INFLUENCE OF PROBIOTIC DIETARY SUPPLEMENTS ENRICHED WITH OMEGA-3 FATTY ACIDS ON THE DYNAMICS OF THE LIPID METABOLISM OF RATS UNDER CHOLESTEROL LOADING

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Abstract. For the first time, we have studied the influence of polyunsaturated fatty acids on cholesterol metabolizing activity of bifidobacteria. High levels of destruction of cholesterol in the process of cultivation of strain Bifidobacterium Longum DK 100 was noted. Based on the results, the technology of probiotic dietary supplements (DS), enriched with polyunsaturated fatty acids, has been developed. The paper reveals that the introduction of probiotic DS leads to a twofold reduction in total cholesterol in the experimental groups in comparison with the control one, which indicates high effectiveness of DS. It has been observed that against the background of the atherogenic diet, the employment of probiotic DS is accompanied by a significant reduction in triglyceride levels by 37% and 45% in the "linen" and "cedar" groups, respectively, compared to the control group of animals. It has been established that in the blood serum of animals of experimental groups, the level of high-density lipoproteins increases by 45% in "linen" and 40% in "cedar" groups, while low-density lipoproteins decreased by 19% and 23% respectively. With the introduction of probiotic DS with linseed oil, the atherogenic index decreases by 83%, and with the cedar one by 86%. The results confirm the hypocholesterinemic effect of DS during cholesterol loading.

1 Introduction

Atherosclerosis and related diseases such as coronary heart disease and myocardial infarction are the prime cause of deathin industrialized countries. Despite the existence of many theories of the development of atherosclerosis, there is no doubt that the key role in this process is played by the violation of lipid metabolism. The high-performance antiatherosclerosis drugs from the statin groupusedcurrently have side effects and can cause serious complications [1].

Considering this, drugs of natural origin, which areharmless and can be used long-term, become particularly interesting.

In recent years, a significant amount of data has been accumulated stating that the host's resident and transitory microflora, synthesizing, transforming or destroying exogenous and endogenous sterols, actively participates in cholesterol metabolism. This fact allows us to view the microfloraof the host as the most important metabolic and regulatory organ involved in cooperation with host cells in maintaining cholesterol homeostasis[2].

An analysis of data on biologically active compounds produced by probiotic microorganisms published in the literature has shown that to date, the biotechnological potential of anaerobic microorganisms, bifidobacteria, propionic acid bacteria and lactobacillus is barely tapped. Lactobacillus have long attracted the attention of biotechnologists because of their potential importance for the preservation of health, prevention and treatment of many diseases. The number of publications on the ability of some strains of lactobacillus to exhibit hypocholesterinemic effects, i.e. to reduce cholesterol levels in theblood, is increasing [3,4,5,6].

The relevance of microbial ecology research and the study of cholesterol metabolism by probiotic microorganisms is determined by the need to create mass-consumption bioproducts maintaining and preserving the health of the population, which will become a worthy competitorfor traditional medicines.

There is a known connection between the content of polyunsaturated fatty acids in the human diet and the concentration of cholesterol and triglycerides in the blood. Studies of the lifestyle, health and nutritional habits of Mediterranean peoples or people who regularly eat fish have demonstrated that the low incidence of cardiovascular disease among population groups is due to the high intake of polyunsaturated fatty acids (mainly omega-3) [7, 8].

For the first time, we have studied the influence of polyunsaturated fatty acids on cholesterol metabolizing activity of bifidobacteria. High levels of destruction of cholesterol in the process of cultivation of strain B. Longum DK 100 was noted, reaching 68.09% with the addition of cedar oil and 74.39% with linseed oil. We

have found that the introduction of cedar and linseed oils into the nutrient medium doubled the cholesterol-metabolizing ability of bifidobacteria compared with the control [9, 10].

As aresult of the researchcarried out, we have developedthe technology of probiotic dietary supplements (DS) enriched with polyunsaturated fatty acids.

The goal of the research was to study the effect of probiotic dietary supplements enriched with polyunsaturated fatty acids on the dynamics of lipid metabolism of rats.

2 Methods

In our experiments, we have used Bificardio probi-otic dietary supplements.

These DS were produced using the original technology, by cultivating Bifidobacteria B. Longum DK 100 on nutrient environments containing cedar andlinseed oil, developed at the Department of Dairy Technology, Merchandising and Examination of Goods of the East Siberian State University of Technology and Management.

Studies were conducted on white mature male rats of the "Wistar" line with a body weight of 180–220g obtained from the nursery of the Research Institute of Biophysics of the Angarsk State Technical Academy.Animals were kept in individual cages. All the animals received a standard diet.

The experiments were carried out in accordance with all the rules and recommendations of the European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposesof 18March 1986.

All animals were divided into 4 groups (10 individuals each): the first, intact, the second, control, the third, "linen," and the fourth, "cedar."

Animals of control and experimental groups for 21 days were kept on a diet containing 5% cholesterol, 0.3% thiouracil, 1% of cholic acid according to the methodological guidelines 2.3.2.721–98 guidelines for determination of the safety and effectiveness of biologically active food supplements.

Then, probiotic dietary supplements enriched with polyunsaturated fatty acids, at a dose of 15 ml/kg of rat mass, were injected with a probe into the stomachs of the animals of experimental groups for 14 days, daily before the main feeding.

After the end of the experiment, blood samples were taken from the animals. These blood samples were centrifuged for 10 to 12 minutes.

Concentration of total cholesterol (TC), high-density lipoprotein cholesterol (HDL C) and low-density lipoprotein cholesterol (LDL C), triglycerides (TG) were determined by the automatic biochemical analyzer BS-400 (PRC). The atherogenic index was calculated according to A.N. Klimovusing the formula [11].

$$AI = \frac{TC - HDL\text{-}C}{HDL\text{-}C} \quad (1)$$

where AI is atherogenicindex, TC is concentration of total cholesterol, HDL-C is concentration of high-density lipoproteincholesterol.

This index reflects the ratio of atherogenic lipoproteins to the content of anti-atherogenic lipoproteins in the blood serum.

Statistical processing of the results of the study was performed in MS Excel6.0 using theStudent t-distribution function. The results were considered significant with $p < 0.05$.

3 Results and discussion

The studies have shown the following rates of TC concentrations in the blood serum of experimental animals (Figure 1).

Figure 1 shows that total cholesterol in the control group was 38% higher compared to the intact one and almost twice as high as in experimental groups.

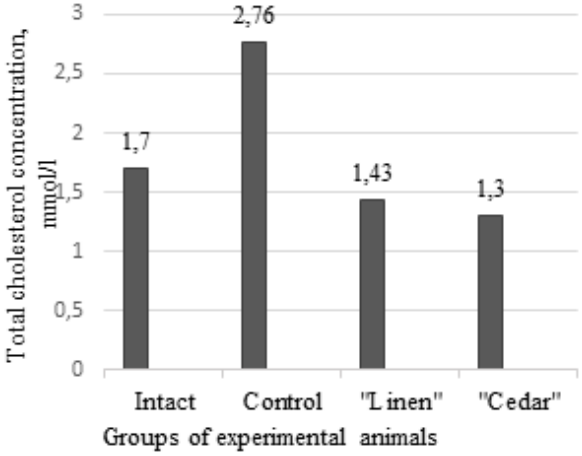

Fig. 1. TC concentration in the blood serum.

Figure 2 presents data on the change of triglycerides (TG) content in the blood serum of experimental animals.

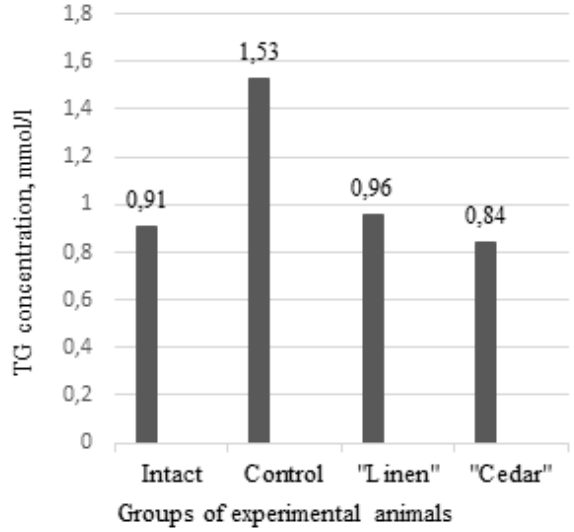

Fig. 2. TG concentration in the blood serum.

Analysis of the data presented in the Figure 2 showed that the use of dietary supplements against the background of the atherogenic diet in the "linen" and "cedar" groups of rats was accompanied by a significant reduction in the TG level by 37% and 45% respectively compared to the control group of animals.

Figure 3 shows changes in the HDL C concentration in the blood serum of experimental animals.

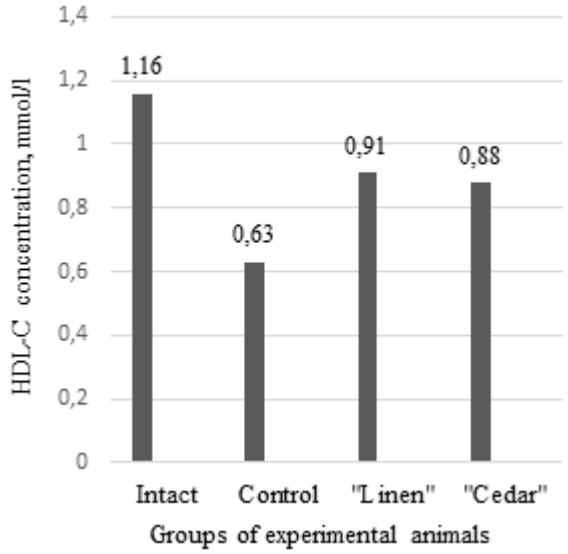

Fig. 3. HDL-C concentration in the blood serum.

As can be seen from the Figure 3, in the blood serum of animals of the control group there was a significant decrease in HDL C content, almost twice compared to the intact animals; however, HDL C level of rats fed with DSincreased by 45% in "linen" and by 40% in "cedar" groups.

Figure 4 showsLDL C concentrations in the blood serum of experimental animals.

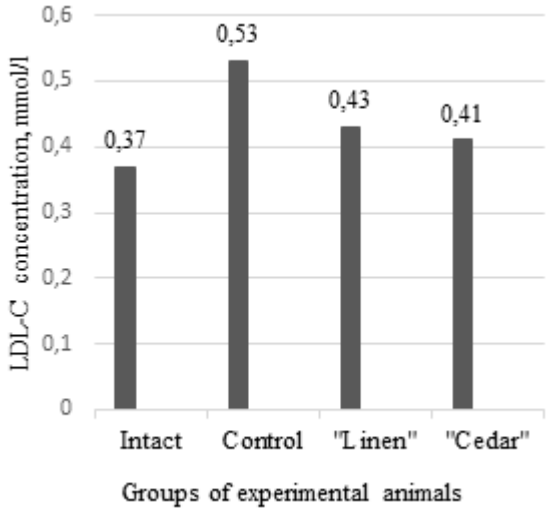

Fig. 4. LDL-C concentration in the blood serum.

The findings indicate that the LDL C level in the control group increased by 30%; the further introduction of probiotic DS with linseed and cedar oils caused a decrease in the LDL C concentration by 19% and 23% respectively.

Further, we analyzed the dynamics of the atherogenic index, which is reflected in Figure 5.

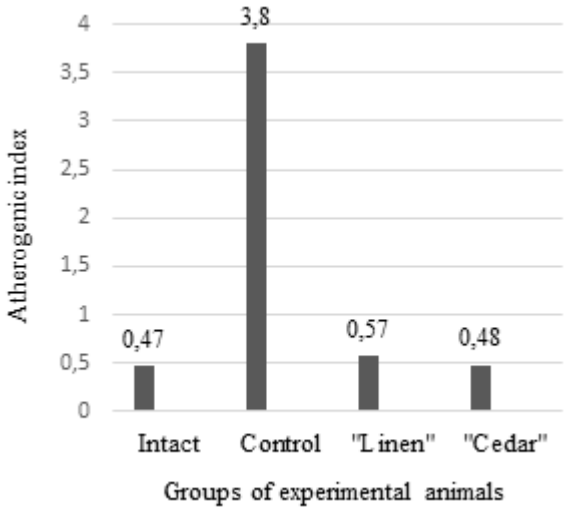

Fig. 5. Atherogenic index.

From the data of the Figure 5, it is clear that the atherogenic index with introduction of probiotic DS with linseed oil decreased by 83%, and with cedar one by 86%.

The results confirm the hypocholesterinemic effect of probiotic DS enriched with polyunsaturated fatty acids under cholesterol loading.

4 Conclusions

As a result of the studies, it was established that against the background of the atherogenic diet of rats, in the experimental groups with introduced DS containing linseed and cedar oil, therewas an increase in HDL C levels and a decrease in total cholesterol, LDL C, and triglycerides compared with the control, and these values were approaching the indicators of the intact group. Meanwhile, a significant decrease in the atherogenic index was observed.

The results demonstrate the high effectiveness of probiotic DS enriched with polyunsaturated fatty acids and the normalization of lipid profile in the blood serum of rats.

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