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PREVENTION OF BRONCHOPNEUMONIA BY THE AEROSOL METHOD AND ITS INFLUENCE ON CALF PRODUCTION INDICATORS

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The aim*: to determine the effectiveness of aerosol prophylaxis of nonspecific bronchopneumonia in calves by using a complex of biogenic compounds of macro- and microelements and plant immunomodulator Echinacea in the form of the drug Kalfmin on production indicators.*

Materials and methods. *The research was conducted in the farm "Podilsky owner 2004", v. Velyka Medvedivka, Shepetivka district, Khmelnitsky region on black-spotted calves, which were in the risk group for bronchopneumonia, taking into account certain technological components, namely – stress due to regrouping of animals, some adjustment of their feeding rations, some excess concentration of livestock animals in groups and other factors.*

Results. *The results of studies indicate a high therapeutic efficacy for the use of the drug "Kalfmin" group aerosol method in the treatment of patients with calf bronchopneumonia, as this drug enters the body in the same way as pathogens. It was found, that 40 % of calves in the control group, which did not receive preventive measures, have clinical signs of bronchopneumonia, and 10 % of cases were fatal. At the same time, signs of bronchopneumonia were found in only 10 % of calves in the experimental groups, who received aerosol prophylaxis according to the experimental scheme; their course was much easier and without fatal consequences.*

Conclusions. *Prevention of bronchopneumonia in young cattle should be comprehensive and aimed at eliminating violations of the technology of keeping, feeding and increasing the resistance of animals. Group aerosol prevention of nonspecific bronchopneumonia in calves using the drug Calfmin in combination with the plant immunomodulator Echinacea is a more promising and effective method of preventing this pathology compared with the use of turpentine, lactic acid and chlorinated lime. The use of the drug Kalfmin in combination with Echinacea is characterized by 1.60 time's higher efficiency and 1.70 times shorter period of prevention of animals*

Keywords: *nonspecific bronchopneumonia, aerosol prophylaxis, resistance, calves, trace elements, macronutrients, plant immunomodulators, Calfmin, Echinacea, efficacy*

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1. Introduction

Bronchopneumonia in young animals is registered in different climatic zones of Ukraine, and in terms of prevalence it ranks second after gastrointestinal diseases [1, 2]. About 20–30 % of calves get bronchopneumonia every year. The disease mainly occurs in winter and spring. The disease mainly affects calves from two weeks to 2–3 months of age. Bronchopneumonia causes significant economic losses to livestock from the cost of treatment, reduced productivity and death of animals [3, 4]. In the etiology of nonspecific bronchopneumonia in calves, in combination with reduced resistance, immunological reactivity of newborns [5, 6] and the action of adverse environmental factors, a large role is played by the bacterial microflora of the anterior respiratory tract, which under certain conditions becomes pathogenic [7]. In recent years, the incidence of calves with bronchopneumonia is increasing, due to reduced natural resistance of the body, suppression of immunity and lack of scientifically sound means and methods of prevention and treatment of animals [8–10]. Prevention of respiratory diseases of animals is based on a set of organizational and economic, zoohygienic and veterinary measures and ensuring full balanced feeding, compliance with optimal conditions for uterine care, hygiene and rearing, especially in the first weeks of life of young animals [11].

The most effective in bronchopneumonia is a comprehensive prevention of animals, which should be aimed at eliminating violations of the technology of keeping and feeding, increasing the resistance of animals [12]. Given the concentration of large numbers of animals in modern high-tech livestock enterprises, the problem of group treatment of animals comes to the fore. One of the methods of group treatment of animals is aerosol prophylaxis, which is increasingly used in intensive technologies in animal husbandry [13, 14].

The aim of the research was to determine the effectiveness of aerosol prophylaxis of nonspecific bronchopneumonia in calves by using a complex of biogenic compounds of macro- and microelements and plant im-

munomodulator Echinacea in the form of the drug Kalfmin on production indicators.

2. Materials and methods

The research was conducted in the farm "Podilsky owner 2004", v. Velyka Medvedivka, Shepetivka district, Khmelnitsky region, Ukraine on black-spotted calves, which were in the risk group for bronchopneumonia, taking into account certain technological components, namely – stress due to regrouping of animals, some adjustment of their feeding rations, some excess concentration of livestock animals in groups and other factors. For this purpose, according to the principle of analogues, 3 groups of clinically healthy calves of 1.5–2 months of age were formed, 50 animals in each group (control and two experimental groups). Aerosol treatments of calves of the control group were not performed.

All animal experiments must comply with ARRIVE guidelines and be carried out in accordance with the UK Animals (Scientific Procedures) Act 1986 and relevant guidelines or the EU Directive 2010/63/EU on the protection of animals, used for scientific purposes.

Group aerosol treatments of calves of the first experimental group were performed according to the generally accepted scheme in the farm, namely – using turpentine at the rate of 0.5 ml/m^3, lactic acid – 0.04 g/m^3 and chlorinated lime – 2 g/m^3. Multiplicity of aerosol treatment of animals – 1 time per day, exposure 45 minutes. Aerosol treatments of animals were carried out every other day, 12 days in a row.

To prevent nonspecific bronchopneumonia in calves of the second experimental group, we used the method of group aerosol treatments using our experimental drug Kalfmin based on compounds of biogenic macro- and microelements (Argentum, Cuprum, Iodine, Cobalt) and plant immunomodulator (Echinacea). The drug was used at a dose of 7 ml per head for 45 minutes. Aerosol treatments of animals were carried out on the 1st, 3rd, 7th days of the research. In order to prevent rapid evaporation of aerosol particles and the action of harmful gases, as well as their long-term retention in a suspended state, the experimental drug was added a stabilizer – 20 % glucose solution at a rate of 1 ml/m^3. Preventive aerosol treatments of animals were carried out in a separate room with carefully closed doors and windows with off ventilation. Blood for the research was taken from animals from the jugular vein in the morning before feeding. The number of erythrocytes, leukocytes, thrombocytes, hemoglobin content in the blood of animals was determined, and the leukogram was examined.

The research results were statistically processed using the Statistica program. Statistical processing of digital data was carried out using the Student's parametric criterion. The control of the effectiveness of aerosol prevention of bronchopneumonia in calves was carried out according to the following indicators: data from clinical trials of animals, the results of laboratory blood tests, production indicators of animals.

3. Research results

Nonspecific bronchopneumonia of calves is a polyetiological disease of non-infectious origin. A significant role in the etiology of this disease is played by cold factors, associated with the action of cold and humidity, in which the body's heat transfer exceeds the production of heat. Contributing factors to the occurrence and development of bronchopneumonia are long-term retention of calves in a room with high concentrations of ammonia and hydrogen sulfide in the air, which is possible with crowded animals, insufficient manure utilization and poor ventilation.

The aerosol method of prevention is the most effective measure to prevent the occurrence of respiratory diseases in animals, as the drug enters the body in the same way as pathogens. In this case, there is direct contact of the drug with the pathogenic microflora of the respiratory tract of animals and the lesion. As a result, more drugs are concentrated on the mucous membrane of the airways of animals than when administered intramuscularly or orally. This results in more efficient and faster absorption of the drug and reduces its costs by 4.0 times or more.

In the aerosol method of animal prevention, drugs are absorbed through the lungs, where then, through the small circulation, enter the large circulation, bypassing the liver, are rapidly absorbed into the blood and lymph, accumulate there and act directly on the affected areas of the lung tissue. Due to this, the activity of the drugs used is not reduced. In previous series of experiments, we found that the occurrence of bronchopneumonia in calves is observed more often at the age of 1.5–2 months, during the period of their transfer to the rearing group and is accompanied by immunodeficiency. Based on this, in this work we compared the effect of the drug Kalfmin on the resistance of calves and prevention of bronchopneumonia.

Table 1 shows the data, characterizing the growth of body weight of calves in the control and experimental groups according to the results of aerosol treatments of animals to prevent bronchopneumonia. The body weight of calves in the control and experimental groups at the beginning of the experiment did not differ statistically.

Table 1

Body weight of calves according to the results of their aerosol treatments according to the scheme of the farm and using the drug Kalfmin, kg (M±m, n=7)

Day of research	Groups of animals		
	Control: Without aerosol treatments	First research group: basic prevention	Second research group: "Kalfmin"
Start of research	51.49±1.10	52.29±1.32	52.03±1.21
End of research (after 30 days)	63.86±1.11***	68.51±1.48***▲	76.14±1.36***▲▲▲

*Note: *** – p≤0.001 relative to the original data; ▲ – p≤0.05; ▲▲▲ – p≤0.001 compared with the control group*

At the end of the experiment we found a significant increase in body weight of calves of the first experimental group, which used the basic aerosol treatment according to the scheme of the economy, relative to base-

line – by 28 % (p≤0.001), and relative to calves of the control group – by 12 % (p≤0.05).

The body weight of calves of the second experimental group, which was treated with aerosol treatment Kalfmin, for the same period of time compared to baseline increased by 35 % (p≤0.001), and compared with calves of the control group – by 13.7 % (p≤0.001).

The average daily weight gain of calves of the control group during the experiment was 412 g, while the one of calves of the first and second experimental groups 540 g and 780 g, respectively. That is, compared with calves of the control group, at the end of the experiment the average daily weight gain was 23 % (p≤0.001) significantly higher in calves of the first group and 38 % (p≤0.001) significantly higher in calves of the second experimental group. Note that the lower growth energy of calves in the control group may be due to their diseases of the gastrointestinal and respiratory diseases, which were manifested in these animals during our experimental studies. At the same time, the high preventive efficiency and speed of aerosol treatment of calves to prevent the occurrence of bronchopneumonia in them is confirmed by the results of our clinical and laboratory studies. The results of the studies indicate a positive trend in changes in hematological parameters of calves in the experimental groups compared with calves in the control group. At the beginning of aerosol prophylaxis, the number of erythrocytes, hemoglobin content, hematocrit and platelet count in the blood of calves of all experimental groups were within the normative indicators. Note that at the end of the experiment, the blood parameters of calves of the first experimental group, which were used for aerosol prophylaxis of nonspecific bronchopneumonia according to the scheme of the farm, were at the level of blood parameters of calves of the control group (Table 2).

Table 2

Blood parameters of calves for aerosol prophylaxis of nonspecific bronchopneumonia, (M±m, n=7)

Day of research	Control group	First research group: basic prevention	Second research group: "Kalfmin"
Erythrocytes, 10^{12}/l			
1 day	6.4±0.3	6.1±0.4	6.1±0.2
3 day	6.4±0.1	6.2±0.2	6.4±0.3
7 day	6.5±0.2	6.1±0.2	6.6±0.2
Hemoglobin, g/l			
1 day	108.0±1.5	104.4±2.1	108.0±1.9
3 day	115.5±2.0	115.7±1.8	120.5±1.1*
7 day	116.3±1.9	118.0±2.5	124.7±0.9*
Hematocrit, %			
1 day	39.0±1.0	42.7±0.8*	40.8±0.9
3 day	41.0±1.8	44.0±0.9	43.2±0.9
7 day	42.8±1.2	42.0±1.2	42.7±1.6
Platelets, 10^{9}/l			
1 day	251.7±10.3	281.6±19.3	294.0±16.9
3 day	286.2±7.4	310.6±9.4	312.4±3.7**
7 day	295.5±18.8	310.3±9.1	320.8±10.5

*Note: * – p≤0.05; ** – p≤0.01; *** – p≤0.001 compared to calves of the control group*

In the blood of calves of the second experimental group, which used the drug "Kalfmin" for aerosol prophylaxis of nonspecific bronchopneumonia, already on the 3rd day found a significantly higher hemoglobin content and a higher number of platelets in 1.05 (p≤0.05) and 1.10 (p≤0.01) times, respectively, compared with these indicators in calves of the control group.

On the 7th day of the study, the content of hemoglobin in the blood of calves of the second experimental group increased 1.2 times compared with this indicator at the beginning of the experiment and was significantly higher 1.1 times (p≤0.01) compared with this indicator in the blood of calves control group (Table 3).

Other blood parameters of calves of the second experimental group tended to improve at the end of the experiment, but did not have a significant difference compared with the corresponding blood parameters of calves of the control group. High safety of calves of the second experimental group may be due to the stimulating effect of the drug "Kalfmin" on cellular and humoral factors of body protection and the positive immunocorrective effect of immunomodulators on T- and B-lymphocytes of immunity, taking into account the positive dynamics of the leukogram of the animals. At the beginning of group aerosol prophylaxis in the blood of calves of all groups the number of leukocytes did not differ and this trend persisted throughout the period of the experimental studies. The analysis of the leukogram of the blood of calves of the experimental groups on the first day of the experiment showed a significant increase in the number of neutrophils by 1.3 times (p≤0.001), while reducing the number of lymphocytes by 1.1 times (p≤0.01) compared with these indicators in the blood of calves from the control group.

On the 3rd day of aerosol prophylaxis of calves of the second experimental group using the drug "Kalfmin" the number of neutrophils in their blood decreased compared to the first day by 1.3 times (p≤0.01), and the number of lymphocytes increased by 1.1 times p≤0.01). The leukogram of calves of the first experimental group, which was aerosol prophylaxis using the scheme of the farm, on the 3rd day was characterized by a tendency to reduce the number of rod and segmental neutrophils by 1.2 times (p≤0.001) and lymphocytes by 1.1 times

($p \leq 0.05$), compared with the first day. The leukogram of calves of the first experimental group did not differ from the leukogram of calves of the control group. On the 7th day of group aerosol prophylaxis, the leukogram of calves of both experimental groups had no significant differences compared with the leukogram of calves of the control group. Thus, the clinical indicators and blood parameters of calves of the second experimental group, which were aerosolized with the drug Kalfmin, at the end of the study had a better overall result compared to calves of the first experimental and control groups.

Table 3

Leukogram of calves for aerosol prevention of nonspecific bronchopneumonia(M±m, n=7)

Day of research	Control group	First research group: basic prevention	Second research group: "Kalfmin"
Leukocytes, 10^9/l			
1 day	5.1±0.3	5.2±0.2	5.4±0.3
3 day	5.3±0.3	5.5±0.1	5.3±0.3
7 day	5.4±0.1	5.5±0.3	5.7±0.2
Basophils, %			
1 day	0	0	0
3 day	0	0	0
7 day	0	0	0
Eosinophils, %			
1 day	1	1	1
3 day	1	1	1
7 day	0	1	0
Band neutrophils, %			
1 day	2.8±0.6	1.5±0.2*	1.2±0.2*
3 day	1.9±0.2	1.7±0.2	1.9±0.3
7 day	2.9±0.4	4.14±0.4	3.4±0.4
Segmental neutrophils, %			
1 day	27.2±0.7	34.4±0.4***	34.8±0.4***
3 day	26.3±0.8	29.6±1.4	27.3±1.7
7 day	26.8±0.7	28.7±0.6	26.7±2.1
Lymphocytes, %			
1 day	62.4±1.1	55.1±0.7***	56.6±0.7***
3 day	63.8±1.3	60.6±1.7	63.4±1.2
7 day	64.5±0.9	62.0±1.2	64.5±1.8
Monocytes, %			
1 day	6.6±0.3	8.0±0.5*	6.4±0.9
3 day	7.0±0.4	7.2±0.6	6.3±0.3
7 day	7.0±0.46	7.0±0.6	6.8±0.4

*Note: * – $p \leq 0.05$; ** – $p \leq 0.01$; *** $p \leq 0.001$ compared to calves of the control group*

During the 30-day period of the experiment, the average daily body weight gain of calves of the second experimental group was 27 % higher compared to calves of the first experimental group. In addition, 10 % of calves of the first experimental group during our studies developed bronchopneumonia in mild form, while among calves of the second experimental group, the disease of bronchopneumonia was not observed after aerosol prophylaxis with the drug Kalfmin.

4. Discussion

Prevention of bronchopneumonia in calves is an important problem in cattle breeding. Congestion of animals, low temperature, drafts, high humidity, lack of exercise contribute to the emergence and spread of calf disease. As a result, favorable conditions are created for the accumulation and development of conditionally pathogenic microflora and its associations in premises for keeping animals. In our study, the drug "Kalfmin" is proposed for aerosol therapy and aerosol prophylaxis of non-specific catarrhal bronchopneumonia in calves, which was used for group aerosol treatment of animals. At the same time, other drugs are used to prevent bronchopneumonia in calves, in particular, Propolis and antibiotics. The authors found that the use of aerosols of 3 % alcohol-water emulsion of propolis for the treatment of catarrhal bronchopneumonia in calves, once a day for 6 days, contributed to the stimulation of cellular and humoral factors of the body's defense in calves and their recovery. Therefore, prophylactic use of aerosols of 3 % alcohol-water emulsion of propolis prevented catarrhal bronchopneumonia in calves [15].

Bronchopneumonia in calves is accompanied by an increased level of circulating immune complexes, and the size, protein and lipid composition of these complexes was analyzed. A relationship has been established between structural properties and their ability to modulate the leukocyte function [16].

Treatment of bronchopneumonia in calves is also a big problem of veterinary medicine. In particular, the group of authors proposed a new scheme for the treatment of bronchopneumonia in calves with intravenous use of the drug "VetOks-1000". When using this drug, atomic oxygen is formed, which is a strong oxidant and

has pronounced bactericidal, virucidal, fungicidal, detoxifying and deodorizing properties. The drug contributes to the neutralization and removal of toxins from the blood, tissues and body cavities of animals due to the activation of redox processes [17].

An excess of iron and nickel in the blood serum and a deficiency of copper, zinc, arsenic, cobalt and chromium in cows during pregnancy can lead to similar violations of the mineral status in newborn calves. At the systemic level, dyslementosis in combination with the influence of other adverse factors can lead to an increased load on the respiratory and hematopoietic systems of calves during the period of postnatal adaptation and subsequently cause a decrease in the natural resistance of calves and the development of bronchopneumonia [18].

Research limitations. The limitation of the study was the peculiarities of the course of the pathological process in the body of individual animals with bronchopneumonia. This limitation should be taken into account in connection with the fact that the research is not conducted within the framework of the experiment, but on spontaneously diseased animals.

Prospects for further research. The results of the research suggest the continuation of scientific experiments to study the effect of nanoaquachelates of macro- and microelements in combination with Echinacea on other blood parameters of calves with bronchopneumonia.

6. Conclusions

Prevention of bronchopneumonia in young cattle should be comprehensive and aimed at eliminating violations of the technology of keeping, feeding and increasing the resistance of animals. Group aerosol prevention of nonspecific bronchopneumonia in calves using the drug Calfmin in combination with the plant immunomodulator Echinacea is a more promising and effective method of preventing this pathology compared with the use of turpentine, lactic acid and chlorinated lime. The use of the drug Kalfmin in combination with Echinacea is characterized by 1.60 times higher efficiency and 1.70 times shorter period of prevention of animals.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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