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Bovine leukosis control measures

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SUMMARY
Bovine leukosis is one of the most common infectious diseases of farm animals, causing significant economic damage due to a decrease in production of livestock products, premature culling and slaughter of cows and servicing bulls. The disease needs special attention and control on behalf of the on-farm veterinarians and zootechnicians. The article briefly describes epizootic situation on bovine leukosis in the Russian Federation in 2004–2020. It also includes a report on the disease situation in "Sibirskaya Niva" LLC (the Irkutsk Oblast) for 2015–2021 and assesses effectiveness of health support and disease prevention measures taken on the farm. The paper gives a brief description of the agricultural establishment: its zoosanitary status as well as zootechnical, veterinary, therapeutic and preventive measures (disinsection, deratization, vaccination). Based on the data obtained, we found the ultimate cause of bovine leukosis on the farm: presumably, these were crossbred animals brought into the farm. In order to eradicate the disease, "Sibirskaya Niva" LLC has developed a plan on health support and disease prevention, which includes veterinary, zootechnical and economic measures. Thus, due to the actions taken from 2015 to 2019, the number of infected cows and heifers reduced by 6.42 and 2.78 times, correspondingly. At the same time, the overall number of infected animals decreased by 9.9%. Task-oriented measures taken by the state veterinary services made it possible to steadily reduce the number of infected animals by 2020. The comprehensive approach embracing the farm peculiarities has proven to be effective to quickly eliminate bovine leukosis, as the above-mentioned agricultural establishment exemplified it.

Keywords: leukosis, bovine leukosis virus, hematologic tests, serological tests, health support and preventive measures

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Комплекс мероприятий по борьбе с лейкозом крупного рогатого скота

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РЕЗЮМЕ
Лейкоз крупного рогатого скота – одно из наиболее распространенных инфекционных заболеваний сельскохозяйственных животных, наносящих значительный экономический ущерб вследствие недополучения продуктов животноводства, преждевременной выбраковки и убоя коров и быков-производителей. Болезнь требует особого внимания и контроля со стороны специалистов ветеринарной и зоотехнической служб хозяйств. В статье кратко охарактеризована эпизоотическая обстановка по лейкозу крупного рогатого скота на территории Российской Федерации в 2004–2020 гг., а также представлены результаты изучения ситуации по заболеванию за 2015–2021 гг. в ООО «Сибирская Нива» Иркутской области и оценена эффективность оздоровительно-профилактических мероприятий, проведенных в хозяйстве. Приведена краткая характеристика сельскохозяйственного предприятия: зоогигиенические показатели, зоотехнические, ветеринарные и лечебно-профилактические (дезинсекция, дератизация, вакцинация) мероприятия. На основании полученных данных была установлена первопричина появления лейкоза крупного рогатого скота в хозяйстве: предположительно, источником вируса явились ввезенные помесные животные. Для ликвидации заболевания в ООО «Сибирская Нива» разработан план оздоровительно-профилактических мероприятий, включающий ветеринарные, зоотехнические и организационно-хозяйственные процедуры. В результате проведенной работы

с 2015 по 2019 г. инфицированность среди коров и телок снизилась в 6,42 и 2,78 раза соответственно. При этом общий уровень инфицированности животных уменьшился на 9,9%. Благодаря целенаправленной работе, проводимой государственной ветеринарной службой, к 2020 г. удалось добиться стабильного снижения уровня инфицированности животных. На примере данного сельхозпредприятия доказана эффективность спланированного с учетом особенностей хозяйства комплексного подхода, позволившего в короткие сроки провести оздоровление хозяйства от лейкоза крупного рогатого скота.

Ключевые слова: лейкоз, вирус лейкоза крупного рогатого скота, гематологические исследования, серологические исследования, оздоровительно-профилактические мероприятия

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INTRODUCTION

Bovine leukosis is a chronic infectious disease caused by bovine leukemia virus (BLV). The damage caused by the disease on farms includes a drop in production of milk, slaughter products and offspring; premature culling and slaughter of cows and servicing bulls [1].

Leukosis is registered in most countries with well-developed livestock industry. The disease is mostly spread in the USA and in some countries of Central Europe, as well as in Denmark and Sweden. Based on the report of the Rosselkhoznadzor Information and Analysis Center on the epizootic situation in the Russian Federation, 18,636 animal cases were registered in the country in 2020 and 442 sites were affected with bovine leukosis [1–6]. Figure 1 depicts an upward trend in the year-on-year dynamic changes in the number of the affected sites.

In 2020, new outbreaks of bovine leukosis were registered in the Altai, Krasnodar, Perm, Primorsky, Khabarovsk Krais, in the Republics of Dagestan, Ingushetia, Kalmykia, Karelia, Crimea, North Ossetia, Tatarstan, in the Khanty-Mansi Autonomous Okrug, in the Amurskaya, Astrakhan, Vladimir, Voronezh, Irkutsk, Kaliningrad, Kaluga, Kirov, Kurgan, Kursk, Novgorod, Tyumen and Chelyabinsk Oblasts [5, 6].

The increase in the number of leukosis cases and lack of effective prevention tools and methods add urgency to the problem which needs to be solved not only for the purposes of veterinary medicine, but also for general biology [7, 8].

The purpose of the research is to assess measures taken to control bovine leukosis in "Sibirskaya Niva" LLC.

To achieve the purpose, the following tasks were set:

– to study epizootic situation on bovine leukosis in "Sibirskaya Niva" LLC;

– to analyze measures taken to control bovine leukosis in "Sibirskaya Niva" LLC;

– to assess effectiveness of the measures taken over the past 7 years.

MATERIALS AND METHODS

Primary veterinary records and veterinary reports were used as a practical basis to study the epizootic situation on bovine leukosis in "Sibirskaya Niva" LLC (the Irkutsk Oblast), as well as to assess the disease control measures.

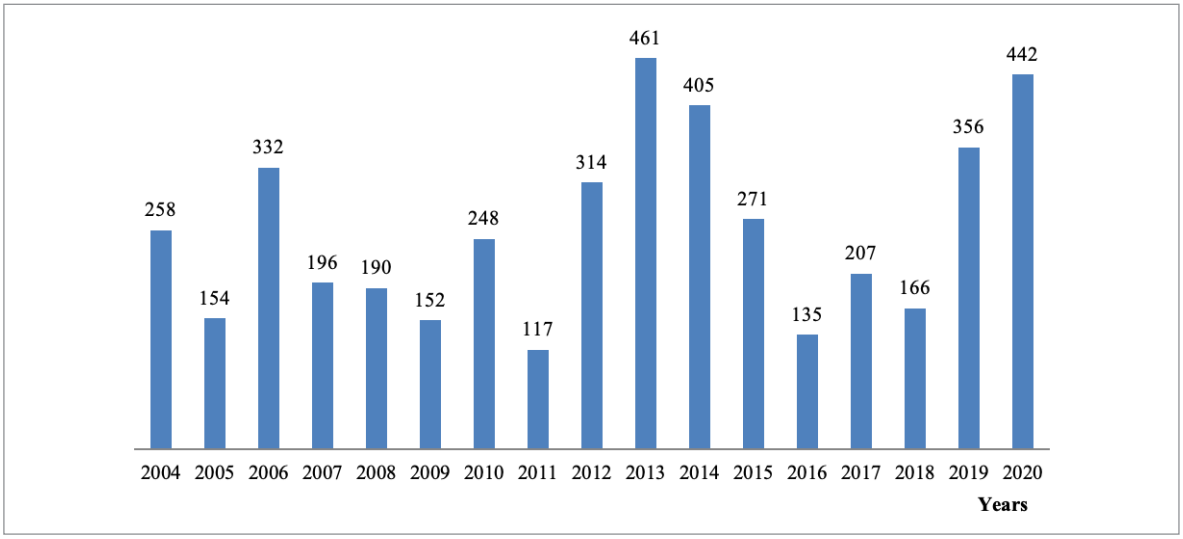

Fig. 1. Number of bovine leukosis-affected sites in the Russian Federation in 2004–2020 [6]

RESULTS AND DISCUSSION

"Sibirskaya Niva" LLC keeps one animal species, i.e. black-and-white dairy cattle. There are no driveways or cow tracks next to the farm. The livestock farms are located at least 500 m away from residential areas and household buildings. The animals are kept in standard cow barns designed for 100 animals. These are brick-built barns complying with the relevant zoosanitary requirements and having artificial lighting, central heating and combined supply and exhaust ventilation.

Cow watering site is equipped with individual water bowls with water supplied from artesian wells. Animal feeds are stored in a specially designated storage facility protected from birds and rodents and silage is stored in a sealed trench. Feeds are regularly tested for bacterial contamination, mycotoxins and heavy metals.

The feed preparation room, isolation pen and veterinary pharmacy properly comply with the sanitary and hygiene requirements.

The manure is removed out of the cow barns twice a day with a scraper conveyor, then transported to the manure storage site located 600 m away from the farm for further biothermal decontamination. On-farm dead livestock and slaughter wastes are buried in burial sites in the settlement of Orinsk or burned in a trench.

Formaldehyde, caustic soda, chloramine and bleach are used on the farm for disinfection. Required amounts of disinfectants are stored in a pharmacy warehouse in sealed original containers with labels on. The use of disinfectants is registered in a special log. A mobile disinfection station (UDP) and a spray nozzle SAG-1 are used for disinfection of cattle barns. For preventive purposes cattle barns are disinfected after the grazing season begins and before the housing season starts. The calving area is sanitized, as soon as the animals leave calving cubicles. Calve nurseries are sanitized every time after the calves are moved to calf barns.

Disinfection of the farm production facilities includes 4 stages:

1. Spray treatment of the interior surfaces in the production facilities and in ventilation shafts with a hot 2% caustic soda solution, exposure time – 30 minutes.

2. Mechanical cleaning: removal of left-over feed, manure, mechanical impurities using pressure washing unit from the mobile disinfection station.

3. Wet disinfection with a hot 5% caustic soda solution, exposure time – 1 hour (concentration of the working solution is 1 L/m^2).

4. Indoor air aerosol disinfection with a 40% formaldehyde solution (15 mL/m^3), exposure time – 2 hours. Then the room is ventilated, the remaining formaldehyde is neutralized by sprayed 20% hydrous ammonia. Walls (to a height of 1.5 m), feeders and cubicle divisions are treated with 15% freshly slaked lime. Disinfection quality control is ensured by the Irkutsk Interregional Veterinary Laboratory which tests farm swabs for coliform bacteria.

For disinsection purposes, a 1% aqueous solution of chlorophos is used to destroy insect breeding sites. Before blood-sucking insect (horseflies) season starts, the skin of animals is treated with a 2% solution of chlorophos. Deratization is carried out regularly after rodents are detected; more often in autumn and winter when the rodents move indoors. For these purposes, baits with zinc phosphide are used. Special attention is given to preventive measures: floors are repaired, doors and gates are sealed, grain feeds scattered on the floor are removed, etc.

Farm workers are provided with overalls and personal protective equipment in accordance with the regulations. The overalls are washed once a month in the laundry room. The clothes are pre-soaked for 30 minutes in a 2% formaldehyde solution. Employees can enter the farm only through the shower and changing facilities, where they take off their casual clothes, take a shower and put on overalls. Industrial and sewage wastewater goes to the settlement sewage system and pass through a sewage treatment plant. Awareness-raising campaign aimed at educating farm workers is in place. The farm workers are monthly lectured on veterinary and sanitary topics.

The dairy herd is restored from the young replacements reared on the farm. The cows showing signs of estrous behavior are artificially inseminated (manocervical method) in compliance with veterinary and sanitary rules (the external genitalia are washed with a 1:5000 solution of furacilin, disposable pipettes and gloves are used). Semen from serving bulls of "Irkutskgosplem" LLC is used for insemination of cows and heifers.

Until 2014, no cases of bovine leukosis were registered in "Sibirskaya Niva" LLC. This is primarily explained by the fact that routine serological diagnosis of leukosis using agar gel immunodiffusion (AGID) test in the Irkutsk Oblast began in 2014. It can be assumed that before some leukosis-infected animals were culled due to weight losses and a decrease in milk production. Probably, the infection was introduced into the farm in 2014, following delivery of mixed-bred heifers. Large gatherings of cattle during blood collection, vaccination, therapeutic manipulations, etc. play a key role in transmission of bovine leukosis to healthy susceptible animals.

In 2015, serological tests of blood sera samples from the entire herd [9] revealed that the number of leukosis infected cows and heifers was 32.1 and 13.9% (on average 19.5%), respectively (Fig. 2, 3, Table). Following the tests, the farm was declared leukosis affected.

In order to eradicate the disease the following health support action plan was elaborated by the Institute of Experimental Veterinary Medicine of Siberia and the Far East of the SFSCA RAS together with the Veterinary Services of "Sibirskaya Niva" LLC.

Veterinary measures:

1. Pursuant to results of serological tests of animal blood sera, the dairy herd shall be divided into leukosis infected and healthy cattle.

2. Leukosis infected cows shall be segregated in one of the yards and tested for leukosis 2 times a year using a hematological method. Blood sera from animals of this group shall not be serologically tested [4, 9].

3. The sick animals shall be culled, sent to meat processing plant or emergently slaughtered on the farm.

4. Calves from the sick cows shall be reared in isolation, shall be fed colostrum from mother cows for 10 days and then milk from healthy animals, bulk pasteurized milk or calf milk replacer [9].

5. Blood sera samples from healthy cows shall be serologically tested every quarter. Reactors shall be transferred to the infected group [2, 10].

6. The main dairy herd shall be restored from seronegative heifers [11, 12].

7. Sera samples from the young cattle shall be serologically tested at the age of 6, 12, 18 months and before they join the main herd. Reactors shall be moved to the fattening group with subsequent slaughter for meat. It is also possible to subject these animals to immunostimulating therapy in combination with the use of immunomodulators [13, 14].

Veterinary and zootechnical measures:

1. Ensure clear identification numbering of cattle of all sex and age groups.

2. Prohibit the use of non-sterile tools and other materials during animal handling.

3. Prevent contacts between infected and intact animals.

4. Any on-farm animal regrouping shall be authorized by the chief veterinarian.

5. AGID-positives shall be culled.

Economic measures:

1. Employees shall be timely assigned to immobilize animals during mass blood sampling for leukosis tests, and vehicles shall be provided for transportation of animals to the meat processing plant.

2. Key implementers of the on-farm health support measures shall get bonus payments.

3. Quarterly reports from livestock specialists on implementation of the action plan aimed at ensuring farm freedom from bovine leukosis shall be reviewed.

4. The action plan shall be annually corrected following its implementation assessment.

The use of such a detailed approach [5, 15, 16] during implementation of the health support plan in 2015–2021 made it possible to achieve a stable decrease in the number of leukosis infected animals (Fig. 2, 3, Table).

The dairy herd animals, whose blood sera contained BLV-specific antibodies, as revealed by serological tests, were subjected to hematological tests. It resulted in detection of cows with hematologic stage which helped to reduce their number in the herd over time [5, 6, 11–14, 17].

As a cost-saving measure for the farm, no BLV genotyping was carried out. Leukosis causative agent is known to include 10 genetic groups and several subgroups.

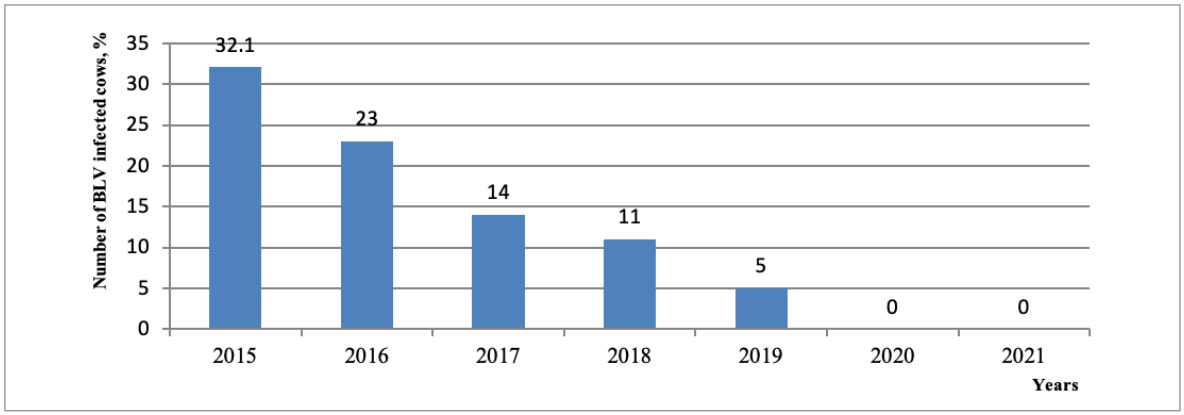

Fig. 2. Dynamic changes in the number of BLV infected cows, 2015–2021

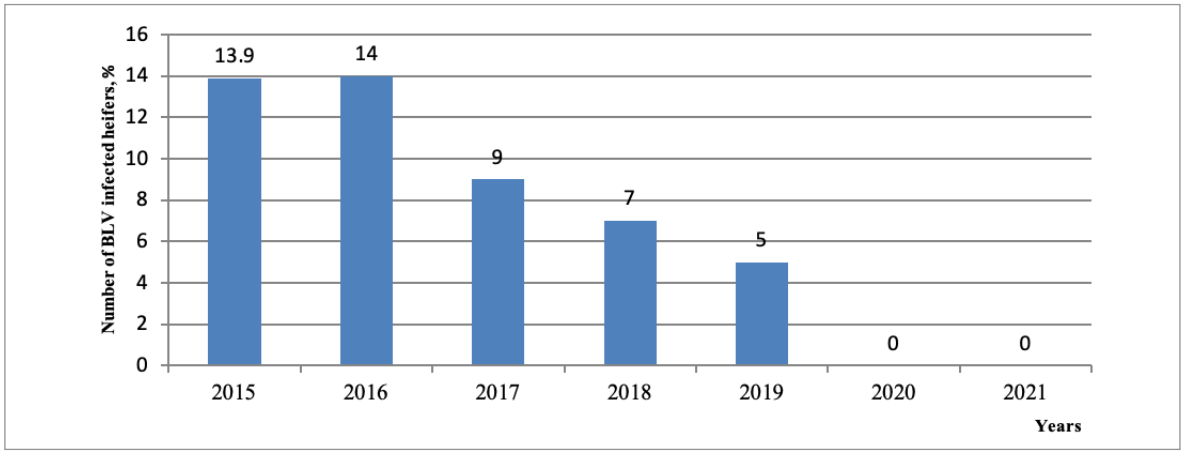

Fig. 3. Dynamic changes in the number of BLV infected heifers, 2015–2021

Table
Changes in the overall number of the infected livestock, 2015–2021

Year	2015	2016	2017	2018	2019	2020	2021
Number of infected animals, %	19.5	19.1	11.5	11.0	9.6	–	–

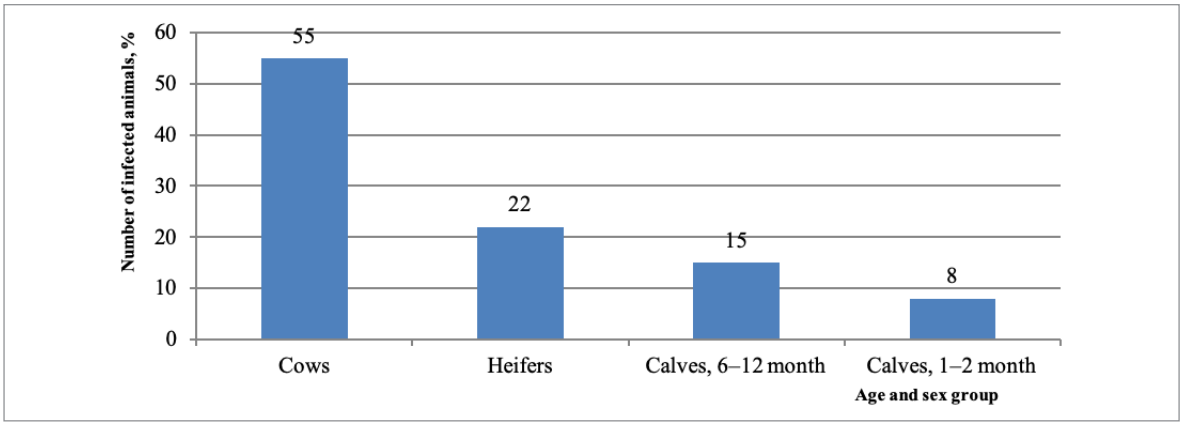

Fig. 4. Assessing the number of BLV-infected animals in 2019

BLV isolates recovered in the Russian Federation belong to genetic groups 4, 7 and 8 [5, 18, 19]. In the Irkutsk Oblast BLV belonging to the Belgian and Australian subgroups circulates in the cattle population.

Calves from infected and sick cows were healthy and received milk only from healthy animals, since BLV can be transmitted through colostrum or milk [5, 16, 19, 20].

From 2015 to 2019, the number of infected cows and heifers decreased by 6.42 and 2.78 times, respectively. At the same time, the overall number of infected animals decreased by 9.9%.

Figure 4 depicts data on BLV spread in different age and sex groups in 2019. The highest percentage of infected animals was reported in cows and heifers.

In 2020, AGID revealed no specific precipitating antibodies to BLV antigens in blood sera from the herd.

Thus, thanks to the purposeful work done by the state veterinary services from 2015 to 2019, the number of BLV-infected animals decreased to 9.6%, and since 2020 no infected animals have been detected on the farm. Lethality and mortality rates were not taken into account, since the disease was chronic and no deaths were recorded. The animals were culled at the very first clinical signs and when changes in blood leukogram were reported. As of 1 October 2020, the disease was completely eradicated on "Sibirskaya Niva" LLC farm.

CONCLUSION

Bovine leukosis was diagnosed on "Sibirskaya Niva" LLC farm following positive results of serological and hematological tests. Epizooty of bovine leukosis on the farm broke out in 2015 and was presumably caused by imported crossbreeds.

In order to eradicate the disease, a plan of health support and preventive measures (veterinary, zootechnical and organizational and economic) was developed.

The measures taken to prevent and eliminate bovine leukosis based on the integrated plan (taking into account peculiarities of the farm as well as timely diagnosis) made it possible to eradicate the disease and improve health status of the herd.

The research was conducted before the Order of the Ministry of Agriculture of the Russian Federation No. 156 of 24 March 2021 was published ("Validating veterinary rules for preventive, diagnostic, restrictive and other measures, the establishment and cancellation of quarantine and other restrictions aimed at preventing the spread and elimination of outbreaks of bovine leukosis").

REFERENCES

1. Agasiev A. Sh., Kozlovskaya A. Yu., Dmitrieva O. S., Polovintseva T. M. Epizooticheskaya situatsiya po leikozu krupnogo rogatogo skota Pskovskoi oblasti = Epizootic situation on bovine leukosis in the Pskov Oblast. *Effektivnoe zhivotnovodstvo.* 2021; 2 (168): 106–109. Available at: https://www.agroyug.ru/magazine/pdf-mailing/ehffektivnoe-zhivotnovodstvo-2-168-mart-2021.pdf. (in Russ.)

2. Abakin S. S., Krivoruchko S. V. New approaches to the diagnosis and sanitation of berds from leukemia and immunodeficiency virus in cattle. *Veterinarnaya patologiya*. 2013; 1 (43): 36–39. Available at: https://vetpat.ru/wp-content/uploads/2014/03/01-43-2013.pdf. (in Russ.)

3. Gulyukin M. I., Ivanova L. A., Kozyreva N. G., Stepanova T. V. Analiz epizooticheskoi situatsii po leikozu krupnogo rogatogo skota v Rossiiskoi Federatsii za 2014 god = Analysis of the epizootic situation on bovine leukosis in the Russian Federation in 2014. *Realizatsiya dostizhenii veterinarnoi nauki dlya obespecheniya veterinarno-sanitarnogo i epizooticheskogo blagopoluchiya zhivotnovodstva Bryanskoi oblasti v sovremennykh usloviyakh*: *materialy nauchno-proizvodstvennoi konferentsii (19–20 iyunya 2015 g.) = Implementation of veterinary science achievements to ensure veterinary-sanitary and epizootic safety of livestock industry in the Bryansk Oblast under the modern conditions: proceedings of the research and development conference (June 19–20, 2015)*. Bryansk: Bryansk SAU; 2015; 78–89. eLIBRARY ID: 23583271. (in Russ.)

4. Perekhod'ko I. N. Epizooticheskaya situatsiya po leikozu krupnogo rogatogo skota v khozyaistvakh Zhukovskogo raiona = Epizootic situation on bovine leukosis on the farms of the Zhukovsky District. *Nauchnye problemy proizvodstva produktsii zhivotnovodstva i uluchsheniya ee kachestva: materialy XXX nauchno-prakticheskoi konferentsii studentov i aspirantov (20–21 maya 2014 g.) = Scientific problems of livestock production and improvement of its quality: materials of the XXX Scientific and practical conference of students and postgraduates (May 20–21, 2014)*. Bryansk: Bryansk SAU; 2014; 39–42. eLIBRARY ID: 23577767. (in Russ.)

5. Petropavlovskiy M., Donnik I., Bezborodova N. Epizootiological and genetic characterization of the bovine leukemia virus in the Russian Federation – evaluation of bovine leukemia virus in Russia. *Veterinarski Arhiv*. 2019; 89 (6): 785–798. DOI: 10.24099/vet.arhiv.0555.

6. Rosselkhoznadzor. Epizootic situation in the Russian Federation, 2020. Available at: https://fsvps.gov.ru/fsvps-docs/ru/iac/rf/2020/iac2020_all.pdf. (in Russ.)

7. Batomunkuev A. S. The leukemia of cattle in the Irkutsk region. *Veterinary, Animal Science and Biotechnology*. 2019; 3: 9–13. DOI: 10.26155/vet.zoo.bio.201903002. (in Russ.)

8. Vlasenko V. S., Bazhin M. A. Evaluating the immune status of cattle at leukosis. *Siberian Herald of Agricultural Science*. 2009; 9 (201): 64–69. eLIBRARY ID: 12869589. (in Russ.)

9. Megrabyan D. S. Metody prizhiznennoi diagnostiki pri leikoze krupnogo rogatogo skota = Methods of lifetime BL diagnosis. *Veterinariya i kormlenie*. 2009; 6-1: 16–17. (in Russ.)

10. Novoselcev G. G., Karabaktyan V. A., Simonyan G. A., Repnikova N. V. Effective and unharmful method of fighting against leucosis of large horned cattle. *Veterinaria Kubani*. 2011; 1: 6–8. eLIBRARY ID: 16543371. (in Russ.)

11. Ponomareva I. S., Sycheva M. V., Poljakov M. A., Nurgalieva R. M., Kartashova O. L. Jeffektivnost' diagnostiki lejkozov krupnogo rogatogo skota metodami RID, IFA i PCR v hozjajstvah Orenburgskoj oblasti = Effectiveness of BL diagnosis using ID, ELISA and PCR methods on farms of the Orenburg Oblast. *Modern High Technologies*. 2010; 9: 134. eLIBRARY ID: 15485848. (in Russ.)

12. Timoshina S. V., Badeeva O. B. Advanced system action on fight with bovine leukosis. *Veterinaria i kormlenie*. 2012; 4: 6–8. eLIBRARY ID: 20356961. (in Russ.)

13. Smirnov Ju. P., Eremin S. P. Naprjazhennost' jepizooticheskoj situacii po lejkozu krupnogo rogatogo skota v zavisimosti ot kolichestva zagotovlennyh kormov = Tension of epizootic situation on bovine leukosis, depending on the amount of harvested feeds. *Vestnik Nizhegorodskoi gosudarstvennoi sel'skokhozyaistvennoi akademii*. 2012; 2: 246–250. eLIBRARY ID: 22574705. (in Russ.)

14. Smirnov Yu. P., Suvorova I. L. Prevention method of postnatal infection by bovine leukosis virus of the young bovine stock. Patent No. 2621146 Russian Federation, Int. A61K 31/00 (2006.01), A61K 31/7105 (2006.01), A61K 36/15 (2006.01), A61K 38/00 (2006.01), A61K 38/20 (2006.01), A61P 35/02 (2006.01). Federalnoe gosudarstvennoe byudzhetnoe nauchnoe uchrezhdenie "Nauchno-issledovatelskij veterinarnyj institute Nechernozemnoj zony Rossijskoj Federatsii". No. 2016138056. Date of filing: 23.09.2016. Date of publication: 31.05.2017. Bull. No. 16. (in Russ.)

15. Hirsch C., Camargos M. F., Barbosa-Stancioli E. F., Fonseca Júnior A. A., Rajão D. S., Heinemann M. B., et al. Genetic variability and phylogeny of the 5' long terminal repeat from Brazilian bovine leukemia virus. *Genet. Mol. Res*. 2015; 14 (4): 14530–14538. DOI: 10.4238/2015.

16. Meas S., Usui T., Ohashi K., Sugimoto C., Onuma M. Vertical transmission of bovine leukemia virus and bovine immunodeficiency virus in dairy cattle herds. *Vet. Microbiol*. 2002; 84 (3): 275–82. DOI: 10.1016/s0378-1135(01)00458-8.

17. Ali A. F., Selim A., Manaa E. A., Abdelrahman A., Sakr A. Oxidative state markers and clinicopathological findings associated with bovine leukemia virus infection in cattle. *Microb. Pathog*. 2019; 136:103662. DOI: 10.1016/j.micpath.2019.103662.

18. Licursi M., Inoshima Y., Wu D., Yokoyama T., González E. T., Sentsui H. Genetic heterogeneity among bovine leukemia virus genotypes and its relation to humoral responses in hosts. *Virus Res*. 2002; 86 (1–2): 101–110. DOI: 10.1016/s0168-1702(02)00059-x.

19. Zyrianova I. M., Koval'chuk S. N. Bovine leukemia virus pre-miRNA genes' polymorphism. *RNA Biol*. 2018; 15 (12): 1440–1447. DOI: 10.1080/15476286.2018.1555406.

20. Rahman M. M., Takashima S., Kamatari Y. O., Badr Y., Kitamura Y., Shimizu K., et al. Proteomic profiling of milk small extracellular vesicles from bovine leukemia virus-infected cattle. *Sci. Rep*. 2021; 11 (1):2951. DOI: 10.1038/s41598-021-82598-2.

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