in live weight.

2 Materials and methods

Fatty acid analysis was carried out in the Testing Laboratory Center of Federal Scientific Center "All-Russian Research and Technological Poultry Institute" of Russian Academy of Sciences The test results were presented for a native substance. Determination of the fatty acid content was determined by gas chromatography.

Average samples of the following feeds were selected for research: herring waste (heads, ridges), trout waste (entrails), salmon waste preserved with acid (silage), chicken fat.

We studied the effect of diets with different levels of fat content, taking into account the analysis of the fatty acid analysis of individual feeds on the growth of young mink of Scandinavian breeding. Scientific and economic experiments were carried out in accordance with the methodological guidelines.

An experiment on feeding young mink using different sources of fat and calories was conducted on the basis of Savvatievo Animal Farm in the period from July 1 to October 1, 2022.

By the method of pairs-analogues, 36 males of young mink of the standard dark brown type breed were selected into 2 groups. The animals were clinically healthy and kept in identical cages, two at a time.

For the first control group, a diet was compiled based on the available data on the fat-acid composition with a digestible fat content of 5.9 g per 100 kcal of feed with a percentage distribution of the energy intensity of nutrients in the feed 35:51:14 (protein:fat:carbohydrates). The percentage of the use of different categories of feed as a source of fat is presented in the scheme of the experiment (Table 1).

For the second experimental group, the diets were compiled based on the data obtained during laboratory analysis. The average Omega-6/Omega-3 ratio was 8:1.

The experiment was carried out according to the scheme presented in Table 1.

Table 1. Experimental design.

Group	n ♂	Feeding period	Percentage of feed use as a source of fat				Caloric content of 100 g of feed, kcal	Energy intensity of protein, fat, and carbohydrates in the diet, %
			fish	meat-and-bone	chicken	veget. orig.		
1	36	July-September	36	31	26	7	160	35:51:14
2	36	July	30	34	31	5	168	33:54:13
		August	22	34	39	5	179	31:56:13
		September	23	33	41	3	180	31:56:13

On each 1st and 15th day of the month, a control weighing of the studied livestock was carried out to control the increase in live weight.

3 Results

Fig. 1 and 2 show the results of the analysis of the FA content in mink feeds obtained from the laboratory.

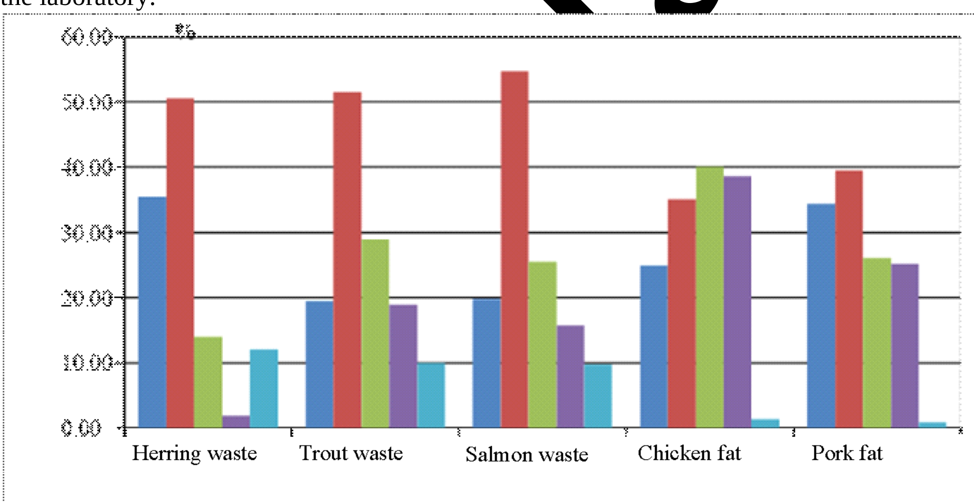

Fig. 1. The content of saturated, monounsaturated, polyunsaturated, Omega-6 and Omega-3 in non-traditional feeds used in feeding young mink, %.

It follows from the data in Fig. 1 that saturated fatty acids are contained in large quantities in herring waste and pork fat – 35.40% and 34.37%, palmitic acid makes up the largest proportion of saturated fatty acids –31.34%. The minimum amount in trout and salmon waste is 19.49% and 19.80%. Monounsaturated fatty acids are mainly found in fish waste: salmon waste – 54.69%, trout waste – 1.59%, herring waste – 50.65. Chicken fat is rich in polyunsaturated acids — 40.05%.

The maximum amount of Omega-6 fatty acids in chicken fat is 38.65%, in second place is pork fat 25.17%, and the minimum amount in herring waste – 1.93%. Omega-3 are found in large quantities in herring fish waste – 12.04%, trout – 9.98%, salmon – 0.64%. The optimal ratio of Omega-6/Omega-3 in trout waste (1.8:1) and salmon (1.6:1).

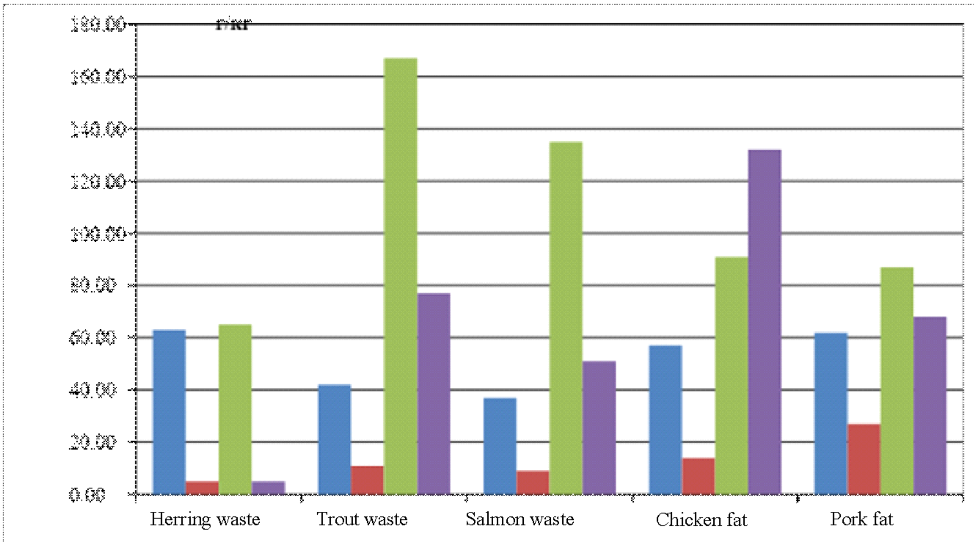

Fig. 2. Mass fraction of palmitic, stearic, oleic, and linoleic acid in fat, g/kg.

Fig. 2 shows information on the mass fraction of palmitic, stearic, oleic, and linoleic acid in fat, which shows that the largest mass fraction of palmitic acid in herring waste and pork fat is 63 and 62 g/kg, the minimum in salmon waste is 37 g/kg. The mass fraction of stearic acid in pork fat – 27.0 g/kg and chicken fat –14.0 g/kg exceeds the mass fraction in other products. The proportion of oleic acid in fat is concentrated in trout waste – 167 g/kg. The mammalian body cannot synthesize linoleic acid, although its cell membranes contain on average 10 times more than Omega-3, so it is critically important that it is regularly supplied with food. The mass fraction of linoleic acid in a larger amount is contained in chicken fat – 132 g/kg.

In this regard, when compiling the diet for the second group, the percentage of fat use in chicken waste was increased with a simultaneous increase in the content of herring waste in the diet.

During the experiment on feeding young mink, the following weighing results were obtained, presented in Table 2.

Table 2. Results of weighing of the studied animals, kg.

Group	Weighing dates						
	01.07	15.07	01.08	15.08	01.09	15.09	01.10
1	1.[illegible]5±0.13	1.30±0.13	1.80±0.20	2.03±0.13	2.41±0.14	2.80±0.11	3.17±0.12
2	1.09±0.09	1.22±0.18	1.93±0.29	2.26±0.20	2.61±0.14	2.94±0.20	3.22±0.26

During the experiment, no significant difference was obtained, but a second group has a tendency to increase the size, in which fat accounted for 31-41% of chicken waste.

4 Discussion

Thus, the conducted studies have shown that when compiling diets for carnivorous fur-bearing animals, it is necessary to take into account not only the fat and energy content in the diet, but also the fatty acid composition of the introduced feed. Take into account the ratio of saturated and unsaturated fatty acids, since unsaturated fatty acids are not only easily digested themselves but also improve the digestibility of saturated fatty acids. The use of feed fats in diets allows reducing protein consumption. Such fatty acid as linoleic acid is not synthesized in the body but comes only with food. It is necessary to take into account the beneficial effect of Omega-3 acids, which is most pronounced when the optimal ratio in the diet with Omega-6 acids. Consequently, a set of certain feeds and feed additives can significantly regulate the lipid and fatty acid composition of diets and change their effect on the productivity and metabolism of fur-bearing animals.

5 Conclusion

Analysis of the fatty acid composition of non-traditional feeds showed that monounsaturated fatty acids are mainly found in fish waste: salmon waste – 54.69%, trout waste – 51.59%, herring waste – 50.65%. Chicken fat is rich in polyunsaturated acids – 40.[illegible]5%.

The maximum amount of Omega-6 fatty acids in chicken fat is 38.65%, in second place is pork fat 25.17%, and the minimum amount in herring waste – 1.[illegible]%.

Omega-3 are found in large quantities in herring fish waste – 1[illegible].04%, trout – 9.98%, salmon – 0.64%.

The mammalian body cannot synthesize linoleic acid, although it is necessary for physiological functions and metabolic processes, so it must be fed regularly. The mass fraction of linoleic acid in a larger amount is contained in chicken fat – 132 g/kg.

The effect of diets in which fat accounts for 31-4[illegible]% of chicken waste, taking into account the analysis of fatty acid analysis of feed on the growth of young mink of Scandinavian breeding showed that there is a tendency to increase live weight in the second experimental group with a higher caloric content of feed compared to the control.

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