MEAT ENRICHED WITH POLYUNSATURATED FATTY ACIDS AGAINST HYPERLIPIDEMIA

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Abstract – We carried out the study on the effect of the fatty acid composition of meat on the blood lipid concentration and the atherogenic index using a rat model of hyperlipidemia. We established the relationship between the PUFA content in meat and the probability of the development of atherosclerosis. As a result of the experiment, we found out that due to the enrichment of beef with ω-3 fatty acids the raw material acquired pronounced hypocholesterolemic properties which consisted in the normalization of the cholesterol metabolism because of the lipid level reduction in blood plasma. We also noted that on the separate addition of ω-3 PUFA or native beef into the animal diet the hypolipidemic effect was less pronounced.

Key Words – atherogenic factor, enriched meat.

I. INTRODUCTION

Nutrition is an important factor determining human health. A present-day human diet should contain no more than 30% of fats (of a diet calorie content); moreover, the proportion of animal fat rich in saturated fatty acids must not be higher than 2/3.

Citizens of Russia on an average consume about 70 kg of meat per year. This figure varies from 95 to 34 kg depending on the region, religion and national peculiarities in nutrition; with that, the consumption of red meat accounts for 60%, the proportion of poultry meat in the overall diet of the country's population is 35-40%.

One of the arguments of the dietarians against the consumption of red meat is its high fat content which at the constant consumption is the key factor of the emergence of a variety of pathologies, first of all, atherosclerosis and, as consequence, cardiovascular diseases, which account for 55% of the total level of mortality in Russia.

The enrichment of meat with essential fatty acids allows to create the line of products not only balanced in fatty acid composition but also having the preventive and curative effects. It is well known that several fatty acids, especially ω-3 and ω-6 PUFA have functional properties; however, the behavior of fatty acids in meat system is still an open question. It should be kept in mind that many essential micronutrients are in complex interrelationships, and various effects from neutral to negative can be observed with their different combinations. Moreover, under specific conditions fatty acids can lose completely their efficiency or assimilability.

In this connection, the research in the field of targeted alteration of fatty acid composition of various kinds of meat is topical and demanded.

II. MATERIALS AND METHODS

The study was carried out on the outbred white male rats with the mass of 300 ± 20 g divided into 4 groups. Each group was fed an individual diet balanced in main nutrients. Modeling of the disease was conducted in all groups and consisted in the inclusion of the cholesterol dissolved in sunflower oil (10% of the diet) and vitamin D2 (2000 IU/day) into the diet [1]. Meat raw material was incorporated in the quantity of 15% of the diet. The 1st group of animals was given ω-3 PUFA in addition to the mixed fodder; the 2nd group was given beef; the 3rd group was given beef enriched with ω-3 fatty acids and the 4th group was fed only mixed fodder.

The animals were kept in the standard conditions of a vivarium with free access to water in compliance with the fundamental normative and ethical requirements for the use of animals in laboratory and other experiments.

We monitored daily their condition, consumption of feed and water, and their weight. The duration of the experiment was 28 days.

The relationship between the fatty acid composition of the diets and muscle tissues of the

experimental animals, and the cholesterol level in blood serum was studied.

The analysis of the fatty acid composition of meat, feed mixture given to the rats, and the muscle tissue of the experimental animals was carried out after the chloroform/methanol extraction of the samples by the Folch method [2].

The atherogenic index of the diet (AId) was calculated based on the total quantity of the consumed fat (Mf), the proportion of fat in meat raw material included to the diet and the atherogenic index of the meat raw material [3]:

AId = ∑AIi (Mi/Mf); Mf = ∑M1…i; where,

Mf = mass of fat consumed with the diet;

M1…i = mass of fat consumed with an individual food product; AIi - the atherogenic index of the tested meat raw material.

The calculation of the AI of the average sample of meat raw material and the rat tissues was performed according the formula presented by Ulbriht [4].

At the end of the experiment the animals were euthanized using carbon dioxide. The blood serum was analyzed using the semi-automatic biochemical analyzer BioChem SA (USA) for total cholesterol (TC) by Trinder method [5], high-density lipoprotein (HDL) by Abel-Kendall modified method [6], low-density lipoprotein (LDL) by Friedewald modified method [7], triglycerides (TG) by Fossati method, which used the classical Trinder reactions [8].

The concentration of very low-density lipoprotein (VLDL) cholesterol in serum was calculated using the Friedewald formula [9].

The atherogenic index of plasma was calculated by the formula [10]: AI = (TC –HDL)/HDL.

III. RESULTS AND DISCUSSION

The results of weighing showed that the maximum weight gains were in the animals from the 1st and 4th groups. The animals which diet contained native and enriched beef showed the negative dynamics (-1.09% and -3.71%, respectively). The weight loss in animals of these groups was the consequence of the more intensive utilization of PUFA esters with cholesterol comparative to the saturated fatty acids.

According to the results of the biochemical analysis of blood (Table 1) the maximum atherogenic index was observed in animals of the 4th group consumed mixed fodder (0.74), lower values were in animals of the 2nd group consumed beef (0.73). The animals of the 1st and 3rd groups consumed mixed fodder and beef enriched with ω-3 demonstrated the similar results (0.48 and 0.5, respectively).

Table 1 The results of the rat blood biochemical analysis on the 29th day

Group	Biochemical indicator				
	TC, mmol/l	HDL chole-sterol, mmol/l	LDL chole-sterol, mmol/l	TG, mmol/l	VLDL chole-sterol, mmol/l
1	1.53 ± 0.25	1.03 ± 0.25	0.34 ± 0.31	0.78 ± 0.06	0.16 ± 0.01
2	2.04 ± 0.3	1.18 ± 0.07	0.61 ± 0.2	1.26 ± 0.05	0.25 ± 0.01
3	2.15 ± 0.33	1.43 ± 0.08	0.47 ± 0.18	1.21± 0.43	0.24 ± 0.08
4	1.59 ± 0.13	0.92 ± 0.07	0.43 ± 0.05	1.25 ± 0.1	0.25 ± 0.02

Thus, it was demonstrated that enriched beef reduced the risk of the development of atherosclerosis 9% more effectively, due to the significant reduction in the levels of triglycerides by 4.62%, LDL by 22.02% and VLDL by 4.36%.

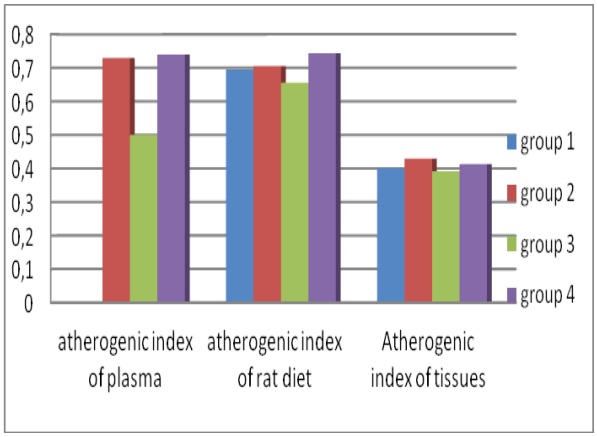

Figure 1. The ratio of the atherogenic indices of blood serum, diets and tissues of animals from the experimental groups at the end of the experiment

The examination of the fatty acids composition of the rat tissues (Fig.1) showed that the enrichment of mixed fodder and beef with ω-3

fatty acids led to more prominent utilization of saturated fatty acids; as a result, the atherogenicity of the rat tissues reduced by 9%. The highest levels of the atherogenic index were observed in the tissues of the rats from the 2nd group consumed beef.

IV. CONCLUSION

Our study showed that the targeted alteration of the fatty acid composition of meat raw material by incorporation of ω-3 fatty acids to its composition increased its functional properties: the significant reduction of the atherogenicity of the body tissues was observed; the utilization of the saturated fatty acids accelerated; the risk of cardiovascular diseases reduced. Enriched raw material was 10% more effective in the reduction of the toxic effect on liver resulted from the high level of cholesterol comparing to the native meat.

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