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Spread dynamics of bovine leukosis on breeding farms in the Republic of Dagestan

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ABSTRACT

Introduction. The problem of bovine leukosis on breeding farms in the Republic of Dagestan has been a pressing issue since the mid-1960s. Due to the fact that the coverage of planned serological testing did not exceed 1–2% of the existing population of susceptible animals, there was no clear understanding of the scale of leukosis spread.

Objective. Analysis of the current situation regarding the spread of bovine leukosis on breeding farms in the Republic of Dagestan.

Materials and methods. Animals infected with the bovine leukemia virus were identified using the agar gel immunodiffusion test (AGID). Animal disease control measures were assessed in accordance with the new "Veterinary Rules for the Implementation of Preventive, Diagnostic, Restrictive and Other Measures as well as for the Imposition and Release of Quarantine and Other Restrictions Aimed at Containing Bovine Leukosis as well as at Eradicating its Outbreaks" approved by Order No. 156 of the Ministry of Agriculture of Russia of March 24, 2021.

Results. The bovine leukemia virus infection rate in animals in the period 2009–2017 ranged from 0.1 to 77.3%. With the adoption of the subprogram "Prevention and Eradication of Bovine Leukosis on Farms in the Republic of Dagestan" (2018–2020) under the republican target program, serological testing coverage has increased by more than 5.7 times over the past seven years, and the detection rate of new seropositive animals has decreased from 23.6 to 0.1% in 2024.

Conclusion. Epizootological analysis revealed a heterogeneous structure and dynamics of the bovine leukosis spread in cattle. The system of measures aimed at prevention and eradication of bovine leukosis in cattle implemented in the Republic of Dagestan has led to sustainable stabilization of the disease situation and a reduction in the infection rate in animals on breeding farms. Owing to the veterinary service's systematic efforts to eradicate the viral infection, breeding farms are now completely free from bovine leukosis. Health improvement work, including the use of serological diagnostics and immediate culling of AGID-positive animals, continues.

Keywords: bovine leukosis (BL), bovine leukemia virus (BLV), spread, breeding farms, serological and hematological testing, health improvement measures, Republic of Dagestan

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Динамика распространения лейкоза крупного рогатого скота в племенных хозяйствах Республики Дагестан

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РЕЗЮМЕ

Введение. Проблема лейкоза крупного рогатого скота в племхозах Республики Дагестан стала актуальной еще с середины 60-х годов XX века. В связи с тем, что в те годыохват плановыми серологическими исследованиями не превышал 1–2% имеющегося поголовья восприимчивых животных, ясного представления о масштабах распространения лейкоза не было.

Цель исследования. Анализ современной ситуации по распространению лейкоза крупного рогатого скота в племенных хозяйствах Республики Дагестан.

Материалы и методы. Инфицированных вирусом лейкоза животных выявляли с помощью реакции иммунной диффузии в агаровом геле (РИД). Противоэпизоотические мероприятия оценивали с учетом новых «Ветеринарных правил осуществления профилактических, диагностических, ограничительных и иных мероприятий, установления и отмены карантина и иных ограничений, направленных на предотвращение распространения и ликвидацию очагов лейкоза крупного рогатого скота», утвержденных приказом Минсельхоза России от 24 марта 2021 г. № 156.

Результаты. Зараженность животных вирусом лейкоза крупного рогатого скота в ретроспективе за 2009–2017 гг. варьировала от 0,1 до 77,3%. С принятием подпрограммы «Профилактика и ликвидация лейкоза крупного рогатого скота в хозяйствах Республики Дагестан» (2018–2020 гг.) в рамках республиканской целевой программы за последние семь лет увеличился охват поголовья серологическими исследованиями более чем в 5,7 раза, частота выявления новых случаев серопозитивных животных снизилась с 23,6 до 0,1% в 2024 г.

Заключение. Эпизоотологический анализ показал неоднородную структуру и динамику распространения лейкозного процесса среди крупного рогатого скота. Реализуемая в условиях Республики Дагестан система мер по предупреждению и ликвидации заболевания крупного рогатого скота лейкозом позволила добиться устойчивой стабилизации эпизоотической обстановки и сократить уровень зараженности животных в племенных хозяйствах. Благодаря проводимой ветеринарной службой планомерной работе по ликвидации вирусной инфекции племхозы сегодня полностью благополучны по лейкозу. Оздоровительная работа, включающая применение серологической диагностики и немедленной выбраковки РИД-позитивных животных, продолжается.

Ключевые слова: лейкоз, вирус лейкоза крупного рогатого скота, распространение, племенные хозяйства, серологические и гематологические исследования, оздоровительные мероприятия, Республика Дагестан

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INTRODUCTION

Bovine leukosis (BL) is a chronic infectious disease caused by an RNA-containing tumorigenic virus of the family *Retroviridae*, genus *Deltaretrovirus* [1, 2, 3, 4]. Diseased animals and bovine leukemia virus (BLV) infected animals are considered to be the source of the disease [5]. Key factors contributing to its spread include delayed or untimely diagnosis, non-compliance with veterinary and sanitary requirements when purchasing livestock for breeding and production purposes, and the common housing of infected and healthy livestock [6, 7, 8, 9].

Bovine leukosis inflicts significant economic losses on agricultural establishments of various forms of ownership, primarily, on breeding farms. The financial impact is multifaceted, arising from: loss of milk and offspring due to the premature culling of BLV-infected cows, slaughter of stud bulls, destruction of carcasses of diseased animals, sale of breeding young stock from diseased dam cows for meat, reclassification of breeding animals into the commercial category if they are BLV-infected, culling of young BLV-infected stock, as well as substantial operational expenses for diagnostic, veterinary-sanitary and zootechnical measures required for herd health management (improvement) and BL outbreak control to be conducted on farms and locations affected by BL. Beyond these direct costs, BL negatively impacts overall livestock productivity and operational efficiency, constraining the economic potential of affected farms [10, 11, 12, 13].

The presence of BLV carriers on breeding farms, which concentrate valuable cattle gene pools, poses a significant risk of spreading the infection to disease-free farms through the sale of animals [14, 15, 16].

The problem of BL on breeding farms in the Republic of Dagestan emerged as early as the mid-1960s. Initial studies conducted by scientists from the Dagestan Research Veterinary Station, employing hematological and pathomorphological methods, detected the disease in 14.0–19.1% of affected cows. Furthermore, the frequent observation of carcasses with BL-characteristic lesions at meat-processing plants during that period confirmed the widespread of the disease [17].

Beginning in 1988, comprehensive lifetime diagnosis of BL was implemented on cattle farms using the agar gel immunodiffusion (AGID) test [18, 19, 20, 21], facilitating the development of optimized BLV prevention and eradication strategies. However, as planned serological testing in those years covered less than 1–2% of the susceptible cattle population, the true scale of BLV infection remained unclear.

This study aims to analyze the current epidemiological situation of BL on breeding farms in the Republic of Dagestan.

MATERIALS AND METHODS

The research was conducted in the Laboratory of Infectious Pathology of Farm Animals at the Caspian Zonal Research Veterinary Institute – Branch of Dagestan Agriculture Science Center.

Data reported by the Committee on Veterinary Medicine of the Republic of Dagestan and republican and district veterinary laboratories were analyzed. This data was obtained from BL monitoring on breeding farms during 2002 and the period from 2009 to 2024, and was subjected to statistical processing.

Serological and hematological tests were conducted in veterinary laboratories in accordance with

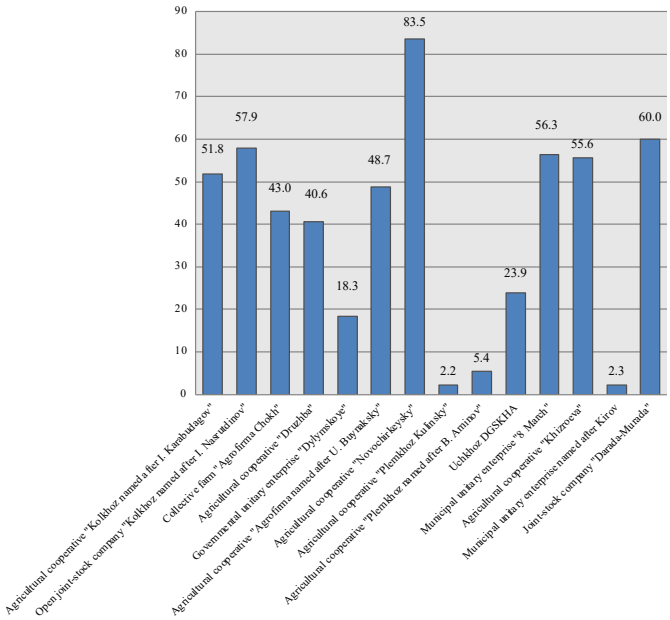

Fig. 1. The BLV infection rate on the breeding farms in the Republic of Dagestan in 2002 (%)

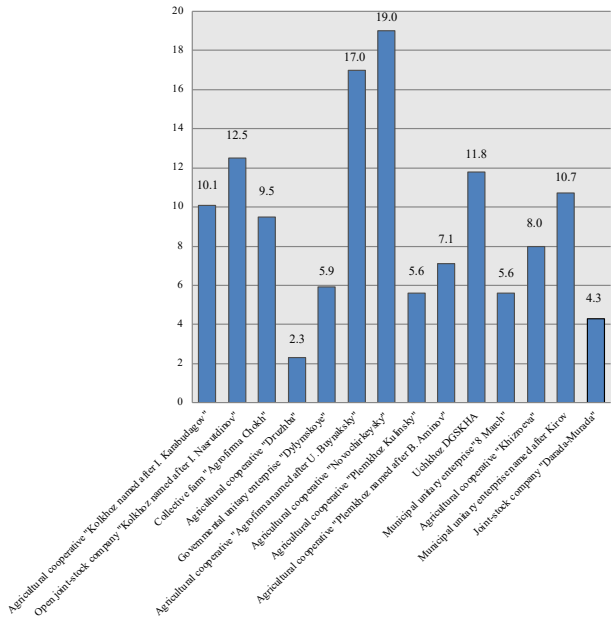

Fig. 2. The BL incidence rate on the breeding farms in the Republic of Dagestan in 2002 (%)

the "Methodological Guidelines for the Diagnosis of BL in Cattle"[1], epizootological tests were conducted in accordance with the "Methodological Recommendations for Epizootological Investigation of BL in Cattle"[2].

The effectiveness of preventive and disease control measures was evaluated based on the new "Veterinary Rules for the Implementation of Preventive, Diagnostic, Restrictive and Other Measures the Establishment and Cancellation of Quarantine and Other Restrictions Aimed at Containing BL as well as at Eradicating its Outbreaks", approved by Order No. 156 of the Ministry of Agriculture of Russia of March 24, 2021[3].

RESULTS AND DISCUSSION

A preliminary assessment of the BL situation on Dagestan's breeding farms was conducted in 2002. Official statistics from January 1, 2002, reported 14 breeding farms in the region, maintaining a total cattle population of 13,411, which included 4,955 cows. The findings on the spread of BL and BLV on these farms are presented in Figures 1 and 2.

Our analysis established a widespread distribution of BL at the start of the study period. Among Dagestan's breeding farms, the BLV infection rate in susceptible animals varied considerably, ranging from 2.2% at agricultural cooperative "Plemkhoz Kulinsky" to 83.5% at agricultural cooperative "Novochirkeysky". Similarly, BLV incidence rates ranged from 2.3% (agricultural cooperative "Druzhba") to 19.0% (agricultural cooperative "Novochirkeysky"), with average rates of 32.2 and 10.4%, respectively.

Serological testing coverage for BL was 37.9%, while hematological testing covered 25.8% of the total cattle subjected to diagnostic screening.

[1] https://docs.cntd.ru/document/1200118749

[2] https://elibrary.ru/ucvzwj

[3] https://docs.cntd.ru/document/603433105

A comparative epizootological assessment revealed a more intense epizootic process caused by BLV on breeding farms compared to commercial and backyard farms, with infection rates of 29.7, 24.7, and 7.9%, respectively [22].

Thus, determining the BLV prevalence rate in cattle and clinical severity of BL on breeding farms through systematic diagnostic testing became imperative. To this end, the dynamics of the BLV infection rate were assessed annually from 2009 to 2017 across an average of 11–19 farms (Table 1).

Over the nine-year period, 33,838 animals were tested using the AGID-test, of which 7,977 (23.6%) were seropositive for BLV. Furthermore, hematological examination of 1,950 cows confirmed a BL diagnosis in 606 individuals (31.1%).

BLV infection rates on breeding farms remained persistently high. The lowest number of virus-carriers in animals was reported in 2012 – 7.2%, in other years it ranged from 10.1 to 37.1%. Similarly, the proportion of animals with BL, as determined by hematological tests, remained elevated, fluctuating between 15.9 and 67.5%.

It was established that breeding farms company "Vympel-1", agricultural cooperative "Agrofirma Sivukh", agricultural cooperative "Named after A. Daniyarov" were free from BL; on family operated farm "Boztorgay", company "Kurbanservice", municipal unitary enterprise named after Kirov, Agricultural cooperative plemkhoz "Urkarakhsky", agricultural cooperative "Plemkhoz Kulinsky", agricultural cooperative "Plemkhoz named after B. Aminov", governmental unitary enterprise "Dylymskoye", the infection rate did not exceed 10%; on agricultural cooperative "Druzhba", company "Agrofirma "Molochnik", agricultural cooperative "Novaya Zhizn", company "Plempredpriyatiye Elita", scientific production association "Plemservice" the infection rate ranged

Table 1
Dynamics of BLV infection on the breeding farms in the Republic of Dagestan in 2009–2017

Breeding farms	Number of BLV-carriers identified, %									Total number for 9 years, %
	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Joint-stock company "Kizlyaragrocomplex"	47.6	37.9	0	–	–	–	0	12.6	44.1	39.9
Company "Plempredpriyatiye Elita"	–	54.1	–	–	–	–	–	11.5	–	27.0
Company "Averyanovka"	–	51.4	48.2	–	–	–	–	–	–	50.8
Company "Agrofirma "Molochnik"	22.5	–	–	–	–	–	–	–	–	22.5
Open joint-stock company "Marenevka"	–	64.2	–	–	–	–	–	–	–	64.2
Agricultural cooperative "Khizroeva"	60.7	60.8	81.5	–	–	70.0	–	90.8	0	62.2
Agricultural cooperative "Kolkhoz Krasny Partizan"	76.1	90.5	92.3	0	94.2	0	69.7	93.0	0	77.3
Scientific production association "Plemservice"	–	–	–	–	–	–	–	76.7	0	27.1
Agricultural cooperative plemkhoz "Urkarakhsky"	2.0	0.5	0	0	0	0	15.8	7.8	7.6	1.8
Collective farm "Agrofirma Chokh"	38.4	13.6	52.8	–	38.9	48.0	64.7	61.3	64.9	48.0
Agrofirma "Sogratl"	–	–	–	–	–	–	–	45.4	36.9	40.9
Agricultural cooperative "Agrofirma named after U. Buynaksky"	34.5	–	0	–	–	0	24.9	55.8	26.9	35.3
Agricultural cooperative "Novochirkeysky"	58.3	–	–	–	–	–	–	–	40.0	53.1
Agricultural cooperative "Plemkhoz Kulinsky"	11.7	14.0	–	21.4	14.7	–	1.9	0	0	6.5
Agricultural cooperative "Plemkhoz named after B. Aminov"	–	14.3	–	8.2	–	4.8	2.0	1.9	2.2	6.8
Joint-stock company "Darada-Murada"	52.7	79.1	58.5	0	20.0	–	62.4	–	–	51.6
Worker cooperative "Murad"	–	68.5	–	34.2	–	–	35.3	8.2	24.0	41.2
Municipal unitary enterprise named after Kirov	0	0	0.6	–	–	–	–	–	–	0.2
Agricultural cooperative "Druzhba"	12.7	49.5	32.1	–	2.2	3.6	0	13.0	9.4	15.5
Agricultural cooperative "Novaya Zhizn"	–	25.4	21.9	22.0	18.9	21.6	21.8	16.3	32,.8	23.1
Governmental unitary enterprise "Dylymskoye"	0	40.3	14.8	0.3	6.9	1.4	0	1.7	0	8.5
Company "Vympel-1"	–	–	–	–	–	–	–	–	0	0
Agricultural cooperative "Agrofirma Sivukh"	–	0	0	0	–	0	–	–	–	0
Agricultural cooperative "Named after A. Daniyarov"	0	0	0	–	0	–	0	–	0	0
Municipal unitary agricultural enterprise "Talovka"	0	84.8	38.3	–	–	–	–	–	–	42.2
Family operated farm "Boztorgay"	–	–	–	0	–	0	0.6	–	0	0.1
Company "Kurbanservice"	–	–	–	–	0.7	–	0	0	0	0.1
Company "OORKh «Dagestanskoye"	–	–	72.9	–	81.8	–	0	–	–	46.1
Total for the year, %	29.0	37.1	35.1	7.2	18.3	10.1	22.6	23.2	13.5	23.6

"–" – there was no data on the status of the breeding farm.

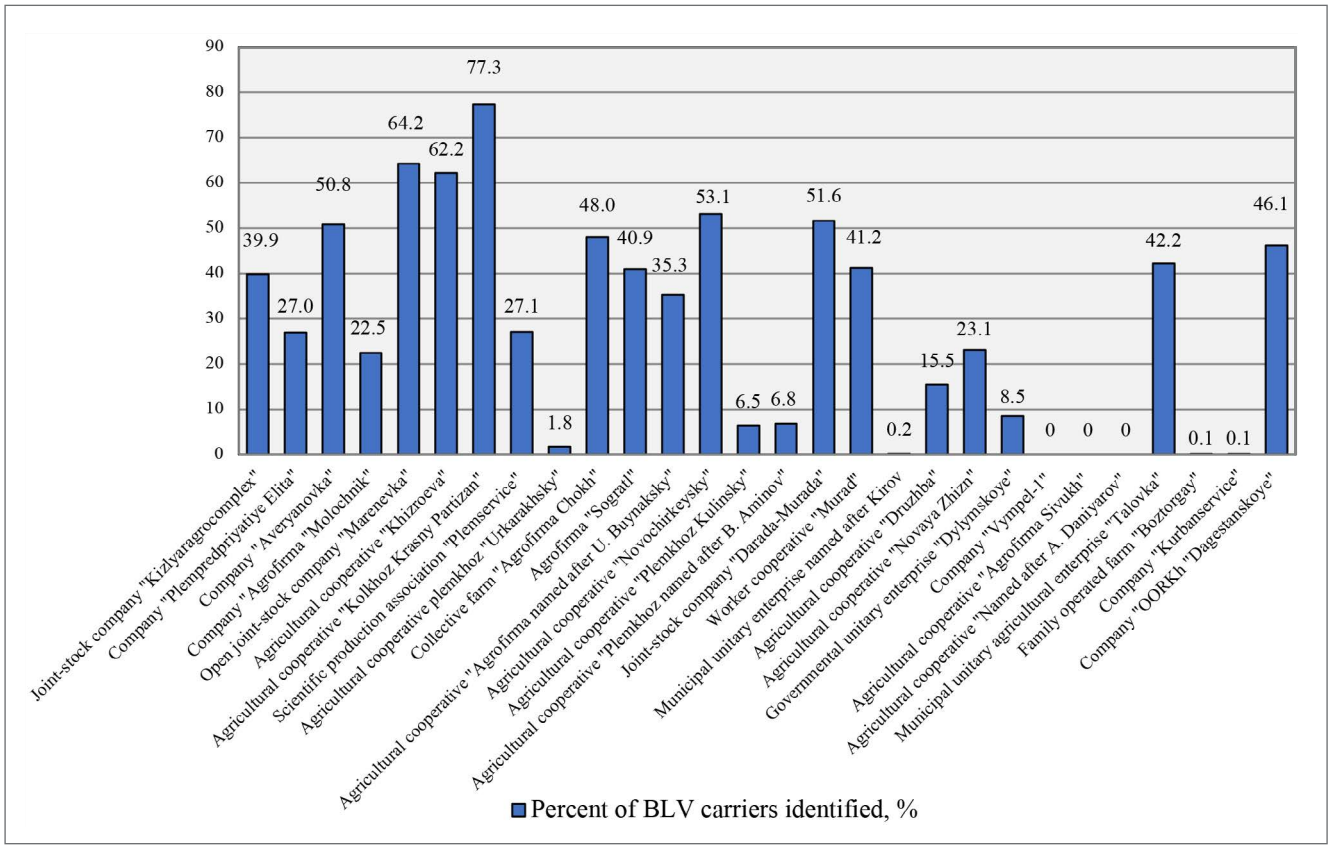

Fig. 3. The BLV infection rate on the breeding farms in the Republic of Dagestan in 2009–2017 (%)

from 10 to 30%, on the remaining breeding farms the infection rate ranged from 35.3 to 77.3% (Fig. 3).

In 2009, BL restrictions were officially imposed on 17 farms, 9 of which were breeding farms.

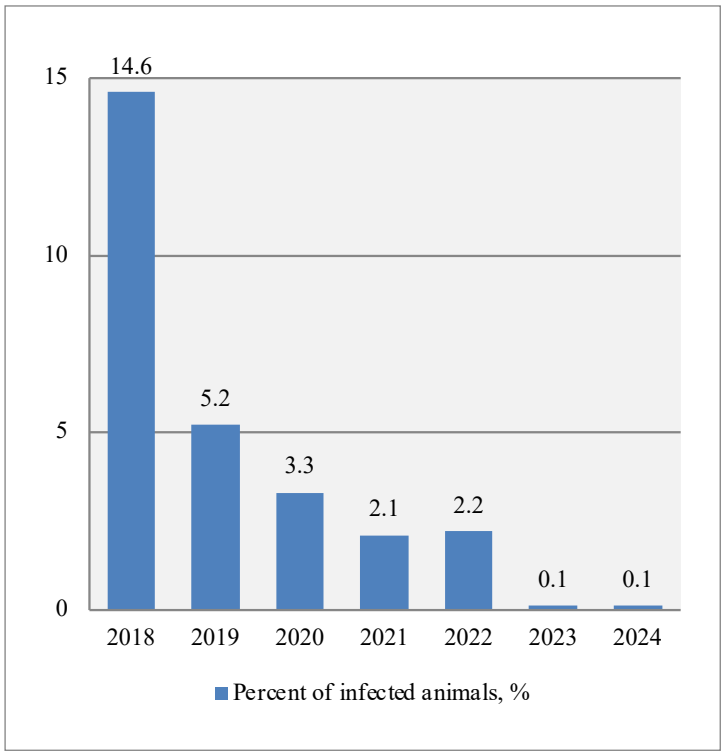

Fig. 4. Dynamics of BLV infection on the breeding farms in the Republic of Dagestan in 2018–2014

By 2013, one additional breeding farm was identified as affected, while health status of animals on 2 farms was improved. However, for a prolonged period (as of January 1, 2019), a significant number of breeding farms remained BLV-positive (agricultural cooperative "Agrofirma named after U. Buynaksky", agricultural cooperative "Kolkhoz Krasny Partizan", scientific production association "Plemservice", agricultural cooperative "Plemkhoz Kulinsky", agricultural cooperative "Plemkhoz named after B. Aminov", agricultural cooperative "Druzhba", governmental unitary enterprise "Dylymskoye", agricultural cooperative "Novaya Zhizn") [23, 24, 25].

When assessing the disease situation, it is important to note that leukosis intensity varied significantly across breeding farms in the Republic of Dagestan. The disease's widespread persistence is attributed to several key factors: the long-standing infection on these farms, a lack of comprehensive control measures, and insufficient diagnostic coverage. From 2009 to 2017, serological testing rates remained critically low, at only 17.5–21.6%.

It should be noted that the number of breeding farms in the region often varied depending on the disease situation. Due to BL restrictive measures, some breeding farms were converted to commercial farms.

Thus, a tense situation regarding BLV persisted in the region's breeding farms until 2017. The presence of hematologically BL-diseased animals and BLV-infected animals was confirmed in almost all breeding herds. In fact, with the exception of agricultural cooperatives "Plemkhoz Kulinsky" and "Plemkhoz

Table 2
Serological testing of cattle for BL on the breeding farms in the Republic of Dagestan in 2018–2024

No. item	2018			2019			2020			2021			2022			2023			2024		
	tests	+	%	tests	+	%	tests	+	%	tests	+	%	tests	+	%	tests	+	%	tests	+	%
1	2,474	705	28.5	6,633	488	7.4	6,062	128	2.1	6,192	98	1.6	2,449	216	8.8	470	13	2.8	619	11	1.8
2	51	34	66.7	851	29	3.4	1,221	255	20.9	813	78	9.6	2,264	23	1.0	1,548	0	0	–	–	–
3	–	–	–	150	91	60.7	533	1	0.2	807	70	8.7	1,223	37	3.0	1,457	0	0	–	–	–
4	422	18	4.3	1,927	96	5.0	1,505	83	5.5	2,017	63	3.1	1,383	20	1.4	1,295	0	0	1,377	0	0
5	511	102	20.0	1,067	83	7.8	1,273	51	4.0	1,751	77	4.4	831	46	5.5	897	0	0	1,457	0	0
6	144	5	3.5	785	4	0.5	415	8	1.9	492	4	0.8	520	11	2.1	660	0	0	510	0	0
7	58	1	1.7	130	1	0.8	158	3	1.9	232	3	1.3	130	0	0	623	0	0	–	–	–
8	67	22	32.8	197	0	0	365	0	0	526	0	0	778	20	2.6	–	–	–	350	0	0
9	640	28	4.4	1,131	83	7.3	1,376	0	0	1,115	9	0.8	1,534	0	0	1,553	0	0	1,060	0	0
10	361	7	1.9	630	5	0.8	700	9	1.3	315	3	1.0	553	0	0	553	0	0	580	0	0
11	1,009	71	7.0	2,028	18	0.9	1,167	0	0	1,192	0	0	1,171	0	0	1,643	0	0	1,646	0	0
12	1,010	0	0	890	0	0	1,185	0	0	1,368	0	0	1,667	0	0	1,809	0	0	2,005	0	0
13	221	44	19.9	306	50	16.3	363	57	15.7	172	0	0	–	–	–	–	–	–	–	–	–
14	161	5	3.1	395	2	0.5	196	5	2.6	180	0	0	–	–	–	–	–	–	–	–	–
15	250	31	12.4	317	50	15.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	–	942	4	0.4	905	0	0	875	0	0	1,002	0	0	1,045	0	0	1296	0	0
17	199	49	24.6	506	49	9.7	403	0	0	65	0	0	–	–	–	–	–	–	–	–	–
18	198	38	19.2	565	2	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19	114	9	7.9	243	2	0.8	–	–	–	–	–	–	–	–	–	267	0	0	271	0	0
20	168	5	3.0	830	6	0.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	505	0	0	1054	0	0
22	–	–	–	–	–	–	86	0	0	270	0	0	114	0	0	126	0	0	140	0	0
23	–	–	–	–	–	–	353	1	0.3	555	2	0.4	767	0	0	1,768	0	0	832	0	0
24	–	–	–	–	–	–	–	–	–	–	–	–	280	0	0	344	0	0	419	0	0
25	–	–	–	–	–	–	–	–	–	–	–	–	261	0	0	320	0	0	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	253	0	0
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	756	0	0
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	230	0	0
Total number	8,058	1,174	14.6	20,523	1,063	5.2	18,266	601	3.3	18,937	407	2.1	16,927	373	2.2	16,883	13	0.1	14,855	11	0.1

* No. (breeding farms): 1 – joint-stock company "Kizlyaragrocomplex", 2 – joint-stock company "Darada-Murada", 3 – worker cooperative "Murad", 4 – collective farm "Agrofirma Chokh", 5 – agrofirma "Sogratl", 6 – agricultural cooperative "Kolkhoz Krasny Partizan", 7 – agricultural cooperative "Alkhas Kuli", 8 – scientific production association "Plemservice", 9 – agricultural cooperative "Plemkhoz Kulinsky", 10 – agricultural cooperative "Plemkhoz named after B. Aminov", 11 – agricultural cooperative "Agrofirma named after U. Buynaksky", 12 – company "Kurbanservice", 13 – agricultural cooperative "Novaya Zhizn", 14 – governmental unitary enterprise "Dylymskoye", 15 – agricultural cooperative "Druzhba", 16 – company "Vympel-1", 17 – company "Averyanovka", 18 – agricultural cooperative "Novochirkeysky", 19 – agricultural cooperative plemkhoz "Urkarakhsky", 20 – agricultural cooperative "Khizroeva", 21 – family operated farm "Iman", 22 – agricultural cooperative "Ulluchai", 23 – agricultural cooperative "Mesed", 24 – agricultural artel "Otgonnik", 25 – family operated farm "Kosulya", 26 – agricultural cooperative "Agrofirma-Tsovkra-2", 27 – company "Chirkeysky ecoproduct", 28 – company "Chokh-Agroproduct";
"+" – number of animals infected with BLV; "–" – no data on the status of the breeding farm.

named after B. Aminov" in the highland zone, all other breeding farms were affected by leukosis.

The most valuable cattle gene pool in Dagestan is concentrated on breeding farms where leukosis infection was also was also widespread. Therefore, in the following years, the primary task for the regional veterinary service became the health improvement on breeding farms from leukosis infection.

This was particularly critical as these farms concentrated Dagestan's most valuable cattle gene pool. Consequently, the regional veterinary service prioritized the improvement of animal health on these breeding farms from leukosis.

A large-scale, systematic effort began with the adoption of the "Bovine Leukosis Prevention and Control Action Plan in the Republic of Dagestan"[4] and the subprogram "Prevention and Eradication of Bovine Leukosis on Farms in the Republic of Dagestan" under a republican target program[5], which has been extended through the current year. The health improvement strategy on BL-affected farms (herds) involves culling and sending for slaughter of all seropositive animals identified during routine laboratory testing.

It should be noted that since 2019, serological testing has covered nearly the entire susceptible cattle population on breeding farms. The resulting trend of reduced BLV infection from 2018 to 2024 is presented in Table 2 and Figure 4.

Over the seven-year period, state veterinary service laboratories tested 114,449 blood serum samples using the AGID test obtained from 28 regional operational breeding farms, revealing an average infection rate of 3.2%. Hematological testing for BLV-infected animals has been discontinued, as all BLV-infected animals are now sent for immediate slaughter without being held over.

Analysis of infection dynamics confirms a consistent downward trend in BLV infection rate among susceptible animals (Fig. 4). Specifically, the infection rate (carrier state) among the tested livestock dropped from 14.6% in 2018 to 5.2% in 2019, 3.3% in 2020, 2.1% in 2021, 2.2% in 2022, and 0.1% in 2023. This progress was sustained in 2024, with only 11 AGID-positive animals (0.1%) detected out of 14,855 tested, underscoring the stability and efficacy of the control measures implemented on the breeding farms in the Republic of Dagestan. The BLV-infected animals were traced to a single source: company "Plempredpriyatiye Elita", a subsidiary of joint-stock company "Kizlyaragrocomplex".

CONCLUSION

Epizootological analysis confirmed a heterogeneous pattern in the spread and progression of BL. The comprehensive system of measures implemented in the Republic of Dagestan aimed at prevention and eradication of BL has successfully stabilized the disease situation and significantly reduced the level of BLV infection on breeding farms. As a result of these systematic veterinary efforts, the breeding farms are now recognized as leukosis-free. Ongoing health improvement work, based on serological testing and the immediate culling of AGID-positive reactors, remains in place to sustain this status.

[4] https://docs.cntd.ru/document/450340001

[5] https://docs.cntd.ru/document/550147549

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