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Determination of the Effectiveness of the *Artemisia Lerchiana*-Based Preparation in Treating Surgical Wounds in Animals

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ABSTRACT

Treating injured animals is the basis for ensuring proper veterinary care for livestock. The study aimed to test the effectiveness of herbal ointments based on *Artemisia lerchiana* in treating aseptic and purulent wounds in animals. The experiment involved dividing 40 sheep heads into four groups. The wounds in two groups were treated with 10 and 20% *A. lerchiana* ointments. The third group received traditional treatment with Vishnevsky liniment. The fourth (control) group did not receive any treatment. The animals' clinical parameters were measured during the treatment, and their morphological and biochemical blood parameters were studied. The results demonstrated the effectiveness of herbal ointments in treating wounds. On average, aseptic wounds healed 1-2 days faster, and purulent wounds healed 2-3 days faster than the traditional treatment method. *A. lerchiana* preparations did not cause side effects or negative consequences and contributed to immunity. Therefore, their further use in veterinary practice is recommended.

Key words: Artemisia lerchiana, Infusion, Essential oil, Sheep, Hematology, Humoral factors

INTRODUCTION

Wound healing in animals is a long-standing issue in veterinary and human medicine. The treatment of open mechanical injuries aims to prevent infection, accelerate the reparative process, and significantly improve the quality of life of the injured animal (Mussayeva et al. 2021). Infected wounds are the most common wounds in veterinary practice. They result in systemic inflammatory response syndrome and sepsis, which occur due to severe tissue damage causing secondary complications and microorganisms causing wound complications (Suchshikh et al., 2023).

Microorganisms that lead to complications in the wound and form bacterial colonies become resistant to antimicrobial preparations. Thus, the main treatment problem is the choice of local and systemic action preparation to ensure wound healing. Timely and systematic wound treatment and antibiotic therapy can lead to better results, although excessive and irregular use of antibiotics results in the development of resistance in microorganisms (Torre et al. 2007; Lepekhova 2013; Nosovskii 2013; Vyas and Vasconez 2014; Shnyakina et al. 2018; Tsioli and Dermisiadou 2018; Firsov et al. 2019).

Despite the active introduction of new antibiotic groups into clinical practice, preventing and treating purulent and septic complications in surgery remain relevant. The increase in the technical level of surgical equipment in modern times has opened up new opportunities for improving surgical wound treatment. However, treatment is often supplemented with medication therapy (Witte et al. 2002; Chiang et al. 2007; Holle et al. 2007).

Phyto preparations for wound healing have been widely introduced as an alternative to traditional treatment. By the nature of their pharmacological action, they are not worse and are often better than existing treatments for wounds and wound infections. Preparations based on plants are effective against microorganisms and harmless to the body (Revyakin et al. 2017; Savina and Nurgalieva 2017; Shnyakina et al. 2018).

Medicinal plants contain a complex of chemical compounds that have a multifaceted effect. Plants contain alkaloids, glycosides, essential oils, phenolic compounds, vitamins, trace elements, and polysaccharides, which are

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sources for new preparations with high therapeutic efficacy. Medicinal plant-based preparations are cheaper, which makes them more accessible to animal owners and allows them to be used for a long time without side effects (Korotkov and Papunidi 2013; Haroon et al. 2023).

In recent years, in studies on phyto preparations, antibacterial, antiviral, anti-inflammatory, vermicidal, and fungicidal properties of essential oils and Artemisia extracts are of interest (Bae et al. 2012; Kislichenko et al. 2013; Alinkina et al. 2013; Gopal and Asmita 2014; Isaeva et al. 2014; Castro et al. 2015; Gradinariu et al. 2015; Saiyudthong et al. 2015; Duan and Chen 2015; Bagci et al. 2016; Tonkovtseva and Mikhailovich 2018). Artemisia antimicrobial activity depends on the place of growth and the extraction technology. Kazakhstan is a priority region for studying the basic properties of essential oils and Artemisia extracts and developing new medicines based on them.

Kazakhstan has unique reserves of raw materials for medicinal plants. 81 Artemisia species grow in Kazakhstan. Only few have been studied: *A. armeniaca, A. atomentella, A. annua, A. pontica, A. tournefortiana, A. laciniata, A. semiarida, A. albida, A. marschalliana*, etc. (Ramazanova et al. 2015). Scientific research indicates that *A. lerchiana* has high antibacterial activity against gram-positive test microbes (Staphylococcus, Streptococcus). A comparative assessment of *A. lerchiana* with the test antiseptic Septarius showed that the former was not worse and, in the form of essential oil, showed an even better effect (Nametov et al. 2023).

Analyzing these data, we can state the prospect of studying Artemisia essential oils as active and auxiliary substances in new medicines to treat infectious and inflammatory diseases associated with stable microflora. The study aims to evaluate the therapeutic effect of ointment made from *A. lerchiana* in various concentrations on aseptic and purulent wounds in animals.

MATERIALS AND METHODS

Ethical approval

The experiments were carried out following the bioethics adopted at the University and the provisions of the European Convention for the Protection of Vertebrates Used for Practical and Scientific Purposes.

Study location

The experiments with the *A. lerchiana* based preparation were conducted in the scientific laboratory of the Zhangir Khan West Kazakhstan Agrarian Technical University.

Animals

For this study, we used 40 heads of sheep aged 1-1.5 years and kept them at the University's animal clinic, which corresponded to sanitary and hygienic standards and requirements.

Methods

In the first experiment, we treated aseptic wounds with infusion and ointment prepared from *A. lerchiana* compared to the traditional treatment (Vishnevsky liniment). The second experiment used similar treatment methods for purulent wounds.

To determine the effectiveness of wound treatment after applying preparations, we analyzed the wound area, blood, and immunity and conducted general clinical studies. The planimetric studies of the wound area were carried out using the method developed by Popova (1942), to determine changes in the wound area.

Blood tests were performed using the Mindray BC-2800 Vet hematology analyzer and the BioChem SA biochemical analyzer. When examining the blood morphological composition, we determined the total number of leukocytes, erythrocytes, hemoglobin, platelets, hematocrit, and thrombocrit. The leukogram and biochemical parameters of sheep blood serum (total protein, albumins, α, β, γ-globulins) were also analyzed. The clinical studies were conducted using conventional methods.

Humoral immunity factors were studied by determining the bactericidal activity of blood serum using the method developed by Emelyanenko et al. (1980). The method is based on the changes in the optical density of a mixture of blood serum and a microbe test for creatine phosphokinase (CPK).

Sample collection

Experimental aseptic and purulent wounds were obtained in animals according to the methods proposed by Abdulla et al. (2008).

Study stages

A complete clinical examination and blood test were performed before the experiments. Clinically healthy animals were admitted to the experiments. After examining the aseptic wound, a treatment strategy (wound cleaning, medicinal treatment, and dressing) was determined. To study aseptic wound treatment, the animals were divided into four groups of five animals each. The first group washed the wound with an *A. lerchiana* infusion and treated it with 10% *A. lerchiana* ointment. The wound was washed with an A. lerchiana infusion and treated with 20% A. lerchiana ointment in the second group. In the third group, the wound was treated using the traditional method (washed with furacilin solution and treated with Vishnevsky liniment). The wounds were treated until they were completely healed. In the fourth group, observations were carried out without wound treatment (control group).

To study purulent wound treatment, the animals were divided into four groups of five animals each, similar to aseptic wound treatment. In the first group, 10% *A. lerchiana* ointment was tested; in the second group, 20% A. lerchiana ointment; in the third group, Vishnevsky liniment (the traditional method); and in the fourth group, no treatment was performed (the control group). The clinical and laboratory studies of aseptic wounds were carried out on days 1, 3, 5, 7, 10, and 14 after the start of treatment, and the studies of purulent wounds were performed on days 1, 3, 5, 7, 10, 14, and 21 after the start of treatment. After this, the statistical processing of the collected data was carried out using digital technology.

RESULTS

In all groups, aseptic wounds had an identical size with an area of about 14cm2. After the wound is inflicted, the

animals feel anxiety and limp on the injured limb, and clinical indicators (temperature, pulse, respiration) are within normal limits. The local reaction (near the wound) was characterized by inflammation and soreness. On the first day, all animals showed increased wound area due to skin tension. In contrast, the difference in the wound area between the groups was insignificant (3-4%) (Fig. 1). The wound cavity was filled with a blood clot, all signs of inflammation were present, and the beginning of the wound cleansing process was noted.

In all groups, body temperature, breathing, and heart rate increased. This is probably due to stress and pain response. The general condition did not show visible changes apart from a slight limp. The increase in the wound area was noted on day 3 in all groups. It was most pronounced in the control group. The inflammatory process in the wound area was pronounced, and the wound-cleansing process continued. Clinical parameters (body temperature, pulse rate, respiratory rate) were slightly increased within the normal range in all groups (Table 1).

On day 5, the wound area was noticeably reduced in the two experimental groups and the group using the traditional treatment. A regenerative process and a decrease in exudation were noted. The wound-cleansing process continued in the control group. The inflammatory process persisted. Clinical indicators for days 5-7 remained within the upper normal level in all groups.

Starting from day 7, the difference between the indicators of changes in the wound area and clinical parameters was observed. The control group sheep showed depression of the general condition, refused to eat, and did not step on the injured limb when walking. The wound area was hyperemic and painful on palpation, and the skin was dense and motionless.

In the experimental groups, the general condition was satisfactory, a slight limp was observed, and general clinical parameters had decreased to the upper limits of the norm. The fibrinous tissue scab began to separate, granulation tissue was observed in scab-free areas of the wound, and the skin became mobile. Here, we observed a significant difference in the wound area size between the control group and the third experimental group, where the wounds were lubricated with Vishnevsky liniment.

The wound area in the first and second experimental groups was slightly larger than in the third experimental group. The scab in these groups began to separate 2-3 days later. In the following days, wound healing accelerated in the sheep treated with 10-20% *A. lerchiana* ointment. This is because of the acceleration of dehydration and granulation under the influence of these preparations. All clinical parameters were restored to normal in these groups. This trend continued until the experiment's end; the wounds in the first and second experimental groups completely healed on days 11-12. In the third group, the wounds were completely covered with scar tissue by day 14. On day 14, we noted a slow tissue repair process in the control group. Some animals developed purulent exudate, so the experiment was stopped and the animals treated.

Table 1: Dynamics of clinical parameters of healthy animals and animals during the treatment of aseptic wounds

Time	Temperature, °C				Heart rate, rpm				Respiratory rate, respiratory movements/min			
	Control	Vishnevsky liniment	10% ointment	20% ointment	Control	Vishnevsky liniment	10% ointment	20% ointment	Control	Vishnevsky liniment	10% ointment	20% ointment
Healthy	39.24±0.10	39.1±0.08	38.5±0.14	39.8±0.07	92.0±0.82	88.8±1.01	87.6±0.87	80.4±1.10	42.4±0.87	38.8±1.21	40.8±0.01	38.2±2.01
Day 1	39.3±0.09	39.5±0.06	39.6±0.08	39.4±0.21	112.8±1.21	98.2±1.06	94.8±1.01	100.0±1.94	42.6±0.56	42.8±0.37	50.8±1.21	48.6±0.65
Day 3	39.5±0.06	39.5±0.05	39.7±0.11	39.2±0.18	108.4±1.45	108.8±0.76	82.8±1.12	90.4±1.28	48.8±0.76	46.8±1.01	48.2±0.76	50.4±1.45
Day 5	39.5±0.09	39.8±0.11	39.2±0.12	39.5±0.21	98.6±1.26	90.8±1.01	88.0±1.62	98.4±1.19	44.8±0.76	48.6±0.65	48.2±0.89	46.4±1.10
Day 7	39.2±0.14	39.0±0.09	39.1±0.16	39.5±0.22	96.8±0.89	74.0±1.56	87.2±1.72	86.4±1.73	48.4±0.87	44.8±0.89	40.4±1.45	42.4±1.79
Day 10	39.4±0.07	39.1±0.09	38.7±0.19	39.2±0.18	96.6±0.80	84.8±1.01	90.4±0.99	90.0±0.94	42.8±0.55	52.0±1.25	56.2±1.64	44.4±1.28

F-statistic: 0.213; P-value: The p-value associated with this F-statistic is 0.886, indicating no statistically significant differences between groups for temperature.

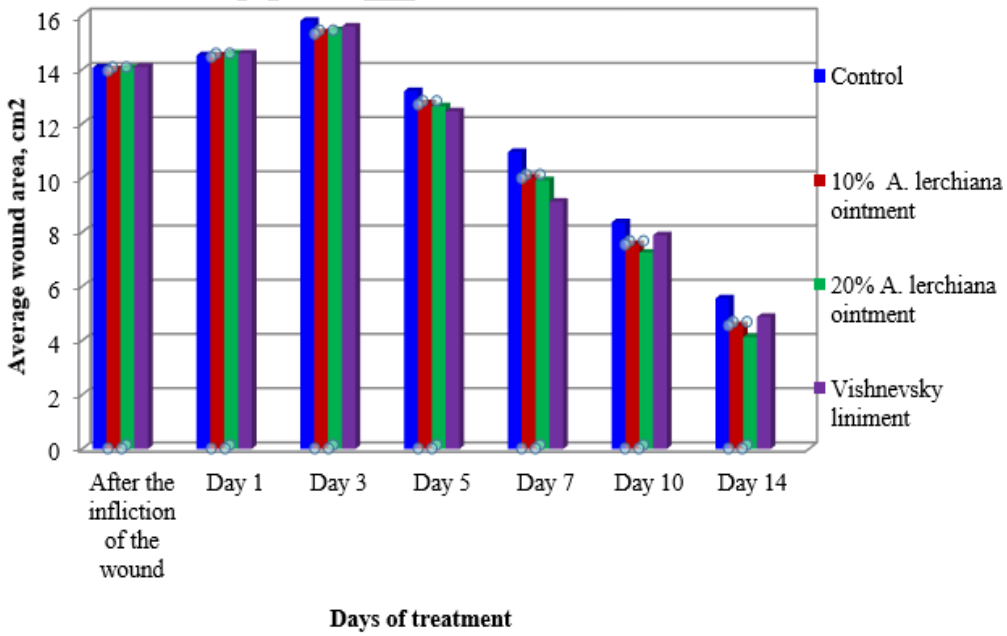

Fig. 1: Dynamics of wound area in treating aseptic wounds in sheep*
*Control vs. Vishnevsky liniment: t = 0.533, P=0.609
Control vs. 10% *A. lerchiana* ointment: t = 0.702, P=0.503
Control vs. 20% *A. lerchiana* ointment: t = 0.864, P=0.413

Clinical indicators for this period of the study were within the normal range. Changes in the morphological composition of blood are reflected in Table 2. In sheep whose wounds were treated, leukocytosis was noted on days 3-5. Subsequently, the number of leukocytes gradually decreased to the level of healthy animals. In the control group, leukocytosis was observed throughout the study. Hemoglobin decreased slightly on day 3 in all groups. Subsequently, the hemoglobin increased within the normal range. When analyzing the number of erythrocytes, platelets, hematocrit, and thrombocrit, no visible changes were noted in all groups.

The analysis of the leukogram of blood in sheep with an aseptic wound showed that neutrophilia occurred on days 3-5 with a shift of the nucleus to the left, while the percentage of lymphocytes in all groups decreased. Subsequently, the percentage of neutrophils decreased and reached the level of the initial indicators by the end of the observation. In the control group, neutrophilia with a nucleus shift to the left was noted on days 3-10, and a decrease occurred only on the 14th day. Similar changes were observed in all groups concerning monocytes, whereas changes in the percentage of basophils and eosinophils did not show any trends. The analysis of biochemical parameters of blood serum showed no visible changes in sheep in all groups throughout the study. All indicators were within the norm.

The dynamics of indicators of bactericidal activity of blood serum (BABS) are shown in Fig. 2. After the wound was inflicted, all animals showed an increase in BABS by an average of 4.62% on day 1. The maximum value was recorded on day 10 in sheep of the control group (63.9±1.27), which was 9.79% higher than the initial values. In experimental animals, the maximum values were observed on day 5 and were higher than the initial values by 9.45, 7.73, and 5.95%, respectively, gradually decreasing to the initial values. These data correlate with clinical indicators, dynamics of changes in blood composition, and leukocyte formula.

In the second experiment, we studied the healing processes in purulent wounds treated with infusion and ointment prepared from *A. lerchiana* compared to the traditional treatment (Vishnevsky liniment). In all groups, the experimental wounds had the same area of about 14cm2.

A clinical examination before the experiment showed general anxiety, limping on the injured limb, increased body temperature, increased pulse and respiratory rate compared to the initial condition, and decreased appetite and mobility. The local reaction (near a purulent wound) was characterized by signs of purulent inflammation, including soreness, purulent exudate, redness, and an increase in the temperature of the tissue around the wound.

On days 1-3, the wound area decreased slightly (2-3%) in all animals (Fig. 3). The skin was tensioned and dense in the wound area, and swelling and soreness of the tissues were noticeable. The wound surface was covered with a grayish-brown fibrinous tissue scab, separated in places, and yellowish-greenish pus was released from under it.

On days 5-7 after the start of treatment, the wound area in groups I, II, and III significantly decreased, whereas in the control group, the decrease was insignificant. Purulent exudate and signs of acute inflammation were observed in the wound area. Body temperature, pulse rate, and respiration were in the upper normal range in groups I, II, and III, whereas these indicators were higher than normal in the control group. On days 10-14, the wound area significantly decreased in groups I, II, and III. The reduction was slower in the control group. Body temperature, pulse rate, and respiratory rate decreased in the treated groups to the initial values, whereas in the control group, they were at the upper normal values (Table 3).

In groups I, II, and III, the completion of wound self-cleaning and the formation of regenerative tissue were

Table 2: Dynamics of morphological composition of blood during the treatment of aseptic wounds

Indicators	Day						
	Healthy animals	1	3	5	7	10	14
Control group							
Leukocytes (10^9/L)	7.72±1.52	9.97±3.47	15.23±4.12	15.52±4.32	12.28±3.34	11.85±2.07	10.58±2.1
Erythrocytes (10^{12}/L)	7.84±1.36	7.84±2.88	7.82±1.05	7.94±1.25	7.91±1.12	8.01±0.45	7.97±1.04
Hemoglobin (g/L)	91.8±2.25	90.5±3.21	85.89±4.72	86.8±2.28	91.4±3.4	92.89±4.58	95.41±3.35
Platelets (10^9/L)	483.8±2.85	457.6±2.34	486.0±2.88	546.4±3.08	521.6±3.04	498.6±2.11	501.2±1.98
Hematocrit (%)	30.0 ±1.11	28.2±1.91	29.8±0.66	29.2±1.02	28.8±1.16	29.6±1.72	30.2±1.79
Thrombocrit (%)	0.38±0.03	0.26±0.02	0.25±0.04	0.29±0.04	0.32±0.03	0.36±0.02	0.31±0.04
1st experimental group							
Leukocytes (10^9/L)	8.56±2.41	9.5±1.29	15.8±2.29	15.4±1.45	10.8±2.27	9.59±2.21	8.4±1.28
Erythrocytes (10^{12}/L)	8.07±2.05	7.95±1.15	7.88±1.28	8.05±2.14	8.18±1.6	8.25±1.38	8.19±1.74
Hemoglobin (g/L)	92.8±2.89	89.2±4.56	89.8±4.7	95.45±5.63	92.2±4.06	96.1±4.21	97.9±4.08
Platelets (10^9/L)	239.2±3.22	329.6±3.04	445.6±3.41	389.2±2.27	387.8±2.33	391.2±1.39	345.8±2.89
Hematocrit (%)	40.4±1.47	42.4±1.83	44.4±1.94	39.2±1.36	40.2±1.49	41.4±1.40	40.8±1.20
Thrombocrit (%)	0.35±0.02	0.26±0.03	0.28±0.04	0.26±0.03	0.29±0.03	0.31±0.03	0.34±0.02
2nd experimental group							
Leukocytes (10^9/L)	7.89±2.02	8.85±2.15	15.2±1.89	14.45±2.74	10.1±2.09	9.4±1.89	8.8±1.2
Erythrocytes (10^{12}/L)	7.75±1.15	7.86±1.08	7.81±2.05	8.1±2.36	8.21±1.9	8.34±2.77	8.32±2.37
Hemoglobin (g/L)	92.5±3.45	91.25±3.98	88.4±4.5	94.4±2.85	96.8±3.56	98.89±3.69	99.21±2.28
Platelets (10^9/L)	326.4±3.21	317.2±2.18	308.6±2.01	292.2±3.12	323.6±2.06	368.6±2.84	351.4±3.08
Hematocrit (%)	30.6±1.72	30.8±2.08	29.8±2.33	28.6±2.27	29.4±2.18	28.6±2.09	29.8±1.85
Thrombocrit (%)	0.32±0.03	0.34±0.02	0.33±0.03	0.37±0.03	0.35±0.04	0.32±0.02	0.35±0.02
3rd experimental group							
Leukocytes (10^9/L)	8.5±1.28	9.1±1.85	14.91±2.05	14.84±2.95	12.6±3.35	9.89±3.06	8.7±2.27
Erythrocytes (10^{12}/L)	8.25±1.28	8.03±2.04	7.97±2.28	7.98±2.36	8.02±2.11	8.16±1.41	8.31±1.29
Hemoglobin (g/L)	90.1±2.41	89.14±3.3	87.23±3.28	91.5±5.4	91.8±4.28	93.5±3.28	93.55±4.02
Platelets (10^9/L)	398.4±3.09	401.4±2.73	466.8±2.84	408.2±2.33	412.4±1.99	402.2±2.44	416.8±3.09
Hematocrit (%)	31.8±2.15	32.8±2.08	33.4±1.54	30.6±1.59	32.6±1.72	34.8±1.74	33.2±1.32
Thrombocrit (%)	0.27±0.03	0.26±0.03	0.25±0.02	0.26±0.03	0.27±0.03	0.28±0.04	0.30±0.03

Table 3: Dynamics of clinical parameters in healthy animals and animals during the treatment of purulent wounds

Time	Temperature, °C				Heart rate, rpm				Respiratory rate, respiratory movements/min			
	Control	Vishnevsky liniment	10% ointment	20% ointment	Control	Vishnevsky liniment	10% ointment	20% ointment	Control	Vishnevsky liniment	10% ointment	20% ointment
Healthy	38.6±0.18	38.7±0.14	38.8±0.33	38.5±0.27	82.4±1.72	78.4±1.83	80.8±1.36	82.4±1.47	32.8±1.85	28.8±1.74	22.4±1.47	26.0±1.41
Day 1	40.2±0.13	39.9±0.12	39.8±0.18	39.7±0.16	108.8±1.62	88.0±1.67	92.0±1.67	90.8±1.36	54.0±1.79	44.4±1.17	36.8±1.85	40.4±1.72
Day 3	40.5±0.17	39.7±0.17	39.9±0.13	40.0±1.72	114.8±1.96	90.8±1.02	88.2±1.85	90.4±1.60	60.4±1.47	40.8±1.36	36.4±1.83	40.8±1.50
Day 5	40.3±0.14	39.2±0.20	39.3±0.17	39.7±0.20	106.4±1.94	86.8±1.85	84.4±1.47	86.4±1.47	56.4±1.59	38.4±1.47	34.4±1.47	38.4±1.72
Day 7	39.9±0.12	39.0±0.12	38.7±0.24	39.0±0.27	100.8±1.74	84.0±1.90	78.4±1.33	78.8±1.36	50.8±1.49	34.8±1.62	36.0±1.67	36.4±1.72
Day 10	39.7±0.17	38.7±0.12	38.6±0.22	38.7±0.21	98.4±1.33	84.4±1.72	72.8±1.74	76.8±1.02	52.4±1.17	32.4±1.47	28.8±2.06	32.4±1.17

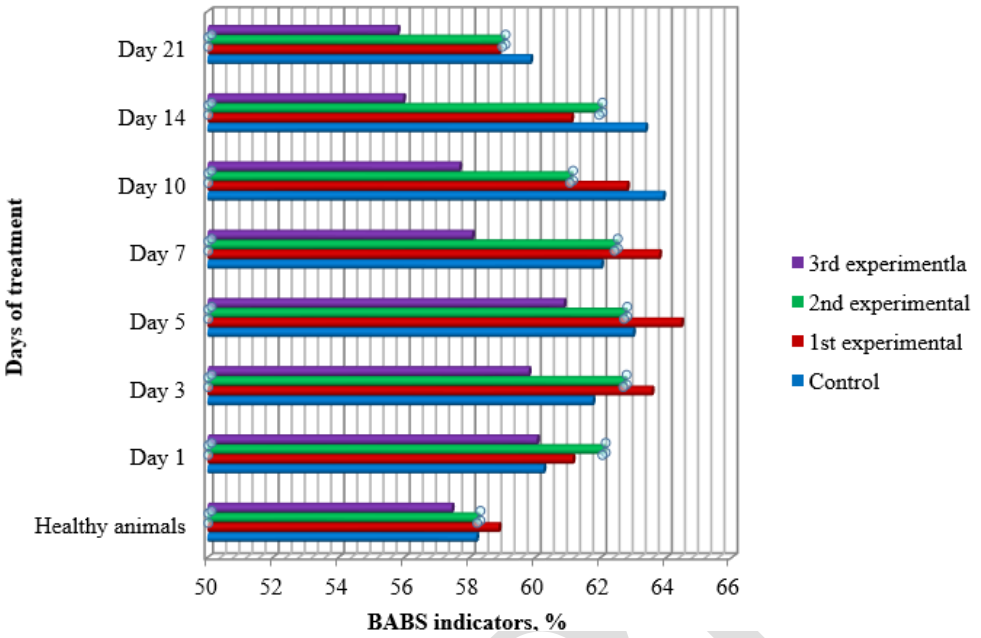

Fig. 2: Dynamics of BABS in treatment with experimental aseptic wounds*
*Control vs. Vishnevsky liniment: t = 0.387, P=0.710
Control vs. 10% *A. lerchiana* ointment: t = 0.259, P=0.802
Control vs. 20% *A. lerchiana* ointment: t = -0.169, P=0.870

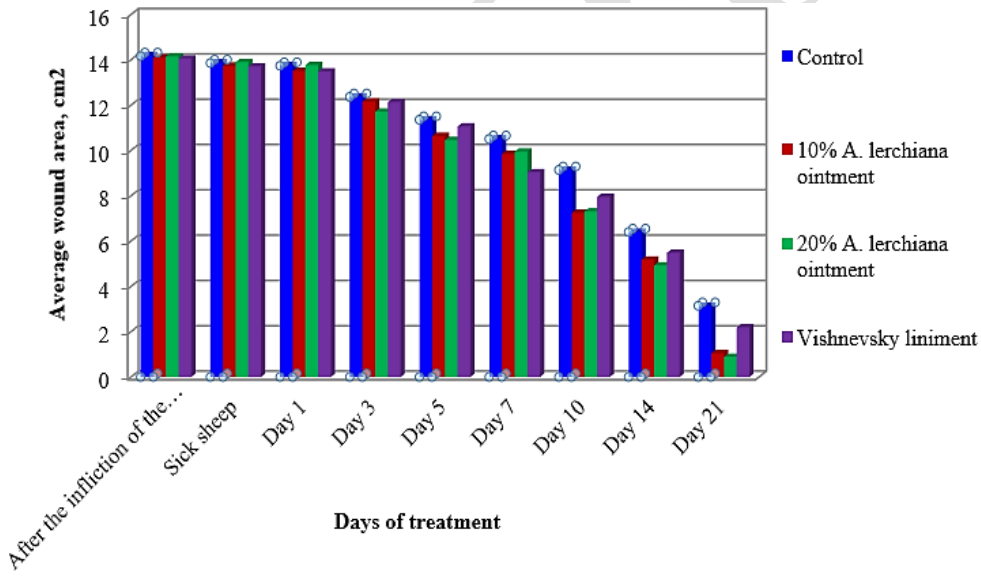

Fig. 3: Dynamics of the wound area in treating purulent wounds*
*Control vs. Vishnevsky liniment: t = 0.843, P=0.424
Control vs. 10% *A. lerchiana* ointment: t = 1.116, P=0.298
Control vs. 20% *A. lerchiana* ointment: t = 1.282, P=0.237

observed. In these experimental groups, the wound cleansing processes occurred identically, whereas in group IV they were slow and long.

On days 14-21, tissue regeneration in the wound area was observed, with the restoration of function, improvement of general condition, and clinical parameters (body temperature, pulse rate, and respiration) within normal limits. Complete wound healing in experimental groups I and II occurred on days 16-18, and in group III (traditional) on days 19-21; in group IV (control), the healing process continued. Subsequently, the animals of group IV were prescribed the necessary medical procedures.

The morphological composition of the blood was studied according to the same parameters as in the first experiment (Table 4). Leukocytosis, neutrophilia, lymphopenia, and a slight decrease in erythrocytes, hemoglobin, platelets, hematocrit, and thrombocrit were observed in all groups compared to the condition before the wound was inflicted (healthy animals). On days 1-5, leukocytosis persisted in all groups. We observed neutrophilia, where the percentage of immature and rod-shaped neutrophils increased markedly (by 2-3%), and lymphopenia. The percentage of basophils, eosinophils, and monocytes remained unchanged. Subsequently, leukocytes and neutrophils gradually decreased, and

Table 4: Dynamics of morphological composition of blood during the treatment of purulent wounds

Groups/ Parameters	Healthy animals	Sick animals (5 days)	Post-treatment (Days) 1	3	5	7	10	14	21
Control group									
Leukocytes (10^9/L)	7.08±1.28	19.89±3.55	19.05±3.84	17.58±2.36	15.34±0.12	13.74±3.54	12.05±3.21	11.25±2.47	9.85±2.47
Erythrocytes (10^{12}/L)	6.08±0.89	5.64±2.74	5.62±1.25	5.07±1.87	5.30±0.19	5.96±1.20	5.89±1.47	5.95±1.24	6.01±1.12
Hemoglobin (g/L)	93.87±2.72	90.75±3.82	89.45±3.24	85.89±3.24	86.4±1.17	87.23±3.24	88.19±4.01	89.41±3.56	91.24±2.74
Platelets (10^9/L)	518.8±2.06	485.6±2.20	448.6±2.28	403.8±1.94	414.2±3.02	429.2±1.62	435.0±2.41	486.4±2.62	491.8±3.12
Hematocrit (%)	31.61±1.17	30.83±1.02	30.26±0.49	29.44±0.98	26.42±2.02	27.66±1.44	28.42±1.60	30.24±1.46	32.21±1.36
Thrombocrit (%)	0.39±0.04	0.32±0.03	0.28±0.02	0.26±0.03	0.23±0.03	0.24±0.03	0.27±0.04	0.31±0.03	0.32±0.04
1st experimental group									
Leukocytes (10^9/L)	7.57±2.47	19.45±0.98	18.58±2.2	15.54±1.89	13.62±0.19	11.25±2.25	10.89±2.87	8.08±1.8	7.01±2.04
Erythrocytes (10^{12}/L)	6.07±2.05	5.54±1.24	5.64±1.07	5.98±2.87	6.06±0.28	6.11±1.56	6.17±1.52	6.21±1.45	6.39±1.2
Hemoglobin (g/L)	93.87±2.14	90.12±4.57	89.18±4.25	91.25±3.28	92.4±1.33	92.82±4.24	96.12±4.57	95.89±4.52	94.18±3.89
Platelets (10^9/L)	511.4±2.23	489.2±2.78	394.2±2.89	258.4±3.17	359.6±2.84	368.8±2.85	375.6±2.66	384.2±3.22	391.8±2.65
Hematocrit (%)	41.6±2.14	41.2±2.06	41.6±1.86	42.0±2.21	39.0±1.73	38.4±2.06	37.6±2.16	40.2±2.15	42.2±2.69
Thrombocrit (%)	0.42±0.03	0.38±0.04	0.33±0.02	0.28±0.03	0.26±0.02	0.29±0.02	0.31±0.03	0.34±0.03	0.37±0.05
2nd experimental group									
Leukocytes (10^9/L)	7.15±2.24	20.05±2.15	19.2±2.219	17.84±2.27	14.32±0.20	11.87±2.24	10.04±2.05	8.78±1.72	7.11±2.25
Erythrocytes (10^{12}/L)	6.11±1.78	5.86±1.08	5.81±2.05	5.91±2.76	6.08±0.29	6.18±1.25	6.24±3.87	6.38±2.1	6.93±1.75
Hemoglobin (g/L)	92.15±1.28	89.25±3.98	88.14±3.85	91.4±2.05	92.4±2.23	93.18±3.14	96.74±3.24	96.25±2.17	97.36±2.15
Platelets (10^9/L)	512.6±2.64	476.2±3.22	415.8±2.50	381.8±2.01	476.2±3.02	486.2±2.89	494.2±3.40	482.2±2.33	493.2±2.84
Hematocrit (%)	41.4±1.89	40.8±1.39	40.2±1.93	39.8±1.93	42.2±2.37	42.0±2.76	41.8±2.65	42.6±2.64	42.8±3.01
Thrombocrit (%)	0.42±0.03	0.41±0.03	0.39±0.03	0.38±0.02	0.37±0.02	0.32±0.02	0.24±0.03	0.38±0.03	0.40±0.03
3rd experimental group									
Leukocytes (10^9/L)	8.15±2.28	19.1±1.85	18.95±2.47	16.84±2.95	14.62±0.24	12.16±2.89	11.25±4.06	9.7±2.7	8.57±1.35
Erythrocytes (10^{12}/L)	5.95±1.5	5.58±2.52	5.67±2.25	5.85±2.16	5.64±0.21	5.87±2.24	6.04±1.72	6.21±1.29	6.18±1, 71
Hemoglobin (g/L)	91.8±2.41	88.54±3.13	86.25±3.21	91.75±3.38	92.8±2.42	93.74±4.77	93.45±3.27	93.58±3.38	92.98±2.77
Platelets (10^9/L)	506.6±3.31	492.0±3.52	475.8±3.18	469.4±2.87	435.4±2.23	456.8±2.71	475.4±3.36	496.6±1.57	492.4±3.33
Hematocrit (%)	35.6±1.81	34.4±1.44	32.2±1.85	31.8±1.74	30.8±2.08	31.4±2.11	31.8±2.22	33.4±1.86	37.2±0.97
Thrombocrit (%)	0.43±0.03	0.42±0.03	0.38±0.03	0.39±0.04	0.37±0.04	0.40±0.02	0.41±0.03	0.40±0.04	0.39±0.03

lymphocytes increased to the initial values in groups I, II, and III. In group IV, the number of leukocytes remained at the upper limits of the norm, and neutrophilia and lymphopenia were noted throughout the study. The remaining hematological blood parameters were within the normal range throughout the study in all groups.

The analysis of biochemical parameters in the blood serum showed significant changes in all groups throughout the study. Changes in total protein, albumins, and globulins tended to increase slightly on days 5-7 (1-2%) in all groups but within the normal range.

Studies of the BABS in animals with purulent wounds showed a reliable increase on day 5 in all groups (17-19%). Subsequently, the level of this indicator gradually decreased, and by the end of the study (day 21), it reached the initial level (Fig. 4). Only in group IV (control) remained the BABS level above the initial level.

DISCUSSION

Our results confirm the efficacy of *Artemisia lerchiana*-based ointments in treating aseptic and purulent wounds in animals, offering advantages over traditional treatments such as Vishnevsky liniment. This finding aligns with the current research trend that emphasizes the potential of herbal preparations in veterinary medicine. Our study agrees with the study of Kuralkar and Kuralkar (2021), which highlights the importance of applying herbal productions and evaluates the considerable antibacterial effect of *Artemisia lerchiana* in comparison with other treatment plans (Nametov et al. 2023).

In our study, we observed no adverse effects in animals treated with A. lerchiana ointments, which corroborates with other studies on the safety profile of plant-based treatments. Our conclusion agrees with Yertleuova et al. (2024), who concluded that there were no adverse side effects when treating aseptic wounds in dogs using *A. lerchiana* ointments. Another study by Yertleuova et al. (2024) showed that the results of an allergy diagnostic study proved that the infusion *A. lerchiana* treatments had no irritating and sensitizing allergenic activity.

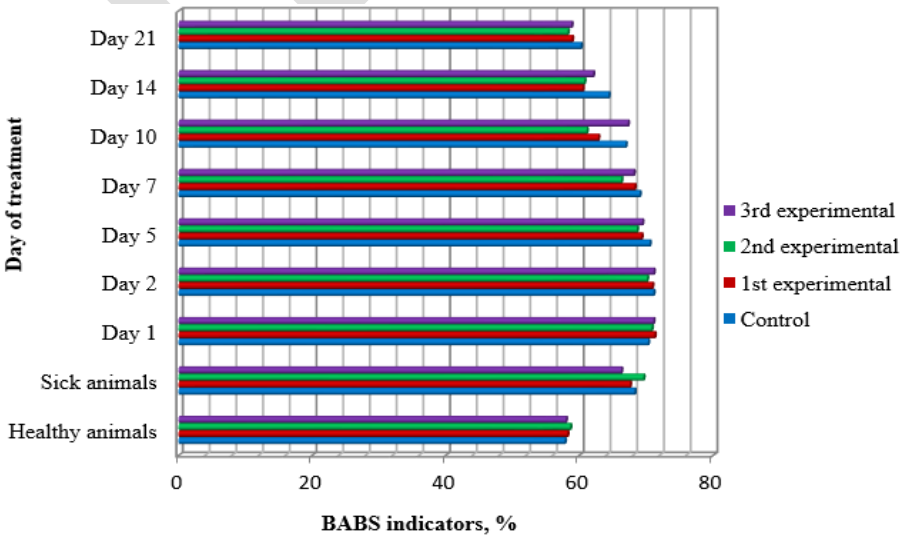

Fig. 4: BABS dynamics during treatment with experimental purulent wounds*
*Control vs. Vishnevsky liniment: t = 0.000, P=1.000
Control vs. 10% *A. lerchiana* ointment: t = 0.071, P=0.945
Control vs. 20% *A. lerchiana* ointment: t = -0.170, P=0.869

The studies show that wound healing did not occur throughout the experiment in the control group and wound cleansing and regenerative processes were slow. This confirms that recovery is difficult to achieve without medical intervention, and the risk of secondary complications increases.

The studies on the treatment of aseptic and purulent wounds using Vishnevsky liniment showed the effectiveness of this traditional method, but the treatment period was long. Excessive and prolonged use of such preparations can lead to the resistance of microorganisms to them, side effects in the form of allergic reactions, and a decrease in the nonspecific immunity.

Our findings agree with other authors (Silva et al. 2022; Balkrishna et al. 2024), who suggest that phyto-preparations, due to their complex chemical composition, provide diverse therapeutic benefits, including antimicrobial and regenerative properties. This finding is confirmed by our results, where treating aseptic and purulent wounds using preparations (10 and 20% ointment) based on *A. lerchiana* showed high effectiveness compared to the traditional method. We observed a 100% recovery rate in both versions of the experiment, reduction of wound healing time by 1-2 days in treating aseptic wounds and by 2-3 days in treating purulent wounds, absence of side effects, and preservation of the level of humoral immunity factors. The effectiveness of 10% A. lerchiana ointment was no lower than that of 20% *A. lerchiana* ointment.

The accelerated wound healing observed in the sheep treated with 10-20% *A. lerchiana* ointment corresponds with the reported effects and application of essential oils and plant-based/herbal preparations in promoting granulation, cellular repair, and tissue regeneration (Buhrmann et al. 2020; Indurkar et al. 2021). The significant reduction in wound area by days 5-7 in our study agrees with findings from recent research on the application of herbal preparations in wound healing and cellular repair mechanisms (Agarwal et al. 2021; Abazari et al. 2022). This result indicates that *A. lerchiana* could be a valuable alternative in veterinary practice.

Concerning immunological responses, we observed stable humoral immunity levels in our study, which agreed with the works of Elumalai et al. (2020) and Zhang et al. (2022), who reported enhanced innate immune system response, white blood count, and serum bactericidal activity following herbal treatments on animals. This finding supports the hypothesis that herbal medicines and ointments can improve the immune system and heal wounds (Ebani and Mancianti 2020; Xu et al. 2023), an uncommon ability with synthetic treatments. Thus, the advantage of drugs based on *A. lerchiana* is their plant origin, the lack of resistance of microorganisms to them, high antibacterial activity, and a stimulating effect on tissue regeneration.

We recommend that future studies should focus on identifying active compounds and their interactions with cellular pathways involved in wound healing. More research is needed to understand the effect of α-thujone and β-thujone on farm animals since they are found in essential oils of *A. lerchiana* (Nurlybekova et al. 2022).

Conclusion

Our findings validate the therapeutic potential of *A. lerchiana* ointments in wound management. The results align with recent advancements in herbal medicine, emphasizing their role as cost-effective and sustainable alternatives in veterinary care. Further research is encouraged to explore these preparations' scalability and broader applications. Despite the absence of statistical differences, the experimental groups consistently showed favorable trends in key clinical outcomes such as wound area reduction and bactericidal activity of blood serum (BABS).

A comparative assessment of the effectiveness of the preparations based on *A. lerchiana* in treating surgical wounds showed that they were not less effective than the traditional preparation (Vishnevsky liniment) and even showed better results in treatment time. These observations suggest that the ointments may have therapeutic potential, particularly in managing aseptic and purulent wounds. An ointment based on *A. lerchiana* is effective at both 10% and 20% concentrations. Thus, the results allow us to recommend preparations based on A. lerchiana as effective antibacterial and wound-healing medicines for surgical wounds. The observed trends, such as reduced wound area and improved BABS dynamics, are clinically meaningful for veterinary medicine. These effects could lead to the development of cost-effective and natural livestock wound management alternatives, potentially reducing reliance on synthetic drugs and antibiotics.

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REFERENCES

Abazari M, Akbari T, Hasani M, Sharifikolouei E, Raoufi M, Foroumadi A, Sharifzadeh M, Firoozpour L and Khoobi M, 2022. Polysaccharide-based hydrogels containing herbal extracts for wound healing applications. Carbohydrate Polymers 294: 119808. https://doi.org/10.1016/j.carbpol.2022.119808

Abdulla A, 2008. The influence of Vetshungit ointment on the clinical and immunological status of animals with surgical trauma: Author's abstract of a dissertation for the candidate of veterinary sciences degree. Almaty, Kazakhstan, pp: 23.

Agarwal T, Tan S, Onesto V, Law JX, Agrawal G, Pal S, Lim WL, Sharifi E, Moghaddam FD and Maiti TK, 2021. Engineered herbal scaffolds for tissue repair and regeneration: Recent trends and technologies. Biomedical Engineering Advances 2: 100015. https://doi.org/10.1016/j.bea.2021.100015

Alinkina EP, Misharina TA and Fatkullina LD, 2013. Antiradical properties of oregano, thyme and savory essential oils. Prikladnaya Biokhimiya i Mikrobiologiya 49(1): 82-82.

Bae D, Seol H, Yoon HG, Na JR, Oh K, Choi CY, Lee DW, Jun W, Youl Lee K, Lee J, Hwang K, Lee YH and Kim S, 2012. Inhaled essential oil from Chamaecyparis obtusa ameliorates the impairments of cognitive function induced by injection of β-amyloid in rats. Pharmaceutical Biology 50(7): 900-910. https://doi.org/10.3109/13880209.2011.642886

Bagci E, Akbaba E, Mihasan M, Maniu C and Hritcu L, 2016. Anxiolytic and antidepressant-like effects of Ferulago angulata essential oil in the scopolamine rat model of Alzheimer's disease. Flavour and Fragrance Journal 31(1): 70-80. https://doi.org/10.1002/ffj.3289

Balkrishna A, Sharma N, Srivastava D, Kukreti A, Srivastava S and Arya V, 2024. Exploring the safety, efficacy, and bioactivity of herbal medicines: bridging traditional wisdom and modern science in healthcare. Future Integrative Medicine 3(1): 35–49. https://doi.org/10.14218/fim.2023.00086

Buhrmann C, Honarvar A, Setayeshmehr M, Karbasi S, Shakibaei M and Valiani A, 2020. Herbal remedies as potential in cartilage tissue engineering: An overview of new therapeutic approaches and strategies. Molecules 25(13): 3075. https://doi.org/10.3390/molecules25133075

Castro MR, Victoria FN, Oliveira DH, Jacob RG, Savegnago L and Alves D, 2015. Essential oil of Psidium cattleianum leaves: Antioxidant and antifungal activity. Pharmaceutical Biology 53(2): 242-250. https://doi.org/10.3109/13880209.2014.914231

Chiang B, Essick E, Ehringer W, Murphree S, Hauck MA, Li M and Chien S, 2007. Enhancing skin wound healing by direct delivery of intracellular adenosine triphosphate. American Journal of Surgery 193(2): 213-218. https://doi.org/10.1016/j.amjsurg.2006.08.069

Duan D and Chen L, 2015. Antidepressant-like effect of essential oil isolated from Toona ciliata Roem var. yunnanensis. Journal of Natural Medicines 69(2): 191-197. https://doi.org/10.1007/s11418-014-0878-0

Ebani VV and Mancianti F, 2020. Use of essential oils in veterinary medicine to combat bacterial and fungal infections. Veterinary Sciences 7(4): 193. https://doi.org/10.3390/vetsci7040193

Elumalai P, Kurian A, Lakshmi S, Faggio C, Esteban MA and Ringø E, 2020. Herbal immunomodulators in aquaculture. Reviews in Fisheries Science and Aquaculture 29(1): 33–57. https://doi.org/10.1080/23308249.2020.1779651

Emelyanenko PA, 1980. Guidelines for testing natural resistance in calves. Moscow, Russia, pp: 64.

Firsov GM, Akimova SA, Ryadnov AA, Ryadnova TA and Firsova YuG, 2019. Dynamics of hematological and biochemical parameters in sheep with infected wounds. Problemy Razvitiya APK Regiona 3(39): 197-202

Gopal K and Asmita N, 2014. Use of essential oils in poultry nutrition: A new approach. Journal of Advanced Veterinary and Animal Research 1(1): 156-162. https://doi.org/10.5455/javar.2014.a36

Gradinariu V, Cioanca O, Hritcu L, Trifan A, Gille E and Hancianu M, 2015. Comparative efficacy of Ocimum sanctum L. and Ocimum basilicum L. essential oils against amyloid beta (1-42)-induced anxiety and depression in laboratory rats. Phytochemistry Reviews 14: 567-575. https://doi.org/10.1007/s11101-014-9389-6

Haroon M, Anas M, Naurin I, Afzal R, Irfan U, Tariq H, Idrees F, Taj MH and Rukh M, 2023. Autoimmunity in plants; a powerful weapon in kingdom plantae to combat stresses. International Journal of Agriculture and Biosciences 12(3): 159-164. https://doi.org/10.47278/journal.ijab/2023.059

Holle G, Germann G, Sauerbier M, Riedel K, von Gregory H and Pelzer M, 2007. Vacuum-assisted closure therapy and wound coverage in soft tissue injury: Clinical use. Unfallchirurg 110(4): 289-300. https://doi.org/10.1007/s00113-007-1265-z

Indurkar A, Pandit A, Jain R and Dandekar P, 2021. Plant-based biomaterials in tissue engineering. Bioprinting 21: e00127. https://doi.org/10.1016/j.bprint.2020.e00127

Isaeva V, Alinkina E, Misharina T, Fatkullina L, Dukhova N, Surinov B and Burlakova E, 2014. The effect of long-term administration of essential oils in small doses on the immune reactivity and sensitivity of mice to ionizing radiation. Radiatsionnaya Biologiya, Radioekologiya 54(1): 35-37.

Kislichenko VS, Velma VV and Zotikova OA, 2013. A comparative analysis of the chemical composition of essential oil from the leaves of plants of the *Petroselinum* genus cultivated in Ukraine. Aktualnye Problemy Meditsiny 23(18): 220-224.

Korotkov AV and Papunidi EK, 2013. Evaluation of irritating and allergenic properties of chlorophyllipt alcohol solution in vivo and in vitro on rabbits. Its antimicrobial impact on some pathogenic microflora. Izvestiya Gorskogo Gosudarstvennogo Agrarnogo Universiteta 50(2): 165-169.

Kuralkar P and Kuralkar S, 2021. Role of herbal products in animal production – An updated review. Journal of Ethnopharmacology 278: 114246. https://doi.org/10.1016/j.jep.2021.114246

Lepekhova SA, 2013. Results of the development of an infected skin wound model for studying the properties of new preparations. Vestnik KrasGAU 9: 155-160.

Mussayeva A, Yegorova N, Yerishov M, Dossanova A, Suchshikh V, Namet A, Siyabekov S, Nussupova S and Yespembetov B, 2021. Molecular-biological properties of the attenuated strain of Salmonella abortus-equi E-841, used in the creation of a vaccine against abortion of mares. American Journal of Animal and Veterinary Sciences 16(2): 144–150.

Nametov A, Yertleuova B, Orynkhanov K, Semenenko MP, Sidikhov B, Murzabayev K, Dushayeva L, Ichshanova A and Marat M, 2023. Evaluation of the antibacterial effect of Artemisia lerchiana compared with various medicines. Brazilian Journal of Biology 83: 1–7. https://doi.org/10.1590/1519-6984.277641

Nosovskii AM, 2013. Small sample statistics in medical research. Rossiiskii Meditsinskii Zhurnal 6: 57-60.

Nurlybekova A, Kudaibergen A, Kazymbetova A, Amangeldi M, Baiseitova A, Ospanov M, Aisa HA, Ye Y, Ibrahim MA and Jenis J, 2022. Traditional use, phytochemical profiles and pharmacological properties of Artemisia genus from Central Asia. Molecules 27(16): 5128. https://doi.org/10.3390/molecules27165128

Popova LN, 1942. How the boundaries of newly formed epidermis change during wound healing: A Candidate at Medical. Med. Sciences. dissertation. Moscow, Russia, pp: 16.

Ramazanova BA, Akyshbaeva KS and Mamatova AS, 2015. The influence of *A. lerchianaA. lerchiana* essential oils on the formation of microbial biofilms. Vestnik Kazakhskogo Natsionalnogo Meditsinskogo Universiteta 1: 364-367.

Revyakin IV, Medvedeva LV and Petrenko VA, 2017. Clinical and morphological evaluation of the effectiveness of new methods of treating skin wounds in animals in a comparative aspect. Vestnik Altaiskogo Gosudarstvennogo Agrarnogo Universiteta 9(155): 165-170.

Saiyudthong S, Pongmayteegul S, Marsden C and Phansuwan-Pujito P, 2015. Anxiety-like behavior and c-fos expression in rats that inhaled vetiver essential oil. Natural Product Research 29(22): 1-4. https://doi.org/10.1080/14786419.2014.992342

Savina IV and Nurgalieva RM, 2017. The effect of bacillus lysates on pathogens causing purulent and inflammatory skin diseases in animals. Izvestiya Orenburgskogo

Gosudarstvennogo Agrarnogo Universiteta 5(67): 141-143.

Shnyakina TN, Bilan AM and Shcherbakov NP, 2018. Treatment of infected wound in sheep in an experiment. Vestnik Altaiskogo Gosudarstvennogo Agrarnogo Universiteta 3(161): 185-189.

Silva DHS, Mannochio-Russo H, Lago JHG, Bueno PCP, Medina RP, Da Silva Bolzani V, Vilegas W and Nunes WDG, 2022. Bioprospecting as a strategy for conservation and sustainable use of the Brazilian flora. Biota Neotropica 22(spe): 1–10. https://doi.org/10.1590/1676-0611-bn-2022-1356

Suchshikh V, Karimov A, Yussupov M, Aitzhanov B, Abutalip A, Mussayeva A, Yegorova N, Mamanova S and Kanatov B, 2023. Effectiveness of different means of disinfection against soil foci of anthrax (Bacillus anthracis) burials at a depth of up to 3.5 m: an experimental study. Caspian Journal of Environmental Sciences 21(4): 893–902.

Tonkovtseva VV and Mikhailovich YA, 2018. The effect of Crimean Red Rose essential oil on the functional state of the cardiovascular system of elderly people. Byulleten Gosudarstvennogo Nikitskogo Botanicheskogo Sada 127: 53-59. https://doi.org/10.25684/NBG.boolt.127.2018.07

Torre DM, De Laforcade AM and Chan DL, 2007. Incidence and clinical relevance of hyperglycemia in critically ill dogs. Veterinary in International Medicine 21: 971-975. https://doi.org/10.1892/0891-6640(2007)21[971]

Tsioli B and Dermisiadou E, 2018. Management of distal limb skin defects in dogs and cats. Journal of the Hellenic Veterinary Medical Society 67(1): 5-16. http://dx.doi.org/10.12681/jhvms.15618

Vyas K and Vasconez HC, 2014. Wound healing: Biologics, skin substitutes, biomembranes and scaffolds. Healthcare 2(3): 356-400. https://doi.org/10.3390/healthcare2030356

Witte MB, Kiyama T and Barbul A, 2002. Nitric oxide enhances experimental wound healing in diabetes. British Journal of Surgery 89(12): 1594-1601. https://doi.org/10.1046/j.1365-2168.2002.02263.x

Xu Z, Dong M, Yin S, Dong J, Zhang M, Tian R, Min W, Zeng L, Qiao H and Chen J, 2023. Why traditional herbal medicine promotes wound healing: Research from immune response, wound microbiome to controlled delivery. Advanced Drug Delivery Reviews 195: 114764. https://doi.org/10.1016/j.addr.2023.114764

Yertleuova BO, Nametov AM, Sidikhov BM, Orynkhanov KA and Semenenko MP, 2024. Toxic and allergic effects of Artemisia lerchiana infusion and essential oil on the body of laboratory animals. Scientific Education 2-1(75): 303-312

Zhang W, Zhao J, Ma Y, Li J and Chen X, 2022. The effective components of herbal medicines used for prevention and control of fish diseases. Fish and Shellfish Immunology 126: 73–83. https://doi.org/10.1016/j.fsi.2022.05.036