Activation of the excretion of radionuclides from the body of fattening gobies and their retention level

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Abstract. The article is devoted to the use of low-intensity laser radiation and pectin containing feed additives in animal husbandry to activate the excretion of radionuclides through the gastrointestinal tract and kidneys of black-motley bulls for fattening in order to reduce their retention in the body. As a result of the studies, the high efficiency of these factors is proved. The specific most effective radiation doses for gobies were determined. Mountain ash berry as a food supplement is recommended to enhance the positive effect of low-intensity laser radiation.

1. Introduction

The main part of radionuclides enters the body of farm animals through the gastrointestinal tract, that is, with food and drinking water, respiratory organs, as well as through the skin. Radioactive sources can be both natural and artificial origin that is, created as a result of human activity. Once inside, they enter into various reactions, participate in metabolic processes, accumulate in organs and tissues, can lead to a change in the physiological status of the body, and, accordingly, reduce the quality of products [1–5]. Then they enter the human body with food and have a detrimental effect.

Among the large number of radionuclides, cesium-137 and potassium-40 often accumulate in the body of farm animals.

Since the main part of radionuclides enters the body of animals with a diet, and there is no way to completely get rid of radionuclides in feeds, it is necessary to find methods even at the stage of growing and fattening animals that enhance the excretion of radionuclides with waste products, and therefore reduce their retention in the body. This becomes even more relevant if animals are raised under conditions of significant radioactive contamination.

In this study, for this purpose, the effect of low-intensity laser radiation on the body of fattening bulls was studied and analyzed. It was done both individually and in combination with pectin-containing feed additives.

Currently, scientists pay great attention to the effect of laser radiation on biological objects, as a factor that stimulates many physiological processes in the body of both animals and plants [6–9].

The appearance of a response of living organisms, organs and tissues to the effects of laser radiation is noted. With laser therapy, desensitizing, bactericidal and bacteriostatic effects are observed, the activity of immune defense cells is activated.

In addition to medicine, laser radiation is also used in veterinary medicine. Back in the 90s, lasers began to be actively introduced into animal husbandry for the treatment of various diseases. It is also
used for pre-milking preparation of the udder of heifers, which reduces the period of adaptation to milking.

With the advent of new areas of use of laser radiation, it becomes necessary to develop various techniques and study the dose-dependent effect of the laser. For this, scientists are developing various mathematical models with which experimentally it is possible to obtain the optimal parameters of the effect of laser radiation on biological media to achieve the desired effect in each case.

Since a separate approach is required for different biological environment, there is a wide variety of types of lasers and laser systems with various nozzles. The dependence of the value of the dose of exposure and the functional state of the biological object is proved. A positive stimulating effect usually manifests itself in a narrow range of exposure doses, and then it can completely disappear or be replaced with inhibition.

In modern animal husbandry, natural feed additives to the main diet, which increase the productivity of animals, as well as their resistance to adverse environmental factors, including under conditions of anthropogenic pollution, are of particular interest [10, 11].

The berries of red mountain ash and sunflower baskets are available pectin-containing raw materials that can be used as top dressing in the diets of farm animals. Pectin refers to multifunctional additives, as it has a radio protective and detoxification properties.

Everyone knows the ability of pectin to form insoluble complexes, remove toxins from the human body, radionuclide isotopes and other harmful substances that accumulate in the body. Studies by scientists have also shown that pectins are able to reduce the allergic effects associated with the environmental situation, regulate the metabolism and functions of the digestive system.

Guided by the foregoing, there is a need to study the combined effect of low-intensity laser radiation and pectin-containing feed additives in the form of flour from the berries of mountain ash and sunflower baskets on the excretion of radiocaesium and radio potassium from the body of bulls for fattening in order to reduce their retention in organs and tissues.

2. Objects and methods of research
In order to activate the excretion of radiocaesium and radio potassium from the body of fattening bulls and minimize their accumulation in the body, three scientific and economic experiments were performed. In all groups, the animals were with similar physiological parameters, that is, of the same breed, their weight and age did not differ significantly during feeding. The subjects were uncastrated bull-calves of black-motley breed. Their age was 14 - 14.5 months and live weight of them ranged from 316 - 320 kg.

Animals of the control group, which was the same for all experiments, received only the feed of the main diet, presented below, and were not subjected to low-intensity laser radiation (LILR).

Gobies fattening the first, second and third experimental groups of the first scientific and economic experiment consumed the feed of the main diet without additional additives and were subjected to low-intensity laser radiation with an appropriate exposure of 16, 32 and 64 seconds.

Gobies of the second scientific and economic experience were also divided into 3 experimental groups and received the main feed, but already mixed with top dressing in the form of 30 g / head / day of flour from the berries of mountain ash and using laser puncture in 16, 32 and 64 seconds, respectively.

The third scientific and economic experiment included three experimental groups, where the animals received the main diet with the addition of 30 g / head / day of flour of sunflower baskets and were subjected to the same laser radiation with the same exposures.

The animals were irradiated with a low-intensity laser apparatus “Uzor-2K”. The power of his laser pulse was 5W, the radiation wavelength was 0.89 µm, the pulse radiation mode was used, the characteristic of the pulse repetition rate was 600 Hz, and the duration was 260 ns. The irradiation was carried out along the spine from both sides of the withers and hips with laser puncture; the irradiation time was 16, 32 and 64 seconds in accordance with the experimental scheme. Irradiation of animals occurred one month before slaughter.
The full value of rations in all cases corresponded to the norms of feeding farm animals. Every day passed the account of the expenditure of feed, water and feed additives. Feed was weighed before distribution, and water was dosed.

The berries of mountain ash and sunflower baskets in the phase of flowering and seed formation were picked manually. Next, the collected plant parts were dried at a temperature of 20-220°C. Dried plants were crushed into flour and after weighing, it subsequently added to the feed with mixed feed.

The experiments were divided into three periods. The accounting period was 90 days and 10 days each - preliminary and final. In the middle of the accounting period, feces and urine were collected and weighed for two days. The collection of excretion products was carried out immediately after irradiation. From each group, for more accurate registration, four heads were allocated (mini-herd method). To determine the concentration of radionuclides in the biological material of gobies, the samples did not undergo preliminary sample preparation. All test samples (feces, urine, feed, feed additives) were not canned.

3. Results and discussion
The daily diets of experimental animals of all three scientific and economic experiments consisted of 3.0 kg of compound animal feedstuff, 5 kg of cereal hay, 20 kg of silage from perennial grasses, 5 kg of red carrots and 60 g of common salt as a mineral supplement. Since animals must drink a lot to gain weight and normal life, therefore, they drank 18 liters of water per day. All of these feeds were included in the main diet. The chemical composition and nutritional value of the feed passed a mandatory assessment.

An analysis of the feed of the main diet showed that 300 Bq of cesium-137 and 1897 Bq of potassium-40 are present in them. These indicators are in the norm applicable to the diets of farm animals, since feed cannot be completely free of radionuclides, and, therefore, correspond to radiation safety.

Since radionuclides were not found in flour from sunflower baskets, the content of radiocesium and radio potassium in the diets of gobies of these experimental groups remained unchanged.

However, in the feed additive from ordinary mountain ash during the study, a small amount of radionuclides was found. Nevertheless, since the weight of the fed supplement was only 30 g / head / day, the content of cesium-137 and potassium-40 in the diets did not change significantly and amounted to 300.16 Bq and 1899.25 Bq, respectively.

In addition, additives in the form of flour of mountain ash and flour of sunflower baskets enriched the diets with fiber, phosphorus, potassium and other trace elements necessary for the full growth of animals.

From the results of the first scientific and economic experience, it can be seen that radio cesium was excreted with feces slightly. Its concentration was 0.74 Bq / kg. However, when using low-intensity laser radiation for all the exposure parameters presented in this experiment, the excretion of cesium-137 through the gastrointestinal tract was activated. The result can be explained with the instantaneous response of the cells of the digestive tract, in the form of physiological excitation to the energy impulse. It should be noted that a relatively high concentration of radionuclide in feces was established with a minimum duration of exposure, namely 3.33 Bq / kg. This means that under these conditions, the highest activation of radio cesium excretion through the gastrointestinal tract occurred, namely, it was 4.5 times more intense than in gobies of the control group.

Both in the control and in all experimental groups of the first scientific and economic experiment, significant excretion of radio potassium with feces was observed. The maximum concentration of this radionuclide was found in the biological sample of gobies that were part of the second experimental group, that is, they were laser treated with an exposure of 32 seconds, although the excess over the control group was only 5%.

The same radiation exposure led to the activation of radiocesium excretion through the kidneys. It should be noted that this factor was the only one in this experiment that provoked the excretion of cesium-137 with urine, and significant, at a rate of 4.44 Bq / l. In addition, in the remaining groups of this experiment, the excretion of radio cesium through the kidneys is zero.
Against the background of significant excretion of cesium-137 through the kidneys of calves for fattening, under similar conditions, there was a noticeable decrease in the intensity of excretion of potassium-40 from the urine of animals.

Unlike radio cesium, radio potassium with urine excreted more intense and was detected in this biological sample of gobies from all three experimental groups and in the control. And in the first and third experimental groups, where the animals underwent LILR for 16 and 64 seconds, respectively, the potassium-40 as a result of the analysis was almost 3.5 times higher than in the second experimental group and 2.5 times higher than in the control.

Based on the results of the experiment, the highest retention of cesium-137 in the animals of the control group was noted. Since the excretion of the radionuclide under these conditions was difficult, it can be assumed that it will accumulate in muscle tissue or in the internal organs of gobies.

It was proved that when using low-intensity laser radiation with an exposure of 32 seconds, it helped to reduce retention of cesium-137 in the body of fattening bulls, since under these conditions there was a significant activation of radio cesium excretion through both the gastrointestinal tract and the kidneys.

The minimum (16 sec.) and maximum (64 sec.) LILR duration led to a negative balance of radio potassium in the body of experimental animals, which is respectively minus 187 Bq and minus 123 Bq. In addition, in the absence of irradiation, the balance of this radionuclide is 470 Bq. This is a significant result, suggesting that a large amount of potassium will not enter the body of gobies, and the meat will be cleaner and safer.

Excretion of radio cesium and radio potassium through the gastrointestinal tract of gobies of all experimental groups of the second scientific and economic experiment, which were exposed to LILR and, in addition to the main diet, received 30 g / head / day of flour from the berries of mountain ash, was significantly higher than that of peers from the control group.

The most effective amount of radiation exposure for the excretion of radio cesium with feces is 16 seconds. In this case, the concentration of cesium-137 in the studied biological sample exceeded 2 times the corresponding concentration in the second and third groups and in the control 5.5 times. We should recall that in the first scientific and economic experiment, this exposure also contributed to the activation of cesium-137 excretion through the gastrointestinal tract of gobies. Moreover, the addition to the meal of flour from the berries of mountain ash ordinary in this case strengthened the effect of LILR. In the first experiment, the concentration of radionuclide in the feces was 3.33 Bq / kg, and in the second experiment was 4.07 Bq / kg.

If we analyze the excretion of potassium-40 with feces, it can be seen that the use of laser puncture in combination with red mountain ash berries contributed to an increase in its intensity under all exposure conditions. The dependence of the concentration of radio potassium in feces on the duration of exposure to LILR was established. This means that with an increase in exposure by 1 second, there is an increase in potassium-40 retention in this biological sample by 0.21 Bq.

From the conducted studies, it can be concluded that the 16-second exposure to low-intensity laser radiation in combination with the berries of mountain ash was the most effective, because under these conditions, radio cesium was excreted maximally, and the concentration of radio potassium in the feces significantly exceeded the concentration in the control.

However, when removing radionuclides with urine, a different picture is observed. Radio cesium was excreted through the kidneys only with an exposure time of 64 seconds and with the addition of flour from mountain ash berries to the main diet. In the remaining experimental groups of the second scientific and economic experience, as in the control, the excretion of radio cesium through the kidneys is zero.

There is a close direct proportional relationship between the duration of radiation and the content of the radionuclide in the urine of gobies. The concentration of cesium-137 in urine increases with increasing exposure to radiation.

Activation of urinary potassium-40 excretion occurs at a minimal exposure to LILR with berries of mountain ash, which is 1.3 times more than the control indicator.
If we consider in general the degree of intensity of excretion of the studied radionuclides with excretion products, the greatest effect was achieved with the maximum analyzed exposure of LILR and flour from mountain ash berries, since with this exposure the level of retention of radionuclides in the body of gobies decreased in one way or another.

From the results of the third scientific and economic experiment, it can be seen that in all experimental groups with all LILR exposure modes and adding flour from sunflower baskets to the diet, cesium-137 excretion with feces is activated in comparison with the control group. It should be noted that a higher concentration of cesium-137 in this isolation product is not the first time observed with a 16-second exposure. In this case, this value is 5.5 times higher than the benchmark. If we compare the level of elimination of this radionuclide with the first scientific and economic experience, we can once again note that the pectin-containing additive enhances the effect. In addition, the excretion of radio cesium with feces at a given exposure of the second scientific and economic experience was similar to excretion in the corresponding group of the third scientific and economic experience and amounted to 4.07 Bq / kg.

Also, with a 16-second exposure of LILR and an increase in sunflower baskets to the feed, activation of excretion of radio potassium through the gastrointestinal tract took place. As a result, the maximum amount of potassium-40 was removed from the body of gobies. This indicator exceeded the control level by 9.4%. However, with an increase in the dose of radiation, the content of feces in the feces decreases.

In the urine of gobies for fattening, both the control and experimental groups of cesium-137 were not found. Moreover, potassium-40 under the created conditions of the third scientific and economic experience in the control group was excreted more intensively than in all three experimental groups. However, if at a minimal exposure to LILR this radionuclide was excreted through the kidneys almost to the same extent as in the control group, then with a further increase in the radiation dose, its excretion decreased.

If we consider in general the results of the third scientific and economic experiment, it is clear that the excretion of the studied radionuclides was activated only through the gastrointestinal tract, and the desired effect was not achieved through the kidneys.

4. Conclusion
As a result of this study, it was necessary to study how many radionuclides enter the body of fattening gobies with feed. In addition, find ways to maximize their excretion. The more intense the excretion of radio cesium and radio potassium, the lower the level of their retention in the animal’s body and the safer the final product, that is, beef.

The feed and feed additives used in the control and experimental groups of all scientific and economic experiments corresponded to the standards for the content of radio potassium and radio cesium. Still, these radionuclides were present in the diet of animals. As for the additive from the berries of mountain ash, cesium-137 and potassium-40 were found in small quantities in it. However, the flour from the baskets of sunflower was completely free from these radionuclides. If even with a further study of the action of these feed additives a certain amount of radionuclides will be present in them, then the scanty part will fall into the diet, since the dose of feeding is very small.

From the results of all three scientific and economic experiments, we can conclude that the use of low-intensity laser radiation to stimulate the physiological processes of uncastrated bulls of black-motley breed for fattening under all exposure conditions led to the activation of excretion of radio cesium through the gastrointestinal tract of experimental animals. Consequently, it led to reduce their retention in the body. It should be noted that the 16-second exposure of LILR, both individually and in combination with pectin-containing additives, turned out to be the most effective, and the additives only strengthened the effect. This can be explained with the properties of pectin to bind and remove various toxins from the body.

As for radio potassium, it can be noted here that it was not excreted as intensely as radio cesium. Its excretion through the gastrointestinal tract was noted only when feeding calves with flour from the
berries of mountain ash ordinary in combination with LILR. The greatest effect was achieved with 64-second exposure.

Although the berries of a mountain ash have a diuretic effect, it did not give special positive results when excreting radionuclides through the kidneys, as did feeding the calves with flour from sunflower baskets. The greatest effect in this case was achieved only when LILR was applied without additives being added to the diets at a radiation dose of 32 seconds to remove radio cesium and at the minimum and maximum dose for activation of radio potassium excretion.

Studies have shown that when fattening gobies of black-motley breed, it is necessary to use laser technology with the appropriate exposure to activate the excretion of radionuclides through the gastrointestinal tract and kidneys and reduce their retention in the body. To enhance the effect, it is necessary use in the diets flour from the berries of mountain ash as an accompanying factor.

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