RUDN Journal of Agronomy and Animal Industries. ISSN 2312-797X (Print). ISSN 2312-7988 (Online)
Вестник РУДН. Серия: АГРОНОМИЯ И ЖИВОТНОВОДСТВО
2025;20(2):214–226
http://agrojournal.rudn.ru

DOI: 10.22363/2312-797X-2025-20-2-214-226
EDN MRPDMW
UDC 619:579.8:616–002:591.2:636.2

Research article / Научная статья

Prooxidant-antioxidant control of the effectiveness of aerosol therapy for acute catarrhal bronchopneumonia in calves

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Abstract. The results of prooxidant-antioxidant control of the efficiency of various schemes of aerosol complex therapy for acute catarrhal bronchopneumonia in calves using the generally accepted scheme (aerosol treatment indoors with iodotriethyleneglycol solution with intramuscular administration of the drug "Penstrep-400"), as well as schemes proposed by us, based on previously conducted studies to determine the sensitivity of isolated microflora to antibacterial drugs (aerosol treatment indoors with iodotriethyleneglycol solution with intramuscular administration of the drug "Marfloxacin") and phytobiotics (aerosol treatment indoors with *Hypericum perforatum* wort extract with intramuscular administration of the drug "Marfloxacin") were presented. Black-and-white calves, aged 1–3 months, mixed sex, with clinical signs of acute catarrhal bronchopneumonia were studied. The sick animals were divided into three experimental groups using the envelope method: $_1$O — experimental group 1, n = 20; $_2$O — experimental group 2, n = 20 and $_3$O — experimental group 3, n = 20 and placed in separate isolators. During the treatment of animals in group $_1$O, the general clinical improvement occurred only on the 9.25 ± 0.91 day, while six cases of complications occurred, and two animals died. The treatment of calves in group $_2$O was accompanied by the general clinical improvement 2.05 days earlier, compared with group $_1$O, and all animals recovered. Therapy in group $_3$O contributed to the general clinical improvement already on the 4.90 ± 0.64 day, which is 47.0% earlier compared with the indicators of group $_1$O, and all 20 calves also recovered. The study of the processes of lipid peroxidation and antioxidant protection in blood plasma of experimental calves in the dynamics of treatment confirmed the best result in $_3$O group, which was accompanied by a significant decrease in LPO products and an increase in AOS indicators, which already on the 7th day of observation approached the physiological norm.

Keywords: respiratory pathologies, lipid peroxidation, treatment, antibiotics, phytobiotics, St. John's wort, *Hypericum Perforatum*

Authors' contribution: conceptualization — Rudenko P.A.; methodology — Rodionova N.Y., Shepeleva K.V.; validation — Prozorovskiy I.E.; data curation — Kulikov E.V., Sotnikova E.D.; writing/original draft preparation — Rudenko P.A.; writing/review and editing — Kulikov E.V., Rudenko P.A.; visualization — Shepeleva K.V. All authors read and approved the final manuscript.

Acknowledgments. The study was funded by a grant from the Russian Science FoundationNo. 24-26-00091, https://rscf.ru/project/24-26-00091/

Conflict of interests. The authors declare that they have no conflict of interests.

Article history: received 6 March 2025; accepted 4 April 2025.

For citation: Kulikov EV, Sotnikova ED, Rodionova NY, Prozorovskiy IE, Shepeleva KV, Rudenko PA. Prooxidant-antioxidant control of the effectiveness of aerosol therapy for acute catarrhal bronchopneumonia in calves. *RUDN Journal of Agronomy and Animal Industries*. 2025;20(2):214–226. doi: 10.22363/2312-797X-2025-20-2-214-226 EDN: MRPDMW

Introduction

The intensification of animal husbandry has led to significant increase in concentration of cattle in artificially created biogeocenoses [1–3]. As a result of high density of animals in artificially created territory, conditions have been formed that have reduced the animals' resistance to negative environmental impacts, including contact with opportunistic bacteria that cause various infections. Under conditions of high density and mechanization of cattle, animals have lost active movement, sunlight, and the opportunity to freely choose food. They also often experience stress, which has negative impact on their physiological state [4, 5]. In addition, in artificial biogeocenoses, the physicochemical and microbiological characteristics of air, lighting, and noise levels have changed dramatically compared to natural conditions [6–9].

In modern animal husbandry, respiratory diseases are often observed among highly productive animals, especially in young animals [10, 11]. They are often widespread, resulting in a steady-state problem with factor diseases. These diseases cause significant economic losses in the industry, including animal deaths, reduced production of products from sick or recovered individuals, slower growth and development, as well as expenses for treatment and preventive measures [7, 12].

Unreasonable use of antibiotics without preliminary determination of their effectiveness against pathogens, as well as the use of maximum doses, arbitrary changes in treatment regimen and frequency of drug use, ignoring the species and age sensitivity of animals, pharmacokinetics of drug, often leads to development of resistance of microorganisms to antibacterial drugs and serious side effects in animals [14–17]. In this regard, the search for alternative treatments for factor diseases in cattle, including acute catarrhal bronchopneumonia in calves, is becoming especially relevant. The solution to this problem will improve methods for combating respiratory diseases.

The aim of the study was to conduct prooxidant-antioxidant control of the effectiveness of various schemes of aerosol complex therapy for acute catarrhal bronchopneumonia in calves using the generally accepted scheme, as well as the schemes

proposed by us, developed on previously determined sensitivity of the isolated microflora to antibacterial drugs and phytobiotics.

Materials and methods

The study was conducted on black-and-white calves aged 1–3 months, of mixed sex, with clinical signs of acute catarrhal bronchopneumonia (n = 60) at livestock farms of 'Babaevo' (Sobinsky District, Vladimir Region), and 'Delta-F' (Sergiev Posad District, Moscow Region), which have total livestock of 3,680 animals, including 1,690 cows. The control group consisted of clinically healthy black-and-white calves (n = 10), randomly selected, aged 1 to 3 months, of mixed sex.

The sick animals were divided into three experimental groups using the envelope method: $_1$O — 1st experimental group, n = 20; $_2$O — 2nd experimental group, n = 20 and $_3$O — 3rd experimental group, n = 20 and placed in separate isolators. In group $_1$O, the generally accepted treatment regimen for bronchopneumonia in calves on the farm was used, and in groups $_2$O and $_3$O, we used regimens developed by us based on previously conducted studies to determine the sensitivity of isolated microflora to antibacterial drugs and phytobiotics [10].

The calves of group $_1$O were treated with aerosol disinfection in the room using the Hayfog industrial cold fog generator with a solution of iodine triethylene glycol (3 ml/m³ of the room + glycerin, 10% of the total volume of the solution), once a day for 30 minutes, for 7 days + intramuscular injection of the combined antibiotic Penstrep-400 (1 ml/10 kg of live weight), once a day, three times.

Animals of group $_2$O were treated with aerosol disinfection in the room using the Hayfog industrial cold fog generator with a solution of iodine triethylene glycol (3 ml/m³ of the room + glycerin, 10% of the total volume of the solution), once a day for 30 minutes, for 7 days. Intramuscular injections of antibacterial drug from fluoroquinolone group "Marfloxine", 10% solution (8 mg/kg of live weight), were administered once a day, three times, based on previously conducted microbiological studies.

The calves in group $_3$O were prescribed aerosol treatment in the room using the Hayfog industrial cold fog generator with experimentally selected herbal medicine, "Extract of St. John's wort", 25% solution (10% of the solution volume + glycerin, 10% of the total volume of the solution + 20% glucose solution, 3 ml/m³ of the room), once a day for 30 minutes, for 7 days. In addition, "Marfloxin", 10% solution (8 mg/kg of live weight), was administered intramuscularly once a day, three times.

The general clinical condition of the sick animals was monitored daily, and blood was collected on days 7 and 12 for biochemical studies.

Blood was collected in the morning hours, before feeding, from jugular vein, in a volume of 10 ml in separate test tubes. The intensity of lipid peroxidation processes — antioxidant system (LPO-AOS) in the blood serum was assessed using commercial colorimetric analysis kits (RANDOX Laboratories Ltd., London, UK), according to the manufacturer's instructions. Level of diene conjugates (DC), ketodienes (KD), content of malondialdehyde (MDA), and level of medium-weight molecules (MWM) were

determined from the lipid peroxidation indicators. The endogenous intoxication index (EII) according to Vasiliev I.T. was calculated, it reflected the ratio of concentration of primary LPO products — diene conjugates (DC) to the level of medium-molecular peptides (MMP). The state of antioxidant protection was assessed by the parameters of carotene, superoxide dismutase (SOD), catalase (CAT), ceruloplasmin (CP) concentration, glutathione peroxidase (GP) activity, glutathione reductase (GR) and total antioxidant activity of blood serum (TAS).

The obtained research results were subjected to statistical analysis and presented in the form of tables and figures. All calculations were performed using the statistical program STATISTICA 7.0. (StatSoft, USA). Normality of distribution was preliminarily estimated using the Shapiro-Wilks tests. In case of normal distribution of quantitative variables, the ANOVA test was used to compare two groups. The reliability of the difference in analytes between the parameters of animals before treatment and during the therapy was calculated using the Mann-Whitney method (* — $p < 0.05$; ** — $p < 0.01$; *** — $p < 0.001$).

Results and discussion

Previously, we studied microbial landscape of alveolar lavage samples collected from calves with acute catarrhal bronchopneumonia. We determined sensitivity of initiators of acute catarrhal bronchopneumonia in calves to antibiotics and phytobiotics [10]. It was found that the isolated microorganisms were sensitive to the fourth-generation cephalosporin antibiotics — cefquinome and cefepime, as well as to the third-generation fluoroquinolone antibiotic — marbofloxacin. The most pronounced antimicrobial properties among phytobiotics were found in extract of St. John's wort (in its original form, in two-, four-, and eight-fold dilutions, it showed 100.0% efficiency against all representatives of gram-positive microflora). Therefore, animals of groups $_2$O and $_3$O were prescribed Marfloxacin as antibiotic therapy, and calves of group $_3$O were prescribed aerosol treatment of the room with phytopreparation extract of St. John's wort. The results of the therapy were presented in Table 1.

Table 1

Results of treatment of calves with acute catarrhal bronchopneumonia

Groups of animals, number	Overall clinical improvement, days	Number of complications		Recovered, number		Died, number	
		Abs. no.	%	Abs. no.	%	Abs. no.	%
1 experimental group, *n* = 20	9.25 ± 0.91	6	30.0	18	90.0	2	10.0
2 experimental group, *n* = 20	7.20 ± 0.61	–	–	20	100.0	–	–
3 experimental group, *n* = 20	4.90 ± 0.64	–	–	20	100.0	–	–

Source: compiled by P.A. Rudenko.

It was shown that during the treatment of animals of group $_1$O, the overall clinical improvement occurred on the 9.25 ± 0.91 day, while during the therapy period six cases (30.0%) of complications occurred, 18 (90.0%) calves recovered, and two animals (10.0%) died. Treatment of calves of group $_2$O led to overall clinical improvement 2.05 days earlier, compared to the indicators of group $_1$O, and all $_2$O (100.0%) animals recovered. Therapeutic measures in group $_3$O resulted in overall clinical improvement in 4.90 ± 0.64 days, which is 47.0% faster compared with $_1$O, while all 20 (100.0%) calves also recovered.

LPO is an important biochemical process that plays significant role in pathogenesis of inflammatory reactions, caused by the reaction of unsaturated fatty acids in cell membranes with oxygen, resulting in formation of peroxides, free radicals and end products of oxidation, such as aldehydes and ketones. LPO processes begin with the generation of free radicals that attack double bonds in unsaturated fatty acids, leading to the launch of reactions that can damage cellular structures [4]. Against the background of adequately conducted therapy for any inflammatory process, including infectious pathology, modulation of free-radical LPO processes is noted [13]. Table 2 shows the dynamics of changes in the level of lipid peroxidation products in the blood serum of calves with acute catarrhal bronchopneumonia during treatment.

Table 2

Level of lipid peroxidation products in blood plasma of calves with acute catarrhal bronchopneumonia during treatment

Indicators	Healthy calves (*n* = 10)	Experimental group	Calves with bronchopneumonia		
			Before treatment (*n* = 10)	day 7 (*n* = 10)	day 12 (*n* = 10)
MDA, μM/L	2.88 ± 0.11	$_1$O	5.19 ± 0.18	4.96 ± 0.18	3.31 ± 0.20***↓
		$_2$O	5.26 ± 0.10	3.70 ± 0.14***↓	2.86 ± 0.05***↓
		$_3$O	5.21 ± 0.08	2.74 ± 0.12***↓	2.78 ± 0.09***↓
DC, optical density units	0.29 ± 0.01	$_1$O	3.20 ± 0.22	2.52 ± 0.18*↓	0.82 ± 0.05***↓
		$_2$O	3.05 ± 0.06	1.28 ± 0.09***↓	0.75 ± 0.02***↓
		$_3$O	2.97 ± 0.13	0.43 ± 0.05***↓	0.36 ± 0.02***↓
MMP, units	0.24 ± 0.01	$_1$O	0.89 ± 0.04	0.75 ± 0.04*↓	0.36 ± 0.02***↓
		$_2$O	0.86 ± 0.02	0.60 ± 0.02***↓	0.39 ± 0.01***↓
		$_3$O	0.82 ± 0.02	0.29 ± 0.02***↓	0.23 ± 0.01***↓
KD, optical density units	0.13 ± 0.01	$_1$O	0.68 ± 0.03	0.56 ± 0.02*↓	0.28 ± 0.02***↓
		$_2$O	0.68 ± 0.02	0.45 ± 0.01***↓	0.18 ± 0.01***↓
		$_3$O	0.69 ± 0.02	0.25 ± 0.01***↓	0.26 ± 0.06***↓

Note. $_1$O — 1 experimental group; $_2$O — 2 experimental group; $_3$O — 3 experimental group; ↑ — significant increase in indicators; ↓ — significant decrease in indicators; * — $p < 0.05$; ** — $p < 0.01$; *** — $p < 0.001$ compared to indicators before the therapy.

Source: compiled by P.A. Rudenko.

Diene conjugates (DC) and ketodienes (KD) are primary products of lipid peroxidation, and malondialdehyde (MDA) is a secondary product of lipid peroxidation. A generally accepted marker of endogenous intoxication is the level of medium-weight molecules (MWM) in blood plasma, which are oligopeptides; their increased formation indicates pathological conditions. The level of MWM can indicate the level of endogenous intoxication, thereby predicting the course of the disease [13]. All the listed LPO products and medium-molecular peptides are mutagens and have pronounced cytotoxicity, leading to metabolic disintegration in the cell and, therefore, to its death. It was found that the clinical manifestation of acute catarrhal bronchopneumonia is accompanied by a significant increase in the amount of DK, KD, MDA and MSM in the blood plasma of calves — by 10.6 times, 5.2 times, 10.8 times and 3.5 times, respectively, compared with the indicators of clinically healthy calves. It should be noted that the treatment of calves of group $_1$0 on the 7th day was accompanied by a reliable decrease (*↓) in the level of DK, MSM and KD by 21.2, 15.7 and 17.6%, respectively, compared with the initial data. Therapy of animals of the second experimental group already on the 7th day was noted by a significant (***↓) decrease in MDA, DK, MSM and KD by 29.6, 58.0, 30.2 and 33.8%, respectively. The greatest positive shift in lipid peroxidation products was observed in calves of group $_3$O, so on the 7th day in their blood a highly reliable decrease in the MDA, DK, MSM and KD indices by 47.4, 85.5, 64.6 and 63.7%, respectively, was recorded compared to the corresponding indices before the therapy. It should be noted that on the 12th day after the start of treatment the studied analytes of lipid peroxidation products in animals of all groups tended to further decrease, and in groups $_2$O and $_3$O they approached the indices of clinically healthy calves.

We also calculated the index of endogenous intoxication of calves with acute catarrhal bronchopneumonia during the treatment (Fig. 1).

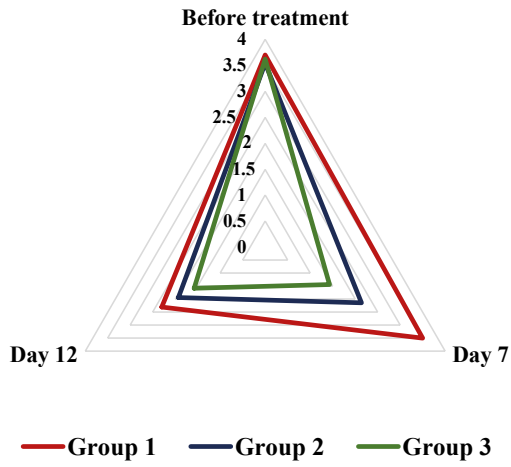

Fig. 1. Level of endogenous intoxication index in calves with acute catarrhal bronchopneumonia during treatment

Source: compiled by P.A. Rudenko.

The presented data indicate that the clinical manifestation of acute catarrhal bronchopneumonia in calves is accompanied by significant increase in the level of EII in blood plasma. When determining the comparative effectiveness of various regimens in the dynamics of disease therapy, it was found that on the 7th day in the blood there was a highly reliable decrease (***↓) in EII in groups $_2$O and $_3$O from 3.54 ± 0.11 to 2.14 ± 0.18 units, or 1.65 times, and from 3.62 ± 0.17 to 1.43 ± 0.08 units, or 2.53 times, when compared with the corresponding indicators before the start of treatment. It should be noted that on the 12th day of therapy, a reliable decrease in EI index was recorded in all three groups: in $_1$O — from 3.70 ± 0.35 to 2.30 ± 0.18 units, by 37.8% (**↓); in $_2$O — from 3.54 ± 0.11 to 1.93 ± 0.07 units, by 45.4% (***↓); in $_3$O — from 3.62 ± 0.17 to 1.58 ± 0.07 units, by 56.3% (***↓).

Inhibition of lipid peroxidation processes and constancy of low level of free radicals in cells are controlled by the presence of AOS in the body, the inhibitors of which are capable of directly reacting with free radicals. Under physiological conditions, AOS protects cellular lipids from excessive peroxidation and is considered one of the significant indicators of homeostasis. Even a short-term failure of AOS causes significant disruptions in homeostatic processes, and a longer existence of free radicals can lead to irreversible damage to cell organelles and tissues. Antioxidant enzymes include superoxide dismutase, catalase, ceruloplasmin concentration, glutathione peroxidase and glutathione reductase activity. All of them catalyze chemical reactions because of which toxic free radicals and peroxides are converted into compounds that are not harmful to the body. In addition, the leading place in the non-enzymatic link of body AOS belongs to carotenoids, which can quench free radicals and neutralize active oxygen forms [4, 13]. The level of antioxidant analytes in blood plasma of calves with acute catarrhal bronchopneumonia during therapy was given in Table 3.

The presented data indicate that with the development of acute catarrhal bronchopneumonia, a sharp decrease in both enzymatic and non-enzymatic links of AOS is observed in blood of calves, indicating the development of oxidative stress. It was found that on the 7th day of treatment, a reliable increase in carotene by 1.29 times (**↑), CP by 1.27 times (*↑), SOD by 1.29 times (**↑), GP by 1.41 times (***↑) and GR by 1.26 times (***↑) was observed in the blood of calves in group $_1$O compared with the initial data. It should be noted that, more significant shifts in AOS inhibitors were recorded in calves of groups $_2$O and $_3$O on the 7th day of treatment. Thus, in animals of group $_2$O, a highly reliable increase (***↑) of carotene, CP, CT, SOD, GP and GR was noted in plasma on the 7th day by 1.81, 2.43, 1.35, 1.61, 2.41 and 1.99 times, respectively. In calves of group $_3$O these indicators increased by 1.94, 2.77, 1.43, 2.06, 2.38 and 2.50 times, respectively, compared with the indicators from the beginning of therapy. It should be emphasized that on the 12th day of the therapy, in animals of all experimental groups, a convincing increase (***↑) of all AOS analytes was recorded, which approached the values of the reference norm.

Table 3

Indicators of antioxidant system for calves with acute catarrhal bronchopneumonia during treatment

Indicators	Healthy calves (*n* = 10)	Experimental groups	Calves with bronchopneumonia		
			Before treatment (*n* = 10)	Day 7 (*n* = 10)	Day 12 (*n* = 10)
Carotene, mg %	0.33 ± 0.01	$_1$O	0.17 ± 0.01	0.22 ± 0.01**↑	0.34 ± 0.01***↑
		$_2$O	0.16 ± 0.01	0.29 ± 0.01***↑	0.34 ± 0.01***↑
		$_3$O	0.17 ± 0.01	0.33 ± 0.01***↑	0.32 ± 0.01***↑
CP, mmol/L	2.02 ± 0.04	$_1$O	0.77 ± 0.06	0.98 ± 0.04*↑	2.10 ± 0.07***↑
		$_2$O	0.67 ± 0.04	1.63 ± 0.07***↑	2.07 ± 0.05***↑
		$_3$O	0.75 ± 0.02	2.08 ± 0.05***↑	2.03 ± 0.03***↑
CT, μkat/L	15.57 ± 0.23	$_1$O	9.79 ± 0.36	10.53 ± 0.35	15.84 ± 0.28***↑
		$_2$O	10.03 ± 0.36	13.59 ± 0.40***↑	15.81 ± 0.39***↑
		$_3$O	10.12 ± 0.25	14.52 ± 0.25***↑	15.52 ± 0.29***↑
SOD, units	0.75 ± 0.02	$_1$O	0.31 ± 0.02	0.40 ± 0.01**↑	0.78 ± 0.03***↑
		$_2$O	0.31 ± 0.02	0.50 ± 0.01***↑	0.69 ± 0.02***↑
		$_3$O	0.31 ± 0.01	0.64 ± 0.02***↑	0.75 ± 0.02***↑
GP, μM/min	14.65 ± 0.23	$_1$O	6.01 ± 0.29	8.47 ± 0.25***↑	14.69 ± 0.32***↑
		$_2$O	5.45 ± 0.21	10.55 ± 0.42***↑	14.85 ± 0.51***↑
		$_3$O	5.67 ± 0.22	13.55 ± 0.22***↑	14.90 ± 0.28***↑
GR, μM/min	142.16 ± 0.44	$_1$O	51.92 ± 1.99	65.85 ± 2.18***↑	132.21 ± 3.23***↑
		$_2$O	54.46 ± 1.72	108.77 ± 2.34***↑	140.68 ± 1.42***↑
		$_3$O	53.82 ± 1.29	134.69 ± 1.91***↑	141.59 ± 0.62***↑

Note. $_1$O — 1 experimental group; $_2$O — 2 experimental group; $_3$O — 3 experimental group; ↑ — significant increase in indicators; ↓ — significant decrease in indicators; * — $p < 0.05$; ** — $p < 0.01$; *** — $p < 0.001$ compared to indicators before the therapy.

Source: compiled by P.A. Rudenko.

The level of total antioxidant activity of blood serum in calves with acute catarrhal bronchopneumonia during treatment was shown in Fig. 2.

It was shown that during clinical manifestation of acute catarrhal bronchopneumonia in calves, a sharp decrease in TAS of plasma by 1.84 times was observed. With comparative effectiveness of various regimens in the dynamics of disease therapy, on the 7th day in blood plasma of animals, an increase in TAS was observed in group $_1$O from 18.98 ± 0.96% to 21.40 ± 0.42%, by 11.3% (*↑), in group $_2$O — from 18.69 ± 0.80% to 33.20 ± 1.04%, i.e. by 43.7% (***↑), in group $_3$O — from 18.68 ± 0.52% to 31.98 ± 0.96%, or by 41.6% (***↑). It should be noted that on the 12th day of therapy, a further highly reliable increase in TAS (***↑) was recorded in animals of groups $_1$O, $_2$O and $_3$O by 1.57 times, 1.79 and 1.81 times, respectively, to 29.88 ± 0.51%, 33.52 ± 0.59 and 33.73 ± 0.68%, compared with the initial data.

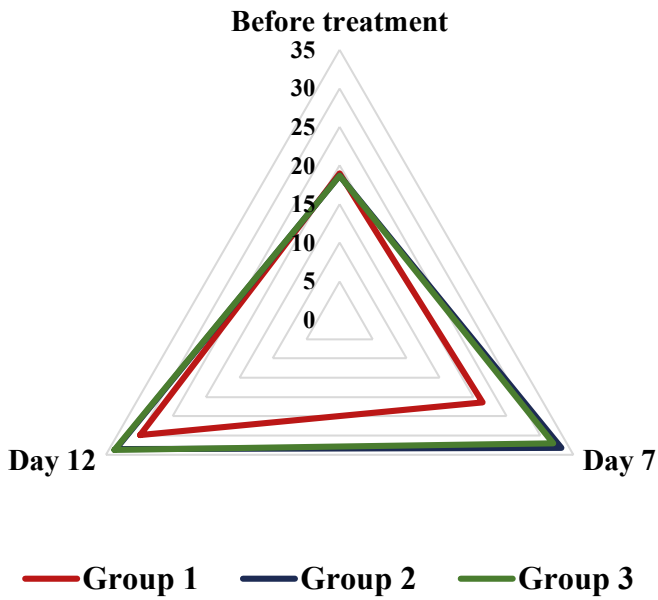

Fig. 2. Total antioxidant activity of blood serum in calves with acute catarrhal bronchopneumonia during treatment

Source: compiled by P.A. Rudenko.

Thus, all three therapeutic schemes for the treatment of catarrhal bronchopneumonia showed relative effectiveness. However, aerosol application of St. John's wort phytobiotic in the complex treatment of sick calves demonstrated the best results. This indicates pronounced antibacterial, anti-inflammatory and immunomodulatory properties of this plant, which makes it relevant for veterinary practice.

Conclusion

A comparative analysis of the effectiveness of various schemes of aerosol complex therapy of acute catarrhal bronchopneumonia in calves was carried out. It was found that when treating animals with aerosol treatment indoors with solution of iodotriethyleneglycol with intramuscular administration of the drug Penstrep-400 (group $_1$O), clinical improvement occurred only on the 9.25 ± 0.91 day, while during the therapy period six cases of complications occurred, and two animals (10.0%) died. Treatment of calves with aerosol treatment indoors with a solution of iodotriethyleneglycol with intramuscular administration of the drug Marfloxacin (group $_2$O) was accompanied by overall clinical improvement 2.05 days earlier, compared with group $_1$O, and all 20 (100.0%) animals recovered. Therapeutic studies in a group of animals using an experimentally selected herbal drug, St. John's wort extract, via aerosol treatment in a room with intramuscular administration of Marfloxacin (Group $_3$O) resulted in overall clinical improvement on the 4.90 ± 0.64 day, which is 47.0% earlier compared to Group $_1$O, and all

20 (100.0%) calves also recovered. A thorough analysis of prooxidant-antioxidant parameters of calves' blood plasma during the therapy revealed that in Groups $_1$O-$_3$O a decrease in LPO products was observed along with an increase in antioxidant system indicators as early as the 7th day. However, only in the group with aerosol application of St. John's wort extract (Group $_3$O) did the LPO-AOS indices approach the physiological norm.

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Прооксидантно-антиоксидантный контроль эффективности аэрозольной терапии острой катаральной бронхопневмонии телят

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Аннотация. Представлены результаты прооксидантно-антиоксидантного контроля эффективности различных схем аэрозольной комплексной терапии острой катаральной бронхопневмонии у телят с использованием общепринятой схемы (аэрозольная обработка в помещении раствором йодтриэтиленгликоля с внутримышечным введением препарата Пенстреп-400), а также схем, предложенных нами на основании ранее проведенных исследований по определению чувствительности изолированной микрофлоры к антибактериальным препаратам (аэрозольная обработка в помещении раствором йодтриэтиленгликоля с внутримышечным введением препарата Марфлоксин) и фитобиотикам (аэрозольная обработка в помещении экстрактом зверобоя продырявленного с внутримышечным введением препарата Марфлоксин). Материалом для исследования служили телята черно-пестрой породы, в возрасте 1–3 месяца, смешанного пола, с клиническими признаками острой катаральной бронхопневмонии. Больные животные методом конвертов были распределены на три опытные группы: $_1$О, n = 20; $_2$О, n = 20 и $_3$О, n = 20 и помещены в отдельные изоляторы. При лечении животных группы $_1$О общее клиническое улучшение наступало лишь на 9,25 ± 0,91 сутки, при этом возникло шесть случаев осложнений, а два животных пало. Лечение телят группы $_2$О сопровождалось общим клиническим улучшением на 2,05 суток раньше, при сравнении с показателями группы $_1$О, при этом выздоровели все животные. Терапия в группе $_3$О способствовала общему клиническому улучшению уже на 4,90 ± 0,64 сутки, что на 47,0 % раньше при сравнении с показателями группы $_1$О, при этом выздоровели также все 20 телят. Изучение процессов перекисного окисления липидов и антиоксидантной защиты плазмы крови опытных телят в динамике лечения подтвердило наилучший результат в группе $_3$О, который сопровождался значительным снижением продуктов перекисного окисления липидов и повышением показателей антиоксидантной системы, которые уже на 7 сутки наблюдения приближались к показателям физиологической нормы.

Ключевые слова: респираторные патологии, липопероксидация, лечение, антибиотики, фитобиотики, зверобой продырявленный, *Hypericum Perforatum*

Вклад авторов: концепция — П.А. Руденко; методология — Н.Ю. Родионова, К.В. Шепелева; валидация — И.Е. Прозоровский; работа с данными — Е.В. Куликов, ЕД. Сотникова; написание первой версии — П.А. Руденко; ревизия и редактирование текста — Е.В. Куликов, П.А. Руденко; визуализация результатов — К.В. Шепелева. Все авторы ознакомились с окончательной версией рукописи и одобрили ее.

Финансирование. Исследование выполнено за счет гранта Российского научного фонда № 24-26-00091, https://rscf.ru/project/24-26-00091/

Заявление о конфликте интересов. Авторы заявляют об отсутствии конфликта интересов.

История статьи: поступила в редакцию 6 марта 2025 г., принята к публикации 4 апреля 2025 г.

Для цитирования: *Куликов Е.В., Сотникова ЕД., Родионова Н.Ю., Прозоровский И.Е., Шепелева К.В., Руденко П.А.* Прооксидантно-антиоксидантный контроль эффективности аэрозольной терапии острой катаральной бронхопневмонии телят // Вестник Российского университета дружбы народов. Серия: Агрономия и животноводство. 2025. Т. 20. № 2. С. 214–226. doi: 10.22363/2312-797X-2025-20-2-214-226 EDN: MRPDMW