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Dynamics of blackleg epizootic process in the Republic of Kazakhstan

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ABSTRACT

In 2012–2021, 2,030 outbreaks of acute infectious animal diseases were registered in the Republic of Kazakhstan. Among all the diseases blackleg accounted for 20.7% (421 outbreaks), which suggests that the nosological unit is of high epizootological significance among other infectious animal diseases in the country. Analysis of the blackleg outbreaks registered over the recent 10 years demonstrates a significant annual growth in the number of outbreaks (from 19 to 81 outbreaks) in the Republic of Kazakhstan and the disease persistence in the territory. Within the mentioned period, the average number of blackleg-infected animals per one outbreak ranged between 1 and 3 animals, which proves that blackleg is a non-contagious disease. The research indicates that blackleg is a seasonal disease in the Republic of Kazakhstan with an incidence rise in autumn. The data analysis for 2012–2022 did not reveal any regular blackleg epizooties. The epizootological zoning made it possible to conclude that the blackleg situation in 6 oblasts (which account for 42.8% of the total territory) was rather tense; in 5 oblasts (35.7% of the country's territory) the epizootic situation was less tense and the remaining 3 (21.5%) oblasts are disease-free. Therefore, blackleg zoning in the Republic makes it possible to use a differential approach to planning preventive veterinary and control measures, depending on the intensity of the epizootic situation. The research results will help to improve the system of blackleg surveillance, to predict the disease spread in animals and can be used to develop anti-epizootic measures.

Keywords: blackleg, outbreak, intensity of the epizootic situation

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Динамика эпизоотического процесса эмфизематозного карбункула животных на территории Республики Казахстан

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РЕЗЮМЕ

В 2012–2021 гг. на территории Республики Казахстан было зарегистрировано 2030 очагов острых инфекционных болезней животных, доля эмфизематозного карбункула животных из их числа составила 20,7% (421 очаг), что указывает на важное эпизоотологическое значение данной нозоединицы в инфекционной патологии животных в стране. Результаты анализа количества зарегистрированных очагов эмкара за 10 лет свидетельствуют о ежегодном (от 19 до 81 очага) значительном распространении заболевания на территории Республики Казахстан и о его стационарности. За этот период показатель

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очаговости по эмкару составил в среднем от 1 до 3 животных на один очаг, что свидетельствует о неконтагиозности эмкарной инфекции. Результаты исследований указывают на то, что эмкар в Республике Казахстан имеет сезонный характер с подъемом заболеваемости в осенние месяцы года, анализ данных за 2012–2022 гг. периодичности эпизоотий не выявил. Проведенное эпизоотологическое зонирование позволило установить, что в 6 областях, площадь которых составляет 42,8% площади всей территории республики, наблюдался высокий уровень напряженности эпизоотической ситуации по эмкару; в 5 областях, занимающих 35,7% территории страны, отмечена низкая степень напряженности эпизоотической ситуации; остальные 3 (21,5%) являются благополучными по заболеванию. Таким образом, зонирование территории республики по эмкару дает возможность дифференцированно планировать профилактические ветеринарные мероприятия и меры борьбы с ним по отдельным территориям (зонам) в зависимости от напряженности эпизоотической ситуации. Полученные результаты исследований позволят усовершенствовать систему эпизоотологического надзора за эмкарной инфекцией, прогнозировать возможное территориальное расширение распространения заболеваемости животных и могут быть использованы при разработке противоэпизоотических мероприятий.

Ключевые слова: эмкар, эпизоотический очаг, напряженность эпизоотической ситуации

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INTRODUCTION

Blackleg (*Gangraena emphysematosa*) is an acute, non-contagious toxic infection of cattle, characterized by rapidly increasing crepitate swellings in muscles and lameness. Cattle, including buffaloes, are susceptible to blackleg. In sheep, blackleg causative agent is of no particular importance; it is more often isolated during malignant edema. Cattle of improved breeds, purebreds and particularly meat cattle (that have more muscle mass and are thick-fleshed) are more susceptible to blackleg. Animals brought to the infected area from other farms, or imported animals often get infected. Cattle of any age can get diseased, but young animals aged from 3 months to 3–4 years are the most susceptible [1, 2, 3, 4, 5, 6, 7].

Blackleg is caused by an anaerobic bacterium *Clostridium chauvoei*. It is a straight or slightly curved rod with rounded ends, observed either single or in pairs, less often in short chains; gram-positive in young cultures. The pathogen spores are very stable: they remain viable in soil for several years, in rotting muscles and manure for up to 6 months and at the bottom of water-bodies for over 10 years. Under appropriate conditions, the bacteria can survive and multiply in soil. Many researchers have studied the blackleg pathogen properties [8, 9, 10, 11, 12]. The blackleg agent synthesizes and releases an exotoxin. Hemotoxic and necrotizing components were found in the toxin. The ability of the agent to produce aggressins is another diagnostic criterion [13, 14, 15, 16].

Blackleg is seen in livestock all over the world, regardless of the geographical location and soil and climatic conditions. It causes great economic damage to the infected farms resulting from the livestock death and the cost of anti-epizootic measures [17, 18, 19, 20, 21]. In the CIS countries, the disease has been registered in all regions [22, 23, 24].

Blackleg has been known to herdsmen since ancient times. Kazakhs have long been able to distinguish this disease from anthrax and named it "karasan" (black thigh, black rump).

In Kazakhstan blackleg is an issue of top priority among other animal infectious diseases. Many regions of the Republic, regardless of their geographical location and soil and climatic conditions, are permanently infected by the disease [25, 26, 27]. If detected late or the required measures are taken with delays, the disease can cause serious damage to the livestock industry of the Republic resulting from the animal death and the cost of anti-epizootic measures. Regardless of the scheduled vaccinations and measures taken to prevent, detect and eliminate the outbreaks, the disease remains a serious concern in the infected areas that needs further investigation.

Due to the urgency of the problem, the purpose of this research is to implement monitoring activities and to draw a blackleg map of the Republic of Kazakhstan so that to depict current epizootic situation based on the epizootic tension.

The novelty of the research consists in studying common patterns and epizootic trends of the disease spread and in obtaining new epizootological data that will be used to draw an epizootic map of the Republic of Kazakhstan that will depict blackleg-infected areas, thus, helping to efficiently plan and implement measures to control the disease.

The purpose of the work is to assess the epizootic situation on blackleg in 2012–2021 and to zone the territory

of the Republic of Kazakhstan following analysis of the epizootic tension.

MATERIALS AND METHODS

For the purposes of this research, we used the blackleg diagnostic methods officially stipulated by GOST 26503-85. For the purposes of epizootological monitoring, we used the methods described in relevant guidelines [28, 29].

Tension of the epizootic situation on blackleg was calculated using the formula:

$$W = n / N \times t / T,$$

where W – the value of the epizootic tension; n – the number of blackleg outbreaks in 2012–2021; N – the total number of outbreaks of acute infectious diseases in 2012–2021; t – the time when the disease was registered; T – the observation time (years).

In order to study the blackleg-related epizootic process and ensure control over the disease, we collected and analyzed statistics and official reports from the Committee for Veterinary Control and Supervision of the Ministry of Agriculture of the Republic of Kazakhstan and the Republican Veterinary Laboratory. We used the results obtained by the veterinary laboratories and project executors during serological and bacteriological tests, during epizootological and immunological monitoring and blackleg control activities. We used the materials collected after clinical and epizootic examination of blackleg outbreaks in the districts and oblasts.

For the zoning purposes, we used retrospective data on blackleg outbreaks for some years in oblasts. The data were analyzed and an epizootic map was drawn to depict the oblasts with varying risk of infection.

RESULTS AND DISCUSSION

In order to assess the blackleg situation in the Republic of Kazakhstan, we analyzed epizootic data for 10 years.

Table 1 shows the number of outbreaks of acute infectious animal diseases and blackleg registered in the Republic of Kazakhstan in 2012–2021.

During the analyzed period 2,030 outbreaks of acute infectious animal diseases were registered in the Republic, 421 of them were blackleg outbreaks, that is, the disease share in the total number of outbreaks of acute infectious diseases was 20.7%. Outbreaks of rabies and blackleg were most often recorded in 2012–2021. Next in descending order are pasteurellosis, avian influenza, bovine viral diarrhea and rhinotracheitis, etc. In some years, in some oblasts, the share of blackleg in the total number of infectious diseases ranged from 68.8% (2021, Aktobe Oblast) to 86.2% (2019, West Kazakhstan Oblast). These data demonstrate epizootological importance of blackleg among other animal pathogens in the Republic of Kazakhstan.

The number of registered outbreaks over a certain period can also add to the country's epizootic landscape. Thus, the average annual number of blackleg outbreaks per oblast in the Republic can be calculated by dividing the total number of blackleg outbreaks over a ten-year period by the number of territorial units of Kazakhstan: 421 / 14 = 30.

Therefore, the oblasts, where the number of blackleg outbreaks is above 30, can be regarded as territories with a high blackleg prevalence: West Kazakhstan Oblast – 176 outbreaks, East Kazakhstan Oblast – 83, Zhambyl Oblast – 52, Almaty Oblast – 36, Aktobe Oblast – 33, and below 30 – with medium and low prevalence: Pavlodar

Table 1
Number of outbreaks of acute infectious animal diseases and blackleg in 2012–2021

Oblast	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	For the whole period
West Kazakhstan	14/7	45/15	64/23	57/31	23/8	10/3	31/10	29/25	61/47	14/7	348/176
East Kazakhstan	47/5	28/0	32/8	55/5	18/3	24/12	29/13	25/13	38/12	24/12	320/83
Zhambyl	57/4	32/3	21/4	29/2	25/4	34/15	15/7	24/10	8/1	30/2	275/52
Almaty	22/0	18/0	10/0	14/1	15/1	24/14	13/5	20/7	8/4	11/4	155/36
Aktobe	8/2	15/0	8/1	10/2	11/1	9/2	12/3	9/3	15/8	16/11	113/33
Pavlodar	0/0	4/0	6/1	14/3	6/2	3/1	2/0	6/2	26/5	14/3	81/17
Kostanay	7/3	18/0	2/0	17/1	10/2	4/0	7/0	44/1	19//1	17/1	145/9
Karaganda	2/0	10/1	8/2	19/0	8/0	7/0	11/1	5/1	15/1	8/2	93/8
Atyrau	4/0	6/0	9/0	9/0	16/0	7/0	14/1	6/1	7/1	0/0	78/3
Akmola	9/1	15/0	12/0	23/0	2/0	1/0	7/0	4/0	25/1	23/1	121/3
North Kazakhstan	1/0	8/0	3/0	3/0	2/0	2/0	2/0	2/0	56/0	47/1	126/1
Kyzylorda	0/0	0/0	0/0	6/0	0/0	0/0	0/0	0/0	4/0	0/0	10/0
Mangystau	4/0	4/0	4/0	3/0	0/0	0/0	15/0	1/0	6/0	0/0	37/0
Turkistan	5/0	9/0	15/0	18/0	13/0	17/0	5/0	8/0	38/0	0/0	128/0
Total	180/22	212/19	194/39	277/45	149/21	142/47	163/40	183/63	326/81	204/44	2,030/421

* In the numerator – total number of outbreaks of acute infectious diseases; in the denominator – number of blackleg outbreaks.

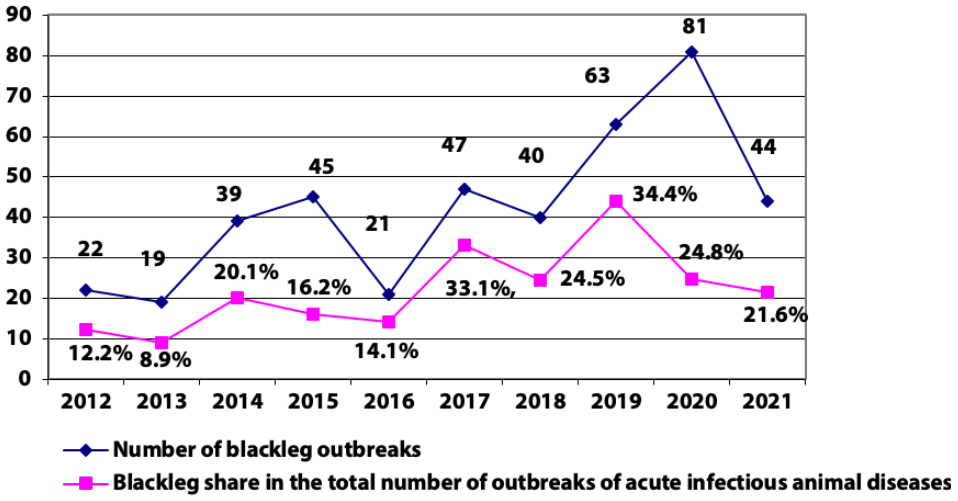

Fig. 1. Registration of blackleg outbreaks and its share in the total number of acute infectious animal diseases in the Republic of Kazakhstan (2012–2021)

Oblast – 17, Kostanay Oblast – 9, Karaganda Oblast – 8, Atyrau Oblast – 3, Akmola Oblast – 3, North Kazakhstan Oblast – 1. The remaining three oblasts (Kyzylorda, Mangystau, Turkistan) are considered free from this infection.

Figure 1 shows dynamics of blackleg registration in the Republic of Kazakhstan and its share in the total number of acute infectious animal diseases in 2012–2021.

As you can see, the curve reflecting the share of blackleg in the total number of infectious animal diseases has been running almost parallel to the curve showing the annual number of the disease outbreaks all these years. The only exception is 2020, when the largest number of blackleg outbreaks (81) was recorded over a 10-year period, and its share in the total number of acute infectious animal diseases decreased by almost

Table 2
Indicators of the epizootic process in case of blackleg in the Republic of Kazakhstan for 2012–2021

Oblast	Indicators of the epizootic process						
	n	N	Blackleg share	t	T	Epizooty index	W
West Kazakhstan	176	348	50.5	10	10	1.0	0.51
East Kazakhstan	83	320	25.9	9	10	0.9	0.23
Aktobe	33	113	29.2	9	10	0.9	0.26
Zhambyl	52	275	18.9	10	10	1.0	0.19
Almaty	36	155	23.2	7	10	0.7	0.16
Pavlodar	17	81	20.9	7	10	0.7	0.15
Kostanay	9	145	6.2	6	10	0.6	0.04
Karaganda	8	93	8.6	6	10	0.6	0.05
Atyrau	3	78	3.8	3	10	0.3	0.01
Akmola	3	121	2.5	3	10	0.3	0.01
North Kazakhstan	1	126	0.8	1	10	0,1	0.001
Kyzylorda	0	10	0	0	10	0	0
Mangystau	0	37	0	0	10	0	0
Turkistan	0	128	0	0	10	0	0
Total	421	2030	20.7	7.1	10	0.71	0.15

n – number of blackleg outbreaks; N – total number of outbreaks of acute infectious animal diseases in 2012–2021;
blackleg share – blackleg share in the total number of outbreaks of acute infectious animal diseases;
t – number of years when the disease was reported; T – time of observation; W – intensity of epizootic situation.

one and a half times (24.8%) compared to the previous year (34.4%).

Thus, the number of outbreaks registered over 10 years (2012–2021) was analyzed and the analysis showed there had been a significant annual increase in blackleg outbreaks in the Republic of Kazakhstan (from 19 to 81) and the infection was persistent.

To characterize the epizootic process, we apply an outbreak criterion, i.e. the average number of animals that have got diseased within one infected settlement. In 2012–2021, based on the criterion, when the average number of diseased animals in one outbreak in the Republic of Kazakhstan ranged between 1 to 3 animals per outbreak, we confirmed that blackleg is not a contagious disease. These data are consistent with the data of other researchers [30].

We earlier studied blackleg seasons in the Republic of Kazakhstan within 2016–2020. It was found that the maximum number of registered outbreaks was observed in November. Sixty nine outbreaks were recorded in November, which accounted for 27.4% of the total number (252) of registered blackleg outbreaks. This indicator was, in descending order: 25.4% in October, 11.9% in September, 10.3% in August, 7.9% in July, 4.7% in June, 2.7% in March, 2.4% in December; 1.9% were reported both in January and in February; and 1.6% in April and May of the total number of registered blackleg outbreaks over a 5-year period [31].

These data suggest seasonal manifestation of blackleg in the Republic of Kazakhstan (August, September, October and November), which makes it possible for researchers and veterinarians to specify the causes and factors of this pattern and adjust the ongoing preventive and anti-epizootic measures.

During epizootological observation, it is important to establish the frequency of epizooties – ups and downs repeated at certain intervals, usually lasting for several years. The regular time intervals are especially typical for epizooties of such infectious diseases that, due to the high contagiousness of their causative agents, affect most susceptible animals, as well as for spontaneously developing epizooties when effective anti-epizootic measures are not carried out. The blackleg process monitoring in the Republic of Kazakhstan in 2012–2021 did not help to determine the frequency of epizooties.

Based on the major criteria of the blackleg epizootic process over the past 10 years, the Republic of Kazakhstan was zoned according to the epizootic tension.

The tension of the epizootic situation is a comparative feature of particular territories, which implies intensive disease manifestation assessed according to some epizootological indicators.

Table 2 shows the main indicators of blackleg epizootic process in the Republic of Kazakhstan for 2012–2021, that are used to assess epizootic tension.

It was established that the mean tension indicator for the blackleg situation in the Republic of Kazakhstan in 2012–2021, was 0.15. Based on this, oblasts with the indicators of 0.15 and above were classified as territories with an increased epizootic tension, and below 0.15 – as territories with a low epizootic tension. Oblasts with W = 0 (Kyzylorda, Mangystau, Turkistan) were free from the disease during the period.

Based on the results obtained, a map of the Republic of Kazakhstan was drawn to depict zones according to the tension of the epizootic situation on blackleg in 2012–2021.

Figure 2 shows that during these years, 6 oblasts (i.e. West Kazakhstan, East Kazakhstan, Aktobe, Zhambyl, Almaty, Pavlodar) accounting for 42.8% of the Republic territory demonstrated an increased epizootic tension; 5 oblasts (Kostanay, Karaganda, Atyrau, Akmola, North

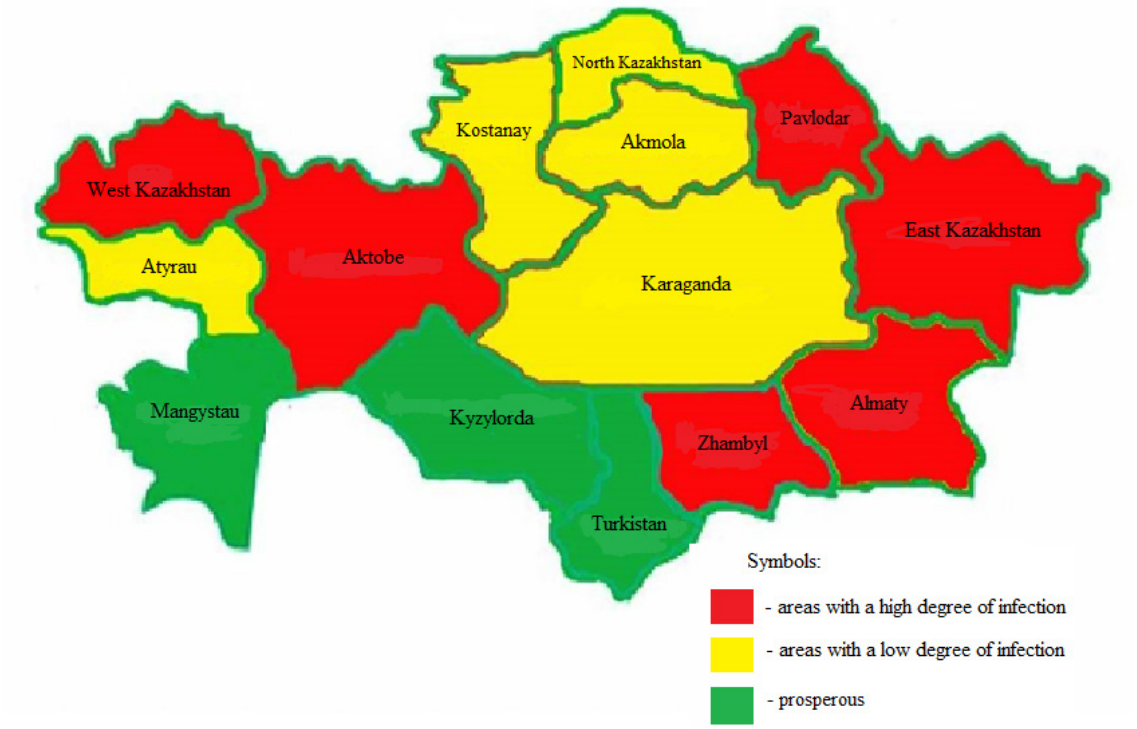

Fig. 2. Zoning the Republic of Kazakhstan according to the intensity of the blackleg epizootic situation in 2012–2021

Kazakhstan) accounting for 35.7% of the country's territory, demonstrated lower degree of epizootic tension.

Thus, 78.5% of the Republic of Kazakhstan turned out to be blackleg – infected from 2012 to 2021. The remaining three oblasts (21.5%): Kyzylorda, Mangystau, Turkistan – were free from the disease.

The epizootic zoning provides data that can be used to take a differentiated approach to planning preventive veterinary measures and measures to control blackleg in particular territories (zones), depending on the epizootic tension.

In the oblasts with an increased epizootic tension, preventive measures shall be applied on all the farms for all the susceptible farm animals of all the age groups.

In the oblasts with a low epizootic tension, preventive vaccination of susceptible livestock in the disease-infected settlements shall be provided. In the territories where the disease has not been registered during the entire research, general veterinary and sanitary measures shall be taken.

The obtained results make it possible to improve the system of blackleg surveillance, to predict the disease spread in animals and these results can be used to develop anti-epizootic measures.

CONCLUSION

The research results show that the ultimate goal has been achieved: the epizootic situation in 2012–2021 was assessed and the Republic of Kazakhstan was zoned according to the epizootic tension.

It was found, that 2,030 outbreaks of acute infectious animal diseases were registered in the Republic of Kazakhstan from 2012 to 2021 (10 years), 421 out of them were blackleg outbreaks, that is, the share of this disease in the total number of acute infectious diseases was 20.7%, which suggests epizootological significance of blackleg in the infectious pathology of animals.

The analysis of the registered outbreaks during this period indicates that every year blackleg easily spreads in the Republic of Kazakhstan (from 19 to 81 outbreaks) and remains persistent.

In order to characterize the blackleg epizootic process, we calculated the average number of blackleg-infected animals per one outbreak (outbreak criterion) as ranging between 1 and 3 animals. It proves that blackleg is a non-contagious disease.

The research indicates that blackleg in the Republic of Kazakhstan is seasonal (August, September, October and November) and the frequency of epizooties was not established during observation of the epizootic processes in 2012–2021.

Based on the main indicators of the epizootic process over the past 10 years, territory of the Republic of Kazakhstan was zoned according to the tension of the epizootic situation on blackleg in 2012–2021. The zoning makes it possible to use a differential approach to planning anti-epizootic measures, depending on the tension of the epizootic situation.

REFERENCES

1. Danilyuk A. V., Kapustin A. V. The prevalence and species diversity of clostridia, the causative agents of anaerobic infections in cattle. *Proceedings of the All-Russian Research Institute of Experimental Veterinary Medicine. Ya. R. Kovalenko*. 2019; 81: 19–26. DOI: 10.30917/ATT-PRINT-2019-10. (in Russ.)

2. Datta S., Karmakar U. K. Black quarter in a cow: A case report. *Exploratory Animal and Medical Research*. 2017; 7 (1): 113–115. Available at: https://animalmedicalresearch.org/Vol.7_Issue-1_June_2017/Sanjoy%20Dutta.pdf.

3. Ziech R. E., Gressler L. T., Frey J., de Vargas A. C. Blackleg in cattle: current understanding and future research needs. *Ciência Rural*. 2018; 48:e20170939. DOI: 10.1590/0103-8478cr20170939.

4. Daly R. F., Miskimins D. W., Good R. G., Stenberg T. Blackleg (*Clostridium chauvoei* infection) in beef calves: a review and presentation of two cases with uncommon pathologic presentations. *The Bovine Practitioner*. 2009; 43 (2): 153–158. DOI: 10.21423/bovine-vol43no2p153-158.

5. Harwood D. G., Higgins R. J., Aggett D. J. Outbreak of intestinal and lingual *Clostridium chauvoei* infection in two-year-old Friesian heifers. *Veterinary Record*. 2007; 161 (9): 307–308. DOI: 10.1136/vr.161.9.307.

6. Kriek N. P. J., Odendaal M. W. *Clostridium chauvoei* infections. *In: Infectious diseases of livestock. Ed. by R. Coetzer, R. C. Tustin. 2nd ed.* Oxford: Oxford University Press; 2004; 1856–1862.

7. Useh N. M., Nok A. J., Esievo K. A. N. Blackleg in ruminants. *CABI Reviews*. 2006; 1 (040): 1–8. DOI: 10.1079/PAVSNNR20061040.

8. Minett F. C. Pathogenesis of black quarter; tissue damage and spore latency. *The Journal of comparative pathology and therapeutics*. 1948; 58 (3): 201–209. DOI: 10.1016/s0368-1742(48)80020-2.

9. Pires P. S., Santos R. L., da Paixão T. A., de Oliveira Bernardes L. C., de Macêdo A. A., Gonçalves L. A., et al. Intracellular survival of *Clostridium chauvoei* in bovine macrophages. *Veterinary Microbiology*. 2017; 199: 1–7. DOI: 10.1016/j.vetmic.2016.11.027.

10. Rychener L., In-Albon S., Djordjevic S. P., Chowdhury P. R., Nicholson P., Ziech R. E., et al. *Clostridium chauvoei*, an evolutionary dead-end pathogen. *Frontiers in Microbiology*. 2017; 8:1054. DOI: 10.3389/fmicb.2017.01054.

11. Schocken-Iturrino R. P., et al. Presence of viable spores of bacteria of the genus *Clostridium* in muscle and liver of bovine slaughtered for consumption. *ARS Veterinária*. 2000; 16: 109–111. (in Portuguese)

12. Kolesnikova Y. N., Pimenov N. V., Kapustin A. V. The etiology of anaerobic infections of cattle and comparative characteristics of the isolated strains of clostridium. *Russian Journal of Agricultural and Socio-Economic Sciences*. 2016; 8 (56): 39–48. DOI: 10.18551/rjoas.2016-08.07. (in Russ.)

13. Useh N. M., Nok A. J., Esievo K. A. N. Pathogenesis and pathology of blackleg in ruminants: the role of toxins and neuraminidase. A short review. *Veterinary Quarterly*. 2003; 25 (4): 155–159. DOI: 10.1080/01652176.2003.9695158.

14. Frey J., Johansson A., Bürki S., Vilei E. M., Redhead K. Cytotoxin CctA, a major virulence factor of *Clostridium chauvoei* conferring protective immunity against myonecrosis. *Vaccine*. 2012; 30 (37): 5500–5505. DOI: 10.1016/j.vaccine.2012.06.050.

15. Mudenda Hang'ombe B., Kohda T., Mukamoto M., Kozaki S. Purification and sensitivity of *Clostridium chauvoei* hemolysin to various erythrocytes. *Comparative Immunology, Microbiology and Infectious Diseases*. 2006; 29 (4): 263–268. DOI: 10.1016/j.cimid.2006.06.002.

16. Cortiñas T. I., Mattar M. A., de Guzmán A. M. S. Alpha and beta toxin activities in local strains of *Clostridium chauvoei*. *Anaerobe*. 1999; 5: 297–299. DOI: 10.1006/anae.1999.0211.

17. Abreu C. C., Blanchard P. C., Adaska J. M., Moeller R. B., Anderson M., Navarro M. A., et al. Pathology of blackleg in cattle in California, 1991–2015. *Journal of Veterinary Diagnostic Investigation.* 2018; 30: 894–901. DOI: 10.1177/1040638718808567.

18. Heckler R. F., de Lemos R. A. A., Gomes D. C., Dutra I. S., Silva R. O. S., Lobato F. C. F., et al. Blackleg in cattle in the state Mato Grosso do Sul, Brazil: 59 cases. *Pesquisa Veterinária Brasileira.* 2018; 38 (1): 6–14. DOI: 10.1590/1678-5150-pvb-4964.

19. Hussain R., Ehtisham-ul-Haque S., Khan I., Jabeen G., Siddique A. B., Ghaffar A., et al. Clinico-hematological, patho-anatomical and molecular based investigation of blackleg disease in Cholistani cattle. *Pakistan Journal of Agricultural sciences.* 2021; 58 (3): 1017–1025. DOI: 10.21162/PAKJAS/21.1240.

20. Gacem F., Madadi M. A., Khecha N., Bakour R. Study of vaccinal properties of *Clostridium chauvoei* strains isolated during a blackleg outbreak in cattle in Algeria. *Kafkas üniversitesi veteriner fakültesi dergisi.* 2015; 21 (6): 825–829. DOI: 10.9775/kvfd.2015.13616.

21. Wolf R., Hiesel J., Kuchling S., Deutz A., Kastelic J., Barkema H. W., Wagner P. Spatial-temporal cluster analysis of fatal *Clostridium chauvoei* cases among cattle in Styria, Austria between 1986 and 2013. *Preventive Veterinary Medicine.* 2017; 138: 134–138. DOI: 10.1016/j.prevetmed.2017.01.019.

22. Blokhin A. A., Toropova N. N., Burova O. A., Iashin I. V., Zakharova O. I. Blackleg in cattle in the Irkutsk Region. *Frontiers in Veterinary Science.* 2022; 9:872386. DOI: 10.3389/fvets.2022.872386.

23. Kapustin A. V., Aliper T. I. Epizootologiya i profilaktika klostridiozov krupnogo rogatogo skota = Epizootology and prevention of bovine clostridiosis. *Edinyi mir – edinoe zdorov'e: materialy kongressa (Ufa, 19–21 aprelya 2017 g.) = One world – one health: proceedings of the Congress (Ufa, April 19–21, 2017).* Ufa: Russian Veterinary Association; 2017; 106–108. EDN: ZARMNR. (in Russ.)

24. Maksimovich V. V., Bagretsov V. F., Biletsky O. R., Bublov A. V., Verbitskiy A. A., Gaisenok S. L., et al. Epizootology and infectious diseases: textbook. 2nd ed., revised and supplemented. Minsk: IVTs Minfina; 2017; 106–108. (in Russ.)

25. Kaiyrbolat A. S. Epizooticheskaya situatsiya po emfizematoznomu karbunkulu v Kazakhstane = Epizootic situation on blackleg in Kazakhstan. *Seifullinskie chteniya – 16: Molodezhnaya nauka novoi formatsii – budushchee Kazakhstana: materialy mezhdunarodnoi nauchno-teoreticheskoi konferentsii (24 aprelya 2020 g.) = Seifullin readings – 16: Youth science of a new formation – the future of Kazakhstan: materials of the international scientific and theoretical conference (April 24, 2020)*. Nur-Sultan: KATU; 2020; 1 (1): 278–280. Available at: https://kazatu.edu.kz/assets/i/science/sf16-animal-130.pdf. (in Russ.)

26. Odarenko K. I., Gryazin V. I. Reaktsiya agglyutinatsii (RA) pri emfizematoznom karbunkule = Agglutination reaction (RA) in case of blackleg. *Trudy Kazakhskogo nauchno-issledovatel'skogo veterinarnogo instituta*. 1976; 16: 180–184. (in Russ.)

27. Aitzhanov B. D. Effectiveness of immunofluorescence for detection of pathogens and specific antibodies of blackleg and malignant edema in cattle and sheep: Author's Thesis for degree of Cand. Sci. (Veterinary Medicine). Almaty; 1986. 183 p. (in Russ.)

28. Bakulov I. A., Kneize A. V., Kotljarov V. M. Methodical guidance on epizootological monitoring of exotic highly dangerous and understudied animal diseases. Pokrov: VNIIVViM; 2005; 26–50. (in Russ.)

29. Makarov V. V., Svyatkovskiy A. V., Kuz'min V. A., Sukharev O. I. Epizootology research method: textbook. Saint Petersburg: Lan'; 2009; 13–29. (in Russ.)

30. Kovalenko Ya. R. Anaerobic infections in farm animals. Moscow: Sel'khozgiz; 1954. 360 p. (in Russ.)

31. Abutalip A., Laskavy V., Aitzhanov B., Baikadamova G., Abubekova A. Epizootic situation of animal emcar (blackleg) on the territory of the Repulic of Kazakhstan for 2010–2020. *Herald of Science of S. Seifullin Kazakh Agro Technical University.* 2022; 3 (114): 167–180. DOI: 10.51452/kazatu.2022.3(114).1173.

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