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Possibilities of Using a Complex of Probiotics with Microelements for the Production of Functional Nutrition.

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ABSTRACT

In the article we substantiated the method of using a complex probiotic preparation based on *Lactobacillus paracasei* cultures picked out from the pig intestinal microflora with the addition of inorganic forms of selenium and iodine, providing functional pork enriched with microelements. It was determined that the implementation of inorganic forms of selenium and iodine in the diet of pigs as a part of the probiotic preparation contributed to their more efficient accumulation in liver, heart and meat than the addition of microelements without probiotic. In experiments on laboratory animals a decrease in cholesterol, an improvement in the clinical indicators of blood and a significant accumulation of iodine and selenium were determined when feeding meat from pigs that received the complex probiotic with microelements.
Keywords: pigs, complex probiotic, selenium, iodine, meat quality, functional nutrition.

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INTRODUCTION

Food products enriched with functional nutrition ingredients (physiologically useful food substances) constitute an extensive group of functional nutrition products. Such ingredients that improve human health, along with vitamins, dietary fiber and lipids, include minerals, the deficiency of which is really common [5, 8]. In Russia most regions are deficient for iodine. The most difficult situation has developed in the vast territories of Western and Eastern Siberia. Mild iodine deficiency is noted in Tambov, Belgorod and Voronezh regions. The region of easy natural iodine deficiency is Krasnodar region [3].

In Russia, biogeochemical provinces with selenium deficiency stand out – these are the North and North-West of the country, the Transbaikalia, the Urals; some foci were found in Yaroslavl Region, Udmurtia and Tatarstan [1]. Almost 2/3 of the territory of our country is characterized by iodine deficiency and about 40% – by selenium deficiency.

Scientific studies proved the effectiveness of the intravital enrichment of meat of slaughter animals with microelements [9, 11]. The enrichment of meat products with minerals by adding them into feed of farm animals is a task that has been successfully solved in many countries. In Germany, France, Holland, USA, Canada doses of selenium in the ration are regulated by legislation [2, 10].

Currently, in the practice of animal husbandry the effectiveness of the use of probiotics has been proved. They become an important component of modern rational feeding; they contribute to increasing the digestibility of feed, stimulate the growth and development of animals, increase nonspecific immunity, which leads to a high productivity and improve the quality of raw meat [4, 7, 12]. The use of probiotics is especially important in the North Caucasus region, where, when stored in warehouses, feed affects from 30 to 50% of the fungal microflora, which can cause mycoses, mycotoxicosis and other animal poisoning [6].

In modern animal husbandry in demand are probiotics of a new generation, which include substances that enhance probiotic effects: sorbents, antagonistic metabolic products, immunomodulators, prebiotics, enzymes, nutrients.

In connection with the foregoing, it is important to develop a method for enriching rations of pigs using probiotics with microelements iodine and selenium that are deficient for most regions of our country for their intravital enrichment of pig muscle tissue and obtaining of pork with improved quality for production of functional nutrition products.

The aim of this research was to study the quality and properties of pork in relation to its suitability for the production of functional nutrition, intravital enriched with microelements such as iodine and selenium as a part of probiotic based on live lactic acid bacteria.

METHODOLOGY OF RESEARCH

The levels of microelements in the rations were determined depending on the actual content of iodine and selenium in the feed and on the basis of the recommended standards for fattening pigs [2]. The content of microelements in the feed after their addition was: for iodine – 0.35 mg/kg and for selenium – 0.2 mg/kg.

The composition of the complex probiotic was carried out in two versions: the 1st – with KI; the 2nd – with Na2SeO3; in experiments *in vitro* it was found out that co-enrichment of probiotic with sodium selenite and potassium iodide inhibits lactic acid bacteria and leads to a sharp decrease in the titer of lactic acid microorganisms in the preparation. Thus, to enrich the rations of pigs with the probiotic preparation, including both KI and Na2SeO3, we developed the method for its inclusion in feed: the preparation was put into the ration of pigs alternately: one week animals received probiotic with selenium, the other week they received probiotic with iodine, etc.

In order to avoid possible overdose with iodine and selenium, pigs were fed with the probiotic preparation of both variations once in 24 hours. The dose of probiotic in the basic ration was 10 ml per head per day. The preparation was input through a dispenser with water for drinking.

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Scientific and economic experiment was carried out using 4 groups of pigs of the SM-1 breed that were in fattening period for functional nutrition, starting from 4-months old animals to compare the effectiveness of the addition of microelements of iodine and selenium, which were the part of the probiotic and the same elements without probiotic. The scheme of the experiment is presented in Table 1.

Table 1: Scheme of the experiment (n=20)

Group	Characteristics of feeding
1	Basic ration (BR)
2	BR + probiotic based on lactic acid bacteria
3	BR + probiotic + KI / BR + probiotic +Na_2SeO_3
4	BR +KI + Na_2SeO_3

At the end of the experiment, when animals reached the body weight of 100-110 kg, 3 heads from each group were slaughtered. Studies of the quality and safety of raw meat were carried out at the Argus Research Center of the Krasnodar Scientific Center for Animal Husbandry and Veterinary Medicine.

The selenium concentration in meat and internal organs of pigs was determined on a fluorometer according to the method approved by the General Administration of Veterinary Medicine of the Russian Ministry of Agriculture in 1976; determination of the mass fraction of iodine was carried out according to the methodical guidelines 4.1.1106-02 by a titrimetric method. Medical and biological evaluation was carried out on growing laboratory rats-males (n = 50) in the vivarium of the Krasnodar Scientific Center for Animal Husbandry and Veterinary Medicine.

Laboratory blood tests were carried out on a Vitalab Selectra Junior automated biochemical analyzer. Hematological analysis of peripheral blood was carried out on a Mythic 18 vet automated analyzer.

The scheme of the biological experiment is presented in Table 2.

Table 2: Scheme of the biological experiment

Groups	Features of the ration
1	Basic ration for laboratory animals (BR)
2	BR + meat from pigs of the 1st group kept on the main ration
3	BR + meat from pigs of the 2nd group, received probiotic additive to the BR
4	BR + meat from pigs of the 3rd group, received probiotic additive with selenium and iodine microelements
5	BR + meat from pigs of the 4th group, received selenium and iodine, which were not included in the composition of probiotic

RESULTS

As a result of the research, it was determined that according to the level of selenium concentration in liver, heart muscle and meat, the 3rd group of pigs exceeded the 4th group by 11.1%, 14.5% and 13.0% and also exceeded the control group by 42.9%, 85.8% and 35.1%, respectively. Differences between the 4th and control groups of pigs in selenium were 28.6%, 63.3% and 20.8%, respectively (Table 3).

Concentration of iodine was also higher in meat and internal organs of pigs of the 3rd group. Thus, the level of iodine in meat, liver and heart of the 3rd group exceeded the 4th group of animals by 9.4%, 28.1% and 14.9%. In comparison with the control analogues, the differences in this microelement were maximal, exceeding them in 2.5, 1.6 and 7.8 times. In this case, the best absorption of selenium and iodine occurred on the background of the use of probiotic.

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Table 3: The concentration of selenium and iodine in organs and muscle tissue of pigs

Group	In:	Selenium, mg/kg	Iodine mg/kg
1. BR	liver	0.126±0.006	0.057±0.001
	heart	0.085±0.003	0.071±0.009
	longissimus dorsi muscle	0.077±0.004	0.064±0.003
2.BR + probiotic based on lactic acid bacteria	liver	0.129±0.005	0.057±0.004
	heart	0.091±0.008	0.080±0.020
	longissimus dorsi muscle	0.080±0.002	0.080±0.006
3. BR + probiotic + KI/ BR + probiotic +Na_2SeO_3	liver	0.180±0.005	0.140±0.001
	heart	0.158±0.003	0.114±0.001
	longissimus dorsi muscle	0.104±0.007	0.501±0.001
4. BR + KI+Na_2SeO_3	liver	0.162±0.006	0.128±0.005
	heart	0.138±0.002	0.89±0.005
	longissimus dorsi muscle	0.092±0.005	0.436±0.001

Analyzing the results of research, it can be noted that the highest concentration of selenium occurs in liver, then in heart and then in the muscle tissue of pigs. There is a different picture for iodine. Its maximum concentration is recorded in the muscle tissue, and only then in liver and heart.

A biological experiment conducted on laboratory rats on feeding samples of meat of pigs participating in the experiment did not reveal significant differences in the mass of internal organs and integral indicators of chronic intoxication (IICI) between groups of laboratory animals (Table 4).

Table 4: Integral indicator of chronic intoxication of rats (IICI)

Indicator	Group				
	1	2	3	4	5
IICI of liver	4.66 ± 0.22	4.31 ± 0.16	4.52 ± 0.11	4.29 ± 0.20	4.25 ±0.17
IICI of heart	0.41 ± 0.02	0.45 ± 0.05	0.41 ± 0.04	0.39 ± 0.02	0.44 ±0.03
IICI of kidneys	1.14 ± 0.02	1.18 ± 0.09	1.16 ± 0.02	1.14 ± 0.06	1.17 ±0.05
IICI of spleen	0.61 ± 0.06	0.66 ± 0.08	0.68 ± 0.06	0.61 ± 0.09	0.65 ±0.08

From the data presented in Table 4 we can conclude that the ratio of the absolute masses of the internal organs to the body mass in both the experimental and control groups did not differ significantly, corresponding to the existing standards of growing animals.

A clinical analysis of blood of the laboratory animals in the experiment revealed significant positive changes in the hematological parameters of the blood of rats of the 4th group, received meat enriched with microelements together with probiotic: the levels of red blood cells, hemoglobin and iron increased by 6.4%, 8.9%, and 17.4 % that allows to judge about the intensification of oxygen metabolism in tissues; the number of lymphocytes, in contrast, decreased by 7.6% that may indicate a decrease in the tension of nonspecific cellular

immunity. In biochemical indicators were noted an increase in the level of albumin by 16.3% and an increase of total calcium – by 5.7%, as well as a decrease in the level of cholesterol by 27.3%.

The results of the study of the levels of iodine and selenium in the muscles and internal organs of rats revealed an increase in the accumulation of these microelements in muscles, liver and heart of rats of the 4th and 5th groups (Table 5).

Table 5: The level of iodine and selenium in the muscles and internal organs of rats

Group	Selenium, mcg %			Iodine, mcg %		
	muscles	heart	Liver	muscles	heart	liver
1	3.0 ± 0.24	2.4 ± 0.15	3.2 ± 0.30	8.5 ± 0.44	5.4 ± 0.16	6.3 ± 0.51
2	4.5 ± 0.32	3.0 ± 0.16	3.4 ± 0.13	9.0 ± 0.15	5.7 ± 0.34	6.5 ± 0.26
3	5.5 ± 0.34	2.8 ± 0.15	4.4 ± 0.4	9.3 ± 0.25	5.0 ± 0.36	7.5 ± 0.18
4	15.5 ± 0.41	11.5 ± 0.28	14.2 ± 1.3	18.0 ± 0.16	9.1 ± 0.42	19.4 ± 0.14
5	10.5 ± 0.22	10.3 ± 0.19	12.1 ± 1.2	15.5 ± 0.37	10.0 ± 0.23	14.7 ± 0.54

In comparison with the control group (1), the selenium concentration in the 4th group in the muscles increased in 5.16 times, in heart – increased in 4.8 times and in liver – increased in 4.4 times. As for the iodine concentration in this group of laboratory rats, it increased by 2.25, 1.68 and 3.1 times, respectively. In the 5th group of animals that were fed with meat from pigs that got the basic ration of selenium and iodine, which were not included in the composition of the probiotic, the following picture was noted: an increase in the concentration of selenium relative to the control group was in 3.5, 4.3 and 3.8 times in favor of white rats of the 5th group; an increase in the concentration of iodine was in 1.82, 1.85 and 2.3 times, respectively.

Thus, the results of experiments showed the expediency of intravital enrichment of pig meat with the complex probiotic preparation based on live lactic acid bacteria, including inorganic forms of iodine and selenium, for producing pork with functional properties.

CONCLUSION

Two types of the complex probiotic preparation were developed based on *Lactobacillus paracasei* cultures picked out from pig microflora of the SM-1 breed, with the inclusion of inorganic forms of selenium and iodine; as well as the method of their use to obtain functional pork enriched with microelements was developed. The addition of selenium and iodine in the composition of the probiotic preparation to the rations of growing pigs contributed to their accumulation in the internal organs and muscle tissue of animals. The accumulation of iodine and selenium occurred more efficiently with the addition of probiotics than with the introduction of microelements in an inorganic form. A high degree of nutrient adequacy of the obtained functional pork for the adult population has been determined. An increase in the levels of iodine and selenium in the muscles, liver and heart of rats treated with meat intravital enriched with microelements as part of the complex probiotic was determined. Positive changes in clinical blood indices were noted in rats receiving an additive of meat with iodine and selenium as the part of the probiotic.

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