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RESEARCH OF WOUND HEALING EFFECT OF PHYTOMINERALSORBENT ON THE BASIS OF MONTMORILLONITE

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Abstract
Introduction: The results of preclinical investigation of the wound healing effect of phytomineralsorbent (PMS) based on montmorillonite are presented.
Objectives: Study of the possibilities of pharmacological correction of purulent wound process with the help of various medicinal forms of phytomineral sorbent based on montmorillonite.
Methods: Purulent wounds were modeled in white rats of the Wistar line in the interblade area 3 cm^2. Wound dressing was performed daily for 21 days by PMS in the form of powder and gel, and also by the comparison preparation Dexpanthenol (Russia, Pharmstandard). The wound healing effect was carried out according to morphological parameters of histological sections, clinical and biochemical parameters of blood and exudate of the animals under study.
Results and discussion: The wound defect of rats, the ligation of which was carried out by phytomineral sorbents, was significantly less than the control 2 times, the depth of necrosis in the acute phase of the wound process was up to 0.85 microns deep, which is 1.7 times less than in the control group. The use of Dexpanthenol in the acute stage was characterized by a suppuration reaction and the presence of microbes. When studying the dynamics of the most important rat blood parameters during wound healing, it was established that the content of immature neutrophils in the regeneration phase in animals using PMS in the form of powder was lower by a factor of 2 compared to the control group and group of animals using the drug Dexpanthenol; the concentration of the total protein in the blood of animals in experimental groups with the use of the preparation Dexpanthenol and PMS based on montmorillonite in the forms of powder and gel were significantly lower than the control one by 18-25% on the third day of the experiment. Exudation of purulent wounds of animals, wound dressings which were performed by PMS in the form of powder, ceased on the second day, the remaining animals lasted up to 5 days.
Conclusion: PMS in the form of powder has best effect of wound healing on inflammatory stage of injury.
Keywords: phytomineralsorbent, montmorillonite, wound healing, injury.

Introduction

Wound and consequent purulent processes are among the most common pathologies in surgery. They have a different etiology, are widespread and are accompanied by various complications [1]. The wound process can not be considered as a purely local phenomenon, since many body systems are affected to a greater or lesser extent [2]. Local and general infection leads to a variety of disorders of the body's systems and functions. Violated metabolism and hematopoiesis, microcirculation is changing, there is a suppression of liver functions [3].

There is a wide spectrum of various methods and means of treatment of purulent wounds For today in the arsenal of physicians [2, 4]. In this case, the method of local treatment of wounds remains the most common due to its availability, low cost, and most importantly effectiveness [6]. Over time, many funds lose their effectiveness due to the development of resistance of pathogenic microflora to this drug [7, 8].

Studies in the field of wound healing agents have been carried out for many decades, including the influence of sorbents on the wound process [7-12]. Sorbents are able to remove toxic substances, purulent exudate, products of cellular decay, blood elements from the wound, as well as pathogenic microflora, aggravating the severity of the disease [13-15].

Previously, it was proved that sorbents based on montmorillonite with high sorption ability, successfully cope with undesirable microflora, optimize the process of wound healing [16-18].

Among the basic requirements for modern wound coverings, in addition to protecting the wound from infection, care should be taken to ensure vapor permeability and sorption capacity sufficient to maintain the wet state of the wound, as well as the ability to maintain adhesion and cell growth [19].

In this regard, it becomes relevant to study ecologically safe, biologically effective sorption compositions for the treatment and prevention of purulent consequences of wound injuries on the basis of mineral and plant raw materials.

Objective: To study the possibilities of pharmacological correction of purulent wound process with the help of various dosage forms of phytomineral sorbent based on montmorillonite.

Materials and methods

Investigation of wound healing properties of phytomineral sorbents (PMS) in the form of powder and gel, as well as Dexpanthenol spray, was performed on white linear Wistar rats (80 pieces), which were selected as a biological model. FMS is a complex sorption composite based on the inorganic minerals of the montmorillonite group and the extract of the medicinal plant *Thymus serpylum*. For the study, animals weighing 180-200 g were taken without external signs of the disease, who had passed the quarantine regime. Operations and other manipulations in rats were carried out under conditions of general anesthesia by intraperitoneal administration of an aqueous solution of chloral hydrate at a dose of 300 mg / kg. The animals were divided into groups by stratified randomisation with stratification by body weight, diet and nutrition conditions, and by operations and manipulations. All experiments were approved by the Ethics Committee of the "Belgorod State National Research University". Vivisection was carried out in accordance with the ethical principles of the treatment of laboratory animals "The European Convention for the Protection of Vertebral Animals Used for Experimental and Other Scientific Purposes. CETS No. 123 ".

Wounds were applied in the interblade area with an average diameter of 2.83 cm2, which was 1% of the total surface of the skin of the animals. In the area of injury, using a sutured suture, a special port was sewed (for collection of exudate and local examination of the wound), a certain agent corresponding to the experimental groups was inserted into it [20]. Further, a strain of Escherichia coli was applied to the wound region at a fixed infectious dose of 2 10^8 microbial bodies.

All the animals were divided into five experimental groups, 20 each in each group: group I – control (the wound was washed with NaCl 0.9%); Group II – wound dressing Dexpathenol; Group III – dressing wounds PMS in the form of powder; IV group – dressing wounds PMS in the form of gel. Bandaging with PMS (powder, gel) was carried out by applying 0.1 g of the drug to the damaged area daily during the entire period of the experiment once a day. Dexpathenol was applied daily to the affected area of the skin at a distance of 10-20 cm once a day so that the entire affected area was coated with the drug (before use, the balloon was shaken). This dressing technique was chosen based on the instructions for using the drug.

The experiment was carried out for 21 days, which corresponds to the generally accepted wound healing time. The entire period of wound healing was divided into three stages: inflammation, regeneration, scar formation.

Morphological examination was applied to the cutaneous muscle flap of the wound from rats of various groups taken on the third, ninth and twentieth day of the course of the wound process. The cutaneous muscle flap was removed surgically, then it was fixed for 24 hours in a 10% formalin solution and degreased in growing spirits, filled into paraffin and histological preparations with a cut thickness of 3-5 µm, stained with hematoxylin-eosin.

The study of blood in laboratory animals was carried out every third day. Blood sampling for general and biochemical analysis was carried out from the tail vein into tubes with EDTA anticoagulant, under the action of the 1st stage of anesthesia, using analgesics.

Blood tests were performed on the hematological analyzer "Sysmex XP-300" (Germany), and the biochemical "Cobas® 4000" (Germany) c with sets of standard reagents.

A general clinical blood test was examined in terms of: Hb; Ht; the number of erythrocytes, platelets, leukocytes; leukocyte formula: neutrophils, basophils, eosinophils lymphocytes). Biochemical analysis: (total protein, albumin, ALT, AST, urea, creatinine, bilirubin, glucose, electrolytes: K^+, Na^+, iron, Cl^-, pH).

Investigation of exudate purulent wounds was carried out in the acute phase of the wound process, according to the following parameters: pH, concentration of total protein and glucose. Sampling is carried out from the surface of the wound (by sampling an average sample) into special tubes with a lid.

The pH was determined by a potentiometric method using the pH meter of Metter-Toledo AG (Switzerland). In addition, the pH of the isotonic solution and the extract of thyme were determined.

The total protein concentration was determined by a biuret reaction using a spectrophotometric method using the Specord 210 Plus device (Germany). Glucose concentration was determined by titrimetric method.

Results and discussion

All laboratory animals had swelling of the edges, presence of purulent exudate, white-green color, viscous consistency with an unpleasant odor a day after the application of wounds. Since 3 days the animals have died. The most intensive death was in the control group of animals. By the third day in this group, 40% of the animals died. By 20 days 7 animals out of 20 survived. The death of animals was the result of the developed sepsis of diffuse peritonitis. At the autopsy, a part of the dead animals found a reactive adhesive process in the abdominal cavity and intestinal obstruction.

A planimetric study of the wound defect showed that on the 18th day in the group where the wound treatment was performed with the gel form of FMS, the area of the wound surface was significantly less than the original value by 81%. The area of the wound surface in animals where Panthenol Pharmstandard was used was the lowest (65% less on average for the rest of the groups). However, the use of FMS in powder form stimulated a more early reduction in the area of the wound defect than in other animals (Fig. 1).

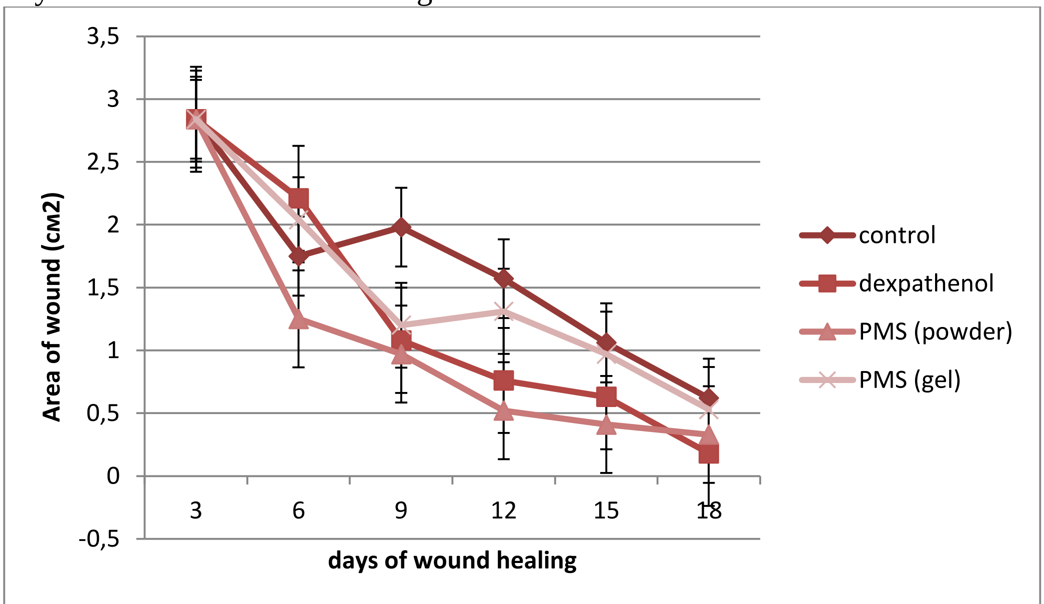

Fig. 1. Change in the area of the wound defect in moulding a purulent wound in rats in the experiment

The morphological pattern of the purulent wound in the control group is the same in all cases: in the acute phase, a large layer of necrotic tissue up to 1.5 μm is present on the wound surface, indicating an active inflammatory process, mast cells and macrophages, (Fig. 2 A). In animals treated with Dexpanthenol, the scab had a thickness of 0.15 to 0.6 μm, consisting of fragments of necrotic tissue with fragments of leukocytes, a thickness of inflammatory infiltration up to 1 μm (Figure 2 B). In rats fed PMS in the form of powder on the acute phase of the wound process, necrotic tissue with dense infiltration of neutrophilic leukocytes and blood clots was up to 0.85 microns deep (Fig. 2C). The area of the wound defect in animals treated with FMS as a gel is covered in the acute phase with a necrotic tissue with neutrophils, the depth of necrosis is up to 1 μm (Fig. 2 D).

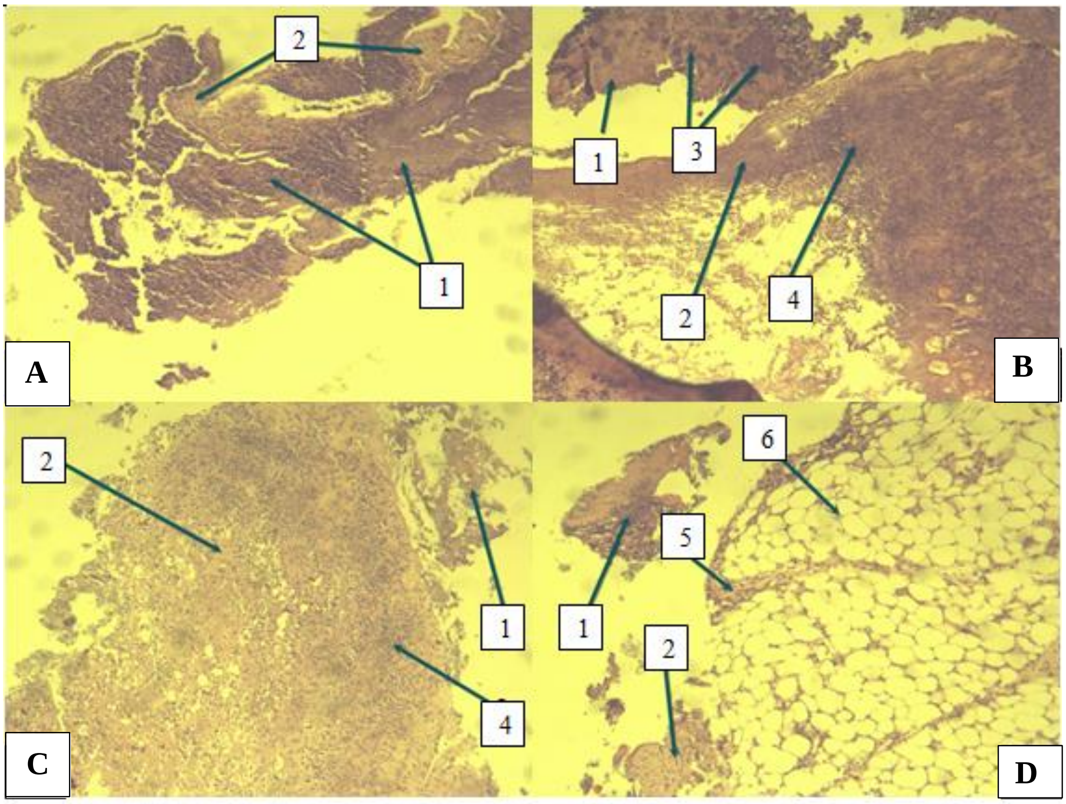

Fig. 2. Section of the skin of a rat after modeling a purulent wound in the interblade area on day 9 under different experimental conditions (regeneration phase). Note: A – control; B – wound dressing Dexpanthenol; B – wound dressing PMS in the form of powder; D – dressing wound PMS in the form of gel.
1 – necrotic tissue; 2 – connective tissue; 3 – colony of microbes; 4 – neutrophilic leukocytes with their fragments; 5-lymphocytic infiltration; 6 – adipose tissue
Note: staining with hematoxylin-eosin. Magnification x 200.

As a result of the conducted microscopic studies of the wound defect, it was found that when using PMS in the early stages of the wound process, lymphonodiocyte infiltration and rapid restoration of the connective tissue are facilitated. Secondary reinfection did not occur, due to the high sorption ability of the drugs. The use of Dexpanthenol in the application of purulent wounds caused the decomposition of tissue in the area of scab formation, the scab was rejected before the wound was healed, a secondary infection with a copious purulent discharge was attached. It should be noted that at the final stage of the wound process, neutrophilic leukocytes were present in the histological preparations of only the control group, which indicates the effectiveness of using both PMS and Dexpanthenol in the treatment of purulent wounds.

Throughout the entire experiment, we studied the morphological parameters of peripheral blood in animals of experimental and control groups.

The clinical picture of the blood of rats in the acute phase of the wound process and shows that in all experimental animals acute blood loss and severe inhibition of the functions of the formation of new cells were observed.

A study of the red blood system of injured animals showed that on the 3rd day hemoglobin in all groups of authentically initial indicator was on average 11% (Table 1). During the regeneration phase (9th and 12th days) in animals where the FMS in the form of powdered Hb was used for dressing the wounds, there were 142.50 ± 1.575 and 143.15 ± 1.602, which may indicate the restoration of hematopoiesis processes that were activated earlier than in the animals of the control group and the application of Dexpanthenol.

Table 1

Concentration of Hb in the blood (g / l), (M ± m; n = 6)

Group of animals	Control	Dexpanthenol	PMS (powder)	PMS (gel)
Baseline	136.25 ± 2.61			
3 day	128.00 ± 1.67*	123.33 ± 2.56*	121.50 ± 0.84*	123.50 ± 1.58*
6 day	152.00 ± 3.37*	116.13 ± 1.69*°	115.00 ± 1.69*°	134.67 ± 4.24°
9 day	149.00 ±1.67	135.50 ± 0.84°	142.50 ± 1.56*°	140.13± 2,58°
12 day	135.43± 2.06	131.30± 2.60	143.15± 1.60*°	138.00± 2.74
15 day	132.02± 1.91	141.36± 2.52°	137.65± 2.40	140.36± 2.03°
18 day	150.96± 1.36*	148.21± 1,95*	148.54± 2.65*	151.87± 2.79*

Note: * significant differences from the corresponding values in animals with a baseline; ° – significant differences in indices compared with the control group of rats (p <0.05)

Adhesion of platelets to the endothelium and subendothelial matrix is the initial stage of hemostasis and thrombosis. The number of platelets was significantly increased on the 6th day after the application of the model wound, which indicates a high thrombus formation (Table 2). The level of platelets at this stage in animals treated with PMS in the forms of powder and gel was 611.33 ± 19.313 and 826.00 ± 16.859, respectively, which is lower than in the control group of rats by 35 and 11%. During the reorganization phase of the rumen, the platelet count gradually decreases, thus the integrity of the endothelium of the blood stream is restored.

Table 2

Platelet concentration in the blood (* 10^9 / l), (M ± m; n = 6)

Group of animals	Control	Dexpanthenol	PMS (powder)	PMS (gel)
Baseline	483.00 ± 43.40			
3 day	624.33 ± 8.65*	595.67 ± 7.01*°	612.00 ± 3.37*	555.67 ± 8.60°
6 day	935.33 ± 25.31*	950.00 ± 50.58*	602.67 ± 53.98*°	826.00 ± 16.86*°
9 day	560.45 ± 18.65	513.67 ± 28.60	611.33 ± 19.31*	620.28 ± 19.29*
12 day	439.25± 32.23	451,15± 41.38	402.46± 35.62	398.25± 26.65
15 day	419.02± 45.21	387.33± 43222	451.21± 42.37	400.00± 44.44
18 day	520.23± 43.37	501,04± 45.37	511.36± 45.60	487.69± 48.46

Note: * significant differences from the corresponding values in animals with a baseline; ° – significant differences in indices compared with the control group of rats (p <0.05)

Reduction of the containing of leukocytes in the peripheral blood during the first three days can be explained by the general reaction of the organism to the local infectious process (Table 3).

Table 3

Concentration of leukocytes in the blood (* 10^9 / l), (M ± m; n = 6)

Group of animals	Control	Dexpanthenol	PMS (powder)	PMS (gel)
Baseline		18,67 ± 1,404		
3 day	16.52 ± 0.73	15.13 ± 0.26*	16.83 ± 0.35	15.18 ± 0.30*
6 day	18.20 ± 0.34	13.20 ± 0.67*°	11.00 ± 1.01*°	14.60 ± 0.84*°
9 day	16.80± 0.73	1410± 1.26*	14.30± 0.96*	16.40± 1.66
12 day	14.30± 1.69	13.93± 0.88*	13.32± 1.22*	14.44± 1.56*
15 day	14.30± 0.99	14.04± 1.86	13.76± 1.73*	14.18± 1.92
18 day	11.36± 0.95*	11.54± 1.36*	11.60± 1.65*	10.67± 1.49*

Note: * significant differences from the corresponding values in animals with a baseline; ° – significant differences in indices compared with the control group of rats (p <0.05)

Analyzing the indicators of the leukogram, it should be noted that during the first three days after the application of wounds, neutrophilia was registered, the content of stab neutrophils was increased 2-fold (Table 4). On the 6th day in the groups where treatment of wounds of PMS occurred, a regenerative shift of neutrophils to the left was observed, with normalization of these indices to the twelfth-fifteenth day.

Table 4

Indicator of the content of stab neutrophils (%) in the blood (M ± m; n = 6)

Group of animals	Control	Dexpanthenol	PMS (powder)	PMS (gel)
Baseline		1.60 ± 0.52		
3 day	2.33 ± 0.97	3.16 ± 0.49*	2.17 ± 0.49	2.35 ± 0.87
6 day	3.00 ± 0.18*	2.17 ± 0.49	2.04 ± 0.12°	2.28 ± 0.429
9 day	2.00 ± 0.97	2.37± 0.92	1.13± 0.42	2.70± 0.36
12 day	2.00± 0.31	2.32± 0.33	1.02± 0.152	2.20± 0.25
15 day	1.80± 0.45	2.00± 0.22	2.02± 0.31	1.20± 0.50
18 day	2.00± 0.65	2.02± 0.75	1.00± 0.12	2.36± 0.16

Note: * significant differences from the corresponding values in animals with a baseline; ° – significant differences in indices compared with the control group of rats (p <0.05)

Studies of blood biochemical analysis of rats with model purulent wounds showed that the concentration of total protein on the 3rd and 6th day was decreased, which indicates catabolic processes in organs and tissues (Table 5). When using the drug Dexpanthenol and PMS based montmorillonite in the forms of powder and gel, the concentration of total protein in the blood of animals was significantly lower than the control protein by 18-25% on the third day of the experiment. By the 9th day there is an increase in the total protein content in the blood plasma, which indicates anabolic processes.

Table 5

Concentrations of total protein in blood serum (g / l), (M ± m; n = 6)

Group of animals	Control	Dexpanthenol	PMS (powder)	PMS (gel)
Baseline		74.78 ± 7.23		
3 day	86.75 ± 1.41	70.87 ± 4.24°	65.00 ± 3.37°	70.20 ± 3.372°
6 day	53.00 ± 5.06*	65.83 ± 5.15	66.87 ± 7.60	59.33 ± 7.60
9 day	56.70 ± 6.74	63.43± 5.15	59.71± 7.60	53.53 ± 7.602
12 day	60.12± 7.23	62.45± 6.29	59.56± 6.74	58.53± 7.15
15 day	68.50± 6.95	69.53± 7.26	54.05± 7.46	45.98± 6.23*
18 day	76.00± 6.98	69.34± 7.46	72.36± 7.26	69.58± 7.75

Note: * significant differences from the corresponding values in animals with a baseline; ° – significant differences in indices compared with the control group of rats (p <0.05)

The activity of aminotransferases throughout the experiment was increased, with a decrease towards the end of the experiment. It should be noted that according to the data of studies, the activity of ALT and AST (Tables 6 and 7) was increased by 2.5 times using Dexpanthenol, while when using PMS, the activity of these enzymes was only 2 times at the acute stage of the wound healing process.

Table 6

Activity of ALT (ME / L) in serum (M ± m; n = 6)

Group of animals	Control	Dexpanthenol	PMS (powder)	PMS (gel)
Baseline		38.40 ± 6.39		
3 day	48.00 ± 0.84	50.70 ± 3.37	64.20 ± 1.69*°	46.70 ± 1.69
6 day	49.93 ± 7.60	59,70 ± 5.06*	38.00 ± 6.74	27.30 ± 6.74
9 day	50.65± 6.39	51.41± 5.06	49.82± 6.74	41.93± 6.74
12 day	41.33± 6.390	41.06± 6.74	37.36± 7.60	39.96± 6.80
15 day	55.00± 7.95	53.81± 6.96	55.82± 6.852	46.73± 6.36
18 day	31.00± 7.12	41.92± 6.16	41.13± 5.65	38.94± 6.26

Note: * significant differences from the corresponding values in animals with a baseline; ° – significant differences in indices compared with the control group of rats (p <0.05)

Table 7

ACT activity (ME/ L) in blood serum (M ± m; n = 6)

Group of animals	Control	Dexpanthenol	PMS (powder)	PMS (gel)
Baseline		97.90 ± 8.62		
3 day	265.67 ± 6.81*	67.30 ± 5.06*°	371.40 ± 5.06*°	285.20 ± 8.43*°
6 day	202.40 ± 8.921*	102.90 ± 8.56°	129.20 ± 5.09.*°	158.63 ± 7.50*°
9 day	135.90± 7.50*	121,74± 8.56*	120.43± 9.39*	154.12± 8.92*
12 day	115.10± 8.56	119.70± 0.51	121.90± 8.92	144.30± 9.39*
15 day	337.64± 28.65*	146.67± 7.99*°	130.65± 8.16*°	136.62± 7.24*°
18 day	118.90± 9.12	109.15± 8.85	117.97± 8.74	134.79± 8.37*

Note: * significant differences from the corresponding values in animals with a baseline; ° – significant differences in indices compared with the control group of rats (p <0.05)

The concentration of iron in the blood plasma in the acute phase of the wound process was increased 2.5-fold in animals whose wound dressings were performed by Dexpanthenol, compared with the initial index and 1.5-fold compared with the control group of animals (Table 8). Such an increase in iron ions may indicate a strong hemolysis of red blood cells.

Table 8

Concentration of iron ions (mmol / L) in blood serum (M ± m), n = 5

Group of animals	Control	Dexpanthenol	PMS (powder)	PMS (gel)
Baseline		19,86 ± 0,460		
3 day	33.74 ± 1.69*	51.75 ± 2.58*°	22.12 ± 1.69°	22.48 ± 0.81*°
6 day	25.30 ± 0.56*	26,90 ± 0.36*	19.60 ± 0.47°	20.90 ± 0.51°
9 day	23.63± 0.56*	25,51± 0.02*°	26.40± 0.02*°	21.81± 0.51°
12 day	25.00± 0.02*	21.41± 0.02°	20.90± 0.56°	21.70± 0.47°
15 day	19.10± 0.02	19.70± 0.36	21.40± 0.56°	20.10± 0.47
18 day	19.80± 0.51	20.10± 0.47	20.50± 0.07	19.2± 0.19

Note: * significant differences from the corresponding values in animals with a baseline; ° – significant differences in indices compared with the control group of rats (p <0.05)

In animals, the application of wounds, which were performed by PMS in the forms of powder and gel, the concentration of iron was slightly higher than the initial value throughout the experiment.

Biochemical changes in exudate – a fluid released from tissues and blood vessels during inflammation play an important role in diagnosis and selection of a method for treating purulent wounds.

pH values of effervescent liquids are used in clinical practice to diagnose the transition of serous exudate to serous-purulent. The common boundary is the pH of 7.20.

The data obtained for the 1st day of purulent process indicate that in rats in groups II and III of the experimental groups with characteristic signs of suppuration, they have a slightly acidic or neutral character: the pH value was in the range from 5.88 to 7.09, which is below the boundary criterion pH is equal to 7.20. This aspect indicates the violation of acid-base balance of cells and tissues and, as a consequence, about acidosis. However, in rats in the experimental group, where the wound dressing was performed with a dry form of PMS, exudation stopped already on the 3rd day of the experiment, and the most uniform dynamics of pH change was observed (Table 9).

Table 9

Parameters of the pH value of suppurative exudate of model l wounds in white rats (M ± m; n = 6)

Group of animals	pH		
	1st day	**2nd day**	**3rd day**
(I) Control	7.26±0.04	5.76±0.03	7.46±0.04.
(II) Dexpanthenol	7.09±0.04*	7.25±0.04*	7.05±0.04*
(III) PMS (powder)	7.07±0.04*	7.04±0.04*	-
(IV) PMS (gel)	7.25±0.04	6.77±0.04*	7.24±0.04*

Note: * significant differences compared to Group I animals, p≤0.05

Determining the concentration of total protein in the effusions is the main point in the study of purulent wounds. With mild vascular damage, not only low-molecular albumin seeps into the focus of inflammation, in more severe lesions, large-molecule globulins appear in the exudate, and, finally, the largest molecules of fibrinogen, which turn into tissues into fibrin. A common value that distinguishes exudate from a transudate is that the protein content in the serum of a biological material should be more than 25 g / ml [21].

The data on the protein content in wound exudate are presented in Table 10. The calculation was carried out by the equation: y = 0.0032x + 0.0061; R = 0.9944, at the analytical wavelength: λ = 547 nm.

The results of the study show that in I, II and IV experimental groups of animals, an increase in the concentration of total protein in the wound exudate was observed. On the third day of the experiment in these groups, the protein content in the sweat was greater than 25 g / ml, which indicates that the effusion from the wound is characterized as exudate. In the III experimental group, the total protein concentration had a negative dynamics, effusions ceased on day 3 of the experiment. On the first day of the experiment, the protein concentration in the exudate was 25 g / ml, and on the 2nd day – 10 g / ml, which is less than the usual value for exudate.

Table 10

Concentration of total protein (g / l) in exudate purulent wounds in rats in the experiment (M ± m; n = 6)

Group of animals	1st day	2nd day	3rd day
		C_p, mg/cm^3	
(I) Control	34.00 ± 0.19	21.60 ± 0.12	90.00 ± 0.50
(II) Dexpanthenol	29.40 ± 0.16*	21.20 ± 0.12	77.30 ± 0.43*
(III) PMS (powder)	25.00 ± 0.14*	10.20 ± 0.06*	-
(IV) PMS (gel)	54.51 ± 0.31*	35.10 ± 0.20*	108.80± 0.61*

Note: *significant differences compared to Group I animals, p≤0.05

With an increase in the permeability of the walls of the vessels, glucose also passes into the exudate of the wound. The presence of glucose in the effervescent fluids creates a favorable environment for the development of pathogenic microflora.

The glucose concentration indices in the wound exudate are presented in Table 11. Based on the results of the study, an uneven change in the glucose concentration is observed in the experimental groups. In rats I, III and IV of the experimental groups, the glucose concentration changes in wave form: it rises on the 2nd day of the experiment and decreases by the third. In groups II and III the glucose content decreases on the second day and rises to the third.

Table 11

The concentration of glucose (mmole / l) in exudate purulent wound (M ± m; n = 6)

Group of animals	1st day	2nd day	3rd day
		Cg, mmole/l	
(I) Control	0.77±0.01	2.27±0.02	0.72±0.01
(II) Dexpanthenol	0.22±0.01*	1.39±0.01*	1.51±0.02*
(III) PMS (powder)	0.33±0.01*	1.11±0.01*	-
(IV) PMS (gel)	0.49±0.01*	2.22±0.02	1.72±0.02*

Note: * significant differences compared to Group I animals, p≤0.05

Thus, it can be concluded that the use of FMS in the exudative phase of the wound healing process helps to reduce the concentration of total protein and glucose, which favors the formation of regeneration processes.

Conclusions

Comparative study of purulent wounds in the control group and groups with the use of the studied drugs showed that phytomineral sorbent based on montmorillonite in the form of powder contains the most pronounced effect on the healing of purulent wounds. This is expressed in the absence of a suppuration reaction in the wound bottom, a significant decrease in the severity of morphological signs of inflammation, a smaller thickness of the scab, lack of microbism, accelerated epithelialization of the lesion, and a good development of the granulation tissue. The survival rate of animals with phytomineral sorbents was more than 65%, while in the control one it was less than 35%.

When studying the dynamics of the most important rat blood parameters during wound healing, it was established that the content of immature neutrophils in the regeneration phase in animals using PMS in the form of powder was lower by a factor of 2 compared to the control group and group of animals using the drug Dexpanthenol; the concentration of total protein in the blood of animals in experimental groups with the use of the preparation Dexpanthenol and PMS based on montmorillonite in the forms of powder and gel were significantly lower than the control one by 18-25% on the third day of the experiment; transamination enzyme activity in animals where treatment was performed with the investigational drug was significantly lower than the control group by 25% (for ALT) and by 31% (for AST); the concentration of iron ions in blood plasma in animals where wounds were applied with dry and gel forms of PMS was significantly lower by a factor of 1.5 compared with the corresponding values in the control group.

The results of investigation of the local inflammatory, purulent and regenerative processes in the wound exudate showed that the concentration of the total protein in the group of rats that treated PMS on the basis of montmorillonite in the form of powder was significantly lower than the control – by 26% in the first day after the start of treatment, by 52 % – in the second, on the third day, exudation in animals of this group stopped. In the remaining experimental groups, exudation lasted up to 5 days.

Conflicts of interest

The authors have no conflict of interest to declare.

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