International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 05, 2020
ISSN: 1475-7192

Approach to the Treatment of Cows with the Diseases of the Distal Part of the Extremities

Irina I. Mikhailova, Tatyana R. Leshchenko, Alexei A. Evglevsky,
Elena P. Evglevskaya, Olesya N. Mikhailova and
Evgeny Yu. Finageiv

Abstract--- *Currently, farming in Russia is focused on the upscale production of meat and dairy products. However, high rate of non-infectious diseases in animals prevent the fulfillment of the state program of import substitution. Thus, there is a great number of cows with hooves diseases registered in the farm complexes of Rostov oblast. The analysis of the origins of the pathology of distal parts of extremities showed that contributing factors to these diseases are metabolism disorders, animal immune status failure, and violation of zoo hygienic norms in the husbandry. Considering all the available data, the authors proposed a complex approach to the treatment of cows with purulonecrotic lesions of the distal parts of their extremities. The approach combines targeting the local abnormal focus and systemic effect. The authors evaluated the effect and implemented in practice energy metabolism enhancing composition that included succinic acid, beetroot molasses, and potassium chloride. Application of this composition allowed for the reparation of immune metabolic processes in cows, improvement in tissue trophic in the pathologic lesion and acceleration of animals' recovery.*

Keywords--- *Laminitis, Phlegmon, Ulcers in Cows, Metabolic Acidosis, Succinic Acid, Molasses, Mamikur, Dressing, Energy Metabolism Enhancement Composition (EMC).*

I. INTRODUCTION

Sufficient provision of the Russian population with the farm products produced in Russia is possible only at the intensive approach to animal farming. However, this system establishment and maintenance has some difficulties. The main one is the high concentration of animals in a small area, which increased the risk of development and spread of different diseases.

Lately, purulonecrotic lesions of digits have been often registered in bovine cattle. These diseases harm the economy of animal farm complexes. Thus, the milk yield in sick cows decreases up to 50%, calf crop – up to 15-

Irina I. Mikhailova, Candidate of Veterinary Sciences, Associate Professor at the Department of Obstetrics, Surgery and Physiology of Domestic Livestock, Don State Agrarian University, 24 Krivoshlykova Str., vil. Persianovskiy, Oktyabrskiy Region, Rostov Oblast, Russia. E-mail: olnimix@mail.ru

Tatyana R. Leshchenko, Candidate of Veterinary Sciences, Associate Professor at the Department of Obstetrics, Surgery and Physiology of Domestic Livestock, Don State Agrarian University, 24 Krivoshlykova Str., vil. Persianovskiy, Oktyabrskiy Region, Rostov Oblast, Russia. E-mail: olnimix@mail.ru

Alexei A. Evglevsky, Doctor of Veterinary Sciences, Professor, Head of the Laboratory "Veterinary Medicine", Federal Agricultural Kursk Research Center, 10 Cheriomushki, Rurskiy Region, Kursk Oblast, Russia. E-mail: evgl46@yandex.ru

Elena P. Evglevskaya, Candidate of Agricultural Sciences, Doctor at the Department of Sanitary Epidemiology and Biotechnology, Kursk State Agricultural Academy, 70 Karla Marksa Str., Kursk, Kursk Oblast, Russia. E-mail: evgl46@yandex.ru

Olesya N. Mikhailova, Candidate of Veterinary Sciences, Veterinary Physician at the Department of Animal Disease Control and Medical and Preventive, Rostov Oblast Station of Animal Disease Control, 18 Liniya 16, Rostov-on-Don, Russia. E-mail: olnimix0103@icloud.com

Evgeny Yu. Finageiv, Post-graduate Student at the Department of Obstetrics, Surgery and Physiology of Domestic Livestock, Don State Agrarian University, 24 Krivoshlykova Str., vil. Persianovskiy, Oktyabrskiy Region, Rostov Oblast, Russia. E-mail: finageev2016@yandex.ru

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

20%. As a result, the economic performance of the industry falls and the breeding plan suffers, which does not allow for the realization of the genetic potential of animals due to the disposal of heavily sick animals [4,7,8,10,12].

Animals, used in modern upscale farm production, should have good health, because the new technology of handling and feeding has a number of negative features, like low insolation, high humidity, increased content of harmful substances in the air, hypodynamia, diet with a variety of premixes. Chronic influence of these factors on animals lead to the weakening of the immune system which is manifested as the inhibition of autarcesis and specific immune response and increase of sensibility to infectious agents [2,5,9,23].

In recent years, the headcount in dairy cattle reduced, which led the decrease in meat and milk production and the reduction of cow productive age to 5-6 years, while their normal productive age is 12-15 years. Besides, noncontagious diseases became widespread, including interventional [1,9,16,17,26].

According to the veterinary records, among the animals, that have interventional diseases developed after the surgery, there are up to 80% of the diseases of the distal part of the extremities: pododermatitis, laminitis, arthritides, ulcers, abscess, and phlegmon. This pathology in cows prevails in single complexes [21].

According to the classification proposed by Prof. N.S. Ostrovskiy [13], all the diseases and pathological conditions in digit are divided into three groups: primary lesions, inflammatory infectious complications that develop after primary lesions and remote incurable complications and deformities.

Primary lesions act as triggers to the development of complicated forms of the disease if an animal does not receive proper treatment. The peculiarities of bovine cattle immune response to the primary etiological factors should be taken into account because timely diagnostics of primary lesions contributes to quick recovery.

The diseases of the second group are characterized by more severe clinical manifestations, long-term morbidity and development of non-specific surgical infection that can be localized in coronet, heel, and other digits segments.

The group of incurable complications and deformities include chronic productive inflammatory processes that lead to deformation of hoofs and digits (digit fibrositis, ossifying periarthritis, ankyloses and pseudankylosis, cloven deformation).

The author specifies that such classification has practical significance. Preventive measures for such diseases have to target the prevention of primary lesions considering the character of etiologic factors that lead to their development. The treatment of primary lesions should be aimed at the prevention of complications development.

A.A. Stekolnikov, A.A. Kirilov, B.S. Semenov, E.P. Mazhukha [11,18] believe that the lesions of distal parts of the extremities directly depend on the age of an animal and the level of their milk productivity. Five-seven-year-old cows have the disease of claws registered 2 times more often than in three-year-old ones. Besides, cows with high milk productivity get sick more often, these cows have milk yield decreased by 9.96% per year, calf crop – by 17.6%, servicing period elongates to 113 days, the majority of cows have repeated inseminations and non-pregnant cows are disposed (around 37.1%).

Lesions of the distal parts of the extremities are caused by infected wounds, ulcers, phlegmon of coronet, heel and other processes that are activated when general immune resistance weakens [1,3,6,20,24,28].

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

Contributory factors to the development of foot diseases are unfavorable conditions of keeping, unbalanced and insufficient diet, reduced immune response, hypodynamia and congenital deformities. All these factors contribute to the development of pathologic process and determine the disease severity. Thus, concentrated same-type diet in modern farm complexes lead to often metabolism disorders in cows that are manifested as metabolic acidosis, significant weakening of the immune system, increase of cow sensibility to endogenous pathogenic agents, worsening of physical properties of hooves, which become fragile. This leads to the peeling of hoof, development of cracks and bends and local trophic disorders, which creates favorable conditions for bacterial invasion. Improper hoof trimming or lack of trimming contributes to the development of digital diseases, and late treatment results in such diseases as heel phlegmon, coronet, etc.

One of the primary tasks in veterinary science and practice is the development and implementation of modern methods of treatment for different pathologies, as well as of efficient biological and chemotherapeutic drugs that contribute to the enhancement of the immune response and status.

At the current level of dairy production development, the creation of new drugs and implementation of new methods of animal treatment with metabolic disorders, foot lesions, and other processes have great practical significance. This will allow for elongation of farm animal production age and increase of economic efficiency of the industry [14,18,22,25,27].

Evglevskiy A.A. et al. developed energy metabolism enhancing composition (EMC) [1,14,15] for the correction of metabolism in animals. It includes widely used and economically available components and can be used in therapy of digital lesions associated with metabolic disorders.

The aim of the present study was to improve the complex of preventive and therapeutic measures for the increase of the therapy efficiency at purulonecrotic lesions of distal parts of extremities in cows that were kept in dairy complexes in Rostov Oblast. The evaluation of energy metabolism enhancing composition efficiency for the correction of metabolism disorders in cows was performed.

II. MATERIALS AND METHODS

The study was conducted in the facilities of three dairy complexes in Matveevo-Kurganskiy and Neklinovskiy Regions in Rostov Oblast. The object of the clinical study was highly productive cows with average body weight of 450- 650 kg.

The surgical health assessment of the cows revealed a number of cows with the diseases of the distal part of the extremities. The authors performed their general clinical examination and took blood samples for biochemical assays.

To perform the analysis of the causes of digital lesions in cows that are kept in dairy complexes, the authors evaluated the cows keeping and feeding conditions and the peculiarities of the in-house preventive and therapeutic protocols. Further, surgical health assessment and treatment of animals were performed, and the complex of measures on the disease elimination was developed.

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

Animal health assessment revealed the cows with digital lesions and clinical manifestations of metabolism disorders. These cows were divided into two groups: control and test. The cows were treated by the method proposed by the Department of Obstetrics, surgery, and farm animal physiology of the Don SAU.

Therapeutic measures were aimed at the creation of unfavorable conditions for the development of saprogenic and anaerobic microflora, reduction of toxemia rate, and creation of favorable conditions for tissue regeneration and normalization of metabolic processes in cows.

For evaluation of the treatment plans, 20 sick cows of Red Steppe Breed and Black and White Breed aged 4-7 years were chosen. Two groups (control and test) of cows were formed. Animal treatment was performed according to the method proposed at the Department of Surgery of the Don SAU. The method includes:

- Thorough mechanical trimming and debridement of the focal lesion, complete removal of the peeled hoof;
- Creation of unfavorable conditions for the development of saprogenic and anaerobic microflora, reduction of toxemia rate, and creation of favorable conditions for tissue regeneration;
- Protection of ulcerous surface from the mechanical and physical influence of the environment.

The cows were fixed standing in the chute, the infected foot was tied to the fixation pole, and the mechanical trimming and debridement of the focal lesion were performed.

After the primary surgical debridement and the excision of the abscessed phlegmon, the sick animals from the control group had phlegmon cavity cleansed with the solution of potassium permanganate (1:1000). Further, the cavity was dried out, and Levomekol ointment was injected into the cavity. Additionally, procaine circular block was performed for therapeutic effect. 80-100 ml of 0.5% procaine solution was used for infiltration of the tissues. Benzylpenicillin sodium salt was added to the procaine solution to prolong and enhance its effect. This combination of the drugs prolongs the effect of the therapeutic block for up to 48 hours. Finally, the ulcerous surface was dressed with a bandage.

Animals from the test groups had mamikur injected into the phlegmon cavity after the phlegmon excision and primary debridement of the cavity. The rationale for the application of this combined antibacterial drug is in its content and mechanism of action that provides synergistic enhancement of the antibacterial activity towards nearly all the known microorganisms (E. coli, Strept. uberis, Staph. aureus). Additionally, the cows were given orally a solution of energy metabolism enhancement composition for the correction of pathological biochemical processes as a part of the complex therapy.

Finally, the animals from the test and control groups had the bandage treated with birch-tar put on the distal part of the sick. The bandage was changed in 3 days.

The efficiency of the proposed approach was evaluated by the results of the examination of the pathological lesion, its size, degree of lameness and general health condition of a sick animal. The control of metabolic processes in cows was performed by biochemical assays of blood sampled on the 5, 10 and 15^{th} day of the treatment with EMC. This composition includes 15-20g of succinic acid, 500-550 ml/g of beetroot molasses and 40-50g of

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

potassium chloride. The components should be diluted in 4-5 L of drinking water and given orally to cows individually. Besides, energy metabolism enhancing composition was used for wetting the feed.

Pharmacologic characteristics of the specified components are provided below as the theoretical ground for its application.

Succinic acid (SA) and its salts have a wide spectrum of activity towards different mechanisms of the regulation of the metabolic activity of cells. SA targets cells and tissues that are excited or pathologically altered. Absolute safety of SA and its compounds, that exert positive effect even in the lowest therapeutic doses, makes them an attractive resource for the development of new generation "smart" drugs.

The application of succinic acid for the correction of pathophysiological conditions is explained by its antioxidant and antitoxic properties that were proved by the schools of Kondrashova and Lukiyanova.

Succinic acid is a highly potent stimulator of cells energy metabolism, which is especially relevant under different pathophysiologic conditions when the organism lacks energy for maintaining vital functions;

- Succinic acid enhances cells gas exchange by dozens of times, which improves oxygen uptake by cells and tissues and deactivates reactive oxygen intermediates;
- Succinic acid normalizes the nervous system functioning, which plays an important role in stress resistance;
- Succinic acid inhibits inflammatory processes and neutralizes toxins, which is important in the treatment of toxicological diseases;
- Stimulatory effect of succinic acid is especially expressed when the organism is weakened and sick.

Currently, succinic acid (SA) is widely used in the development of new drugs due to its antioxidant activity. In the composition of such drugs, SA potentiates pharmacologic effects of many active substances. It actively stimulates metabolism of live cells. SA and its salts (succinates) exert unusually high therapeutic effect in all pathophysiological conditions. It is important to mention that positive influence of SA on the organism is observed even in relatively low doses of 0.5-1 mg/kg of body weight. Absolute safety of SA and its compounds, that exert positive effect even in the lowest therapeutic doses, makes them an attractive resource for the development of new generation "smart" drugs.

Succinic acid was used as the main metabolic. SA and its salts have a wide spectrum of activity towards different mechanisms of the regulation of the metabolic activity of cells. SA enhances detoxicative activity of liver by dozens of times, which is important in the treatment of toxicosis and intoxications. The stimulatory effect of succinic acid is especially expressed when the organism is weakened and sick [10,14].

Succinic acid is a highly potent biostimulator of cells energy metabolism. It provides additional energy for the cells of stomach mucous and improves digestion. Oral indication of succinic acid stimulates the immune system and enhances protective mechanisms in newborns. Positive influence of succinic acid on the organism is observed even in relatively low doses of 0.5-1 mg/kg of the body weight.

An additional component of energy metabolism enhancing composition is beetroot molasses, which is widely used in upscale farm animal production as a source of carbohydrates and for improvement of animal feed taste.

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

Introduction of molasses into the diet of lactating cows significantly increases the content of fat in milk. In veterinary, molasses was traditionally used for activation of uterus involution during the delivery and expulsion of afterbirth.

Introduction of potassium chloride into the energy metabolism enhancing composition is explained by the regulatory activity of potassium ions on the acid-base balance, which is inevitably disturbed at pathobiochemical processes. The balance and metabolism of potassium are disturbed at hypocalcemia, which is expressed in down-calving and lactating cows. Clinically, this process is manifested as bone softening.

The specified weight and volume parts of the components are optimal for the normalization of metabolic processes. The detailed methodology of the energy metabolism enhancing composition is described in the patent of the RF № №2553360.

Clinical observations showed that the animals actively consumed the feed wetted with the energy metabolism enhancing composition; animals' clinical condition significantly improved 30-40 minutes after the consumption of the composition.

III. RESULTS

Surgical health assessment revealed 38 cows with different degree of digital lesions. Primarily, there were lesions in hind legs, like ulcers, phlegmon in coronet, heel and interdigital skinfold. Laminitis, pododermatitis and arthritis of the pedal joint were also registered. The results of the health assessment in cows are presented in Table 1.

Table 1: The Results of Health Assessment in Cows

№	***Diseases***	***Heads***	***%***
1.	Necrotic ulcers of coronet, heel, interdigital claw	17	44.7
2.	Phlegmon of coronet, heel, interdigital claw	10	26.4
3.	Laminitis	4	10.5
4.	Pododermatitis	7	18.4
Total		38	

The data in the table shows that the most often registered diseases are necrotic ulcers in the coronet, heel and interdigital skinfold, which is 44.7% of the total. Phlegmon in the heel and interdigital skinfold are registered in 26.4% of cases, pododermatitis – in 18.4% and laminitis – in 10.5%.

The authors suggest that the main causes of purulonecrotic digital diseases in cows that are kept in farm complexes are violation of zoo hygienic conditions (high air humidity, increased concentration of ammonia, and wet floor). As a result, animals digital and heel area skin gets macerated, the hoof softens, which leads to further cracks formation, skin sensitivity, and footrot bacteria invasion. Another contributing factor is the lack of hooves trimming and proper medical care. This leads to the overgrowth and deformation of the hoof and contributes to the increase of morbidity rate.

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

Purulonecrotic digital diseases in bovine cattle that are kept in farm complexes were characterized by diverse clinical manifestation. Animals' general condition worsened, the body weight reduced up to 69%. The animals lost appetite, their skin hair lost its texture with wide areas of alopecia. Milk productivity and body weight (as compared to the previous lactation) was insufficient; the skeletal muscles were weak; the hoof wall was softened, which led to its peeling and the development of ulcers, phlegmon, laminitis and pododermatitis (Fig. 1 and 2).

Primary lesions were registered in the distal part of extremities. Those were spontaneous phlegmons, localized primarily dorsal and plantar in coronary and heel area, and in the interdigital skinfold. The area of the lesion was characterized by dense or diffused roll-like painful swelling, digits and cloven were spread maximally spread.

One or several abscesses developed in the swollen area. When the abscess was excised, the general state of the animal improved, lameness reduced. The tissues around the excised phlegmon were loose and yellow grayish pus discharged. Perioplic horn peeled around the pathologic focus and roundish ulcers with even edges appeared. The ulcers size ranged from 1-1.5 to 4 cm and were covered with amorphic masses. The lameness was light or moderate. During the process, different areas of the digital skin base were involved.

Fig. 1: Heel Phlegmon of the 4th Digit of the Left Hind Leg; Fig. 2: Heel Ulcer of the 3rd Digit of the Right hind Leg

At rest, the cows kept the sick leg apart, stepping on the digit tips or heel. The animals were inactive and spent most of the time lying (Fig. 3). Distal part of the extremity had primary lesions and their inflammatory and infectious complications, as well as remote incurable deformations of the cloven.

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

Fig. 3: Animal Inactivity at Phlegmon in the Heel

Primary phlegmon, located on the heel, got abscessed. Perioplic horn of the heel, sole and posterior part of the inner wall peeled. On the border between the horn layer of the heel and hairy part of the skin, there was a narrow cleft. There was liquid yellow grayish exudate with blood expressed when the sole was pressed (Fig. 4).

In a number of cases, the newly formed horn and skin base degraded under the peeled heel, the cleft was filled with dirt, decayed tissue and exudate. In severe cases, skin ulcers appeared in the skin base of the heel. After the removal of the peeled horn, ulcers in the heels were seen that were of different sizes and shapes. The edges of the ulcers were loose as compared to the newly formed horny epidermis (Fig.5).

Fig. 4: Abscess in the Heel Phlegmon in the 4th Digit of the Left Hind Leg; Fig. 5: Heel Ulcer in the 3rd Digit of the Left Hind Leg

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

The sick animal spent most of the time lying or barely moved with lameness.

Clinical examination of the lesion after the phlegmon excision showed that the ulcer was covered with cyanotic bleeding granulations with insignificant amount of yellowish exudate. Surgical debridement showed that the inner hoof wall and sole peeled; in complicated cases, the whole horny tissue had to be removed leaving a narrow strip of horny capsule 1-1.5 cm wide along the coronet border. Inflamed necrotized skin base of the hoof was revealed. It was covered with dirty grayish exudate with unpleasant smell. Some animals did not have visible changes in the hoof walls and only lameness was observed. Surgical debridement of such cloven revealed the peeling of a significant part of the horny capsule.

The animals in the control group were treated after the primary surgical debridement and topical application of Levomekol ointment on the ulcers. Additionally, antibiotic circular block was performed in the area of pastel bones.

In the test group, mamikur was injected into the cavity after the mechanical trimming and phlegmon excision. Finally, animals in both groups had the wound bandaged. The bandage was changed in three days (Fig. 6-11). Additionally, the cows in the test group were given individually energy metabolism enhancing the composition.

The general condition of the cows was controlled by clinical examination and biochemical assays that were conducted according to the methods currently used in the “Rostov regional veterinary laboratory”. Biochemical assays included alkali reserve, total calcium, and phosphorus content.

Mathematical processing of the obtained data and estimation of the significance criteria (P) was performed according to the method proposed by V.S. Assatiani [1985].

Composition indication plan. The cows in the test group received orally energy metabolism enhancing composition OD for 5 days. It was also used for feed wetting. Beetroot molasses provided stimulation of water and feed consumption.

Fig. 6: Fixation of a Cow in a Hoof Trimming Chute; Fig. 7: Primary Surgical Debridement

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

Fig. 8: Grinding of the Hoof; Fig. 9: Attachment of a Wooden Shoe to the Healthy Digit

Fig. 10: Injection of Medication into the Phlegmon Cavity; Fig. 11: Wound Dressing

When the therapy was over, it was established that animals recovered by 2-3 days earlier than in the control group (Table 2).

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

Table 2: Efficiency of the Treatment of a Digit Phlegmon in Cows

Group	Heads	Medication	Duration of the therapy, days	Number of applications	Cured animals
1.	5	Levomekol + procaine circular block	18+2	5	5
2.	5	Mamikur + energy metabolism enhancement composition	12+2	3	5

As it can be seen in the Table, the duration of the therapy reduced as well as the number of manipulations decreased from 5 in the control group to 3 in the test group, which reduced the labor input.

The results of biochemical assays showed that at the beginning of the study the cows that decreased the content of total protein, calcium, and phosphorus. Reduced alkaline reserve led to the increase of ketone bodies, which indicated on the metabolism disorders in cows.

Clinical observations showed that animals from the test group, 2 days after oral administration of energy metabolism enhancing composition, became more active, they quickly reacted to external irritants, consumed food and their biochemical picture of blood changed.

The control data on the changes of metabolic status in the cows from the test group is presented in Table 3.

Table 3: Influence of the Energy Metabolism Enhancement Composition on the Metabolic Processes in Lactating Cows

Parameters	Norm	Days of the study after the composition application			
		1	5	10	15
Total protein, g/L	72-86	70.8 ± 2.45 71.1 ± 2.54	84.53 ± 2.34 70.5 ± 2.38	86.9 ± 2.46 72.6 ± 2.02	86.1 ± 2.54 71.7 ± 2.48
Total alkaline reserve, % CO_2	46-66	44.3 ± 2.54* 42.9 ± 2.47	47.2 ± 2.45* 43.6 ± 2.08	52.8 ± 2.54* 51.6 ± 2.09	57.7 ± 2.24* 54.6 ± 1.98
Ketone bodies, mg%	1-6	10.36 ± 0.89 9.29 ± 0.72	4.72 ± 0.56 8.38 ± 0.49	3.94 ± 0.38 7.62 ± 0.34	3.05 ± 0.36 7.76 ± 0.29
Calcium, mmol/L	2.5-3.13	2.1 ± 0.12 2.04 ± 0.12	2.42 ± 0.18 2.03 ± 0.11	2.46 ± 0.14 2.05 ± 0.12	3.1 ± 0.15 2.03 ± 0.14
Non-organic phosphorus, mmol/L	1.45-1.94	1.41 ± 0.26* 1.33 ± 0.28	1.5 ± 0.34* 1.38 ± 0.26	1.69 ± 0.22* 1.41 ± 0.25	1.72 ± 0.18* 1.44 ± 0.32
Glucose, mmol/L	2,2-3,3	2.76 ± 0.28* 2.31 ± 0.32	2.8 ± 0.62* 2.53 ± 0.24	2.89 ± 0.25* 2.76 ± 0.22	3.2 ± 0.32* 2.83 ± 0.34
Bilirubin, mmol/L	0,9-2,8	0.93 ± 0.25* 4.01 ± 0.25	0.87 ±0.25* 3.83 ± 0.25	0.91 ± 0.25* 3.74 ± 0.25	0.9 ± 0.25* 4.53 ± 0.25

Note: numerator – parameters in cows from the test group; denominator – parameters in cows from the control group; * $p < 0.05$

The obtained results indicate on the improvement of liver function in the animals from the test group, which was confirmed by the decrease of ketone bodies in blood. This parameter in the control group did not change significantly.

Indication of energy metabolism enhancing composition had positive influence on mineral metabolism. By the 5^{th} day, the calcium content increased to the physiological norm and remained at that level during all the control

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

studies (increased calcium elimination was observed at acidotic condition). Besides, the content of phosphorus, that is contained in the blood buffer and plays an important role in the regulation of acid-base balance, stabilized.

Thus, the indication of energy metabolism enhancing composition provided quick and effective improvement of the cows' clinical condition, normalization of acid-base balance (alkaline reserve) and mineral metabolism (higher content of calcium in blood). And on the contrary, the cows from the control group had alkaline reserve maintained at the background levels. This indicated on the reduction of liver functioning and the development of the acidotic condition.

By the 17-20th day, the sick animals from the test group had their skin hair texture repaired, it covered evenly all the skin surface. During the formation of the interdigital skinfold, there was a fatty film observed, which indicated on the moderate skin moisture. The color of non-pigmented skin areas was pale pink, the smell was specific. In the test group, the increase of milk yield by 25-30% was registered as compared to the initial values.

It can be concluded that the energy metabolism enhancing composition that contains such ecologically safe the components as beetroot molasses, succinic acid and potassium chloride, does not have contraindications for indication to farm animals, provides significant tendency to the normalization of the main metabolic processes in cows and accelerated the healing of the primary lesions in the distal part of the extremities. Economic efficiency of the therapy for phlegmon in cows in the test group was 36.62 rub/1 rub of the cost, while in the test group it was 44.9 rub.

IV. DISCUSSION

The results of the present study suggest that one of the contributing factors to the development of purulonecrotic processes in digits of cows are metabolic disorders, weakening of its autarcesis and local activity of the microbial agent.

During the experiment, the authors controlled the general conditions of the cows by biochemical assays of their serum. Indication of energy metabolism enhancement composition to the cows from the test group improved their general health condition. Besides, active healing of the pathological focus was observed. The animals from the control group had biochemical serum parameters levels unchanged, and the healing took longer. The authors believe that the normalization of metabolic processes in cows has positive influence on the process of tissue regeneration in the pathological focus.

The proposed composition has high metabolic and energetic activity, provides significant clinical improvement of animals health conditions, efficiently normalizes biochemical processes, positively influence on the tissues regeneration during the therapy for purulonecrotic lesions in the distal part of extremities in cows. Technological simplicity of the composition preparation, availability and absolute safety of the components allows for the preparation of the energy metabolism enhancing composition even in the conditions of animal production farms. The proposed energy metabolism enhancing composition underwent clinical trials and was implemented in an agricultural production complex (APC) "Kolos", APC "Rodina" in Matveevo-Kurganskiy Region and APC "50 let Oktyabrya" in Neklinovskiy Region in Rostov Oblast.

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

The results, obtained in the clinical studies, were used as the grounds for the modification of the proposed composition, in particular, a number of essential microelements should be introduced in the formulation. This significantly expanded the spectrum of biological activity of the composition. Currently, the modified forms of the energy metabolism enhancing composition, that are described in detail in the documentation to the patents of the RF № 2563237, № 2620557 [14,15], undergo clinical trials for indication to highly productive cows for their health maintenance that includes the prevention of delivery pathologies, mycotoxicosis, mineral and iodine deficiency, as well as the diseases of the distal part of the extremities.

Table 4: Economic and Therapeutic Results Obtained after the Cows Treatment Plans Evaluation

Parameter, UM	Parameter values in groups:	
	control	test
Prevented economic loss, rub.	245,366.90	245,366.90
Cost of the treatment, rub.:		
- material	2,151.95	4,080.42
- labor	3,193.79	2,442.31
- total	5,345.74	6,522.73
Economic benefit, rub.	240,021.16	238,844.17
Economic efficiency of the treatment, rub. economic benefit / 1 rub. of cost	44.90	36.62
Therapeutic efficiency:		
- share of cured animals, %	100	100
- average recovery rate, days	18	12

The results presented in the table show that:

- Both treatment plans are economically efficient and feasible;
- The treatment plan, used in the control group, was economically more feasible (by 22.6%) than the treatment plan used in the test group;
- Higher economic efficiency of the treatment in the control group is explained by the fact that it is twice as cheap by the parameter of material costs, despite lower (by 30.8%) labor cost;
- From the therapeutic point of view, both treatment plans are equally effective (100%), but the recovery rate in the test group was higher (by 3 days or by 30.8%) than in the control group.

REFERENCES

[1] Burdenok A.F. Diseases of extremities in production animals. *Kiev, Urozhay,* 1986. - 131 p.
[2] Veremey E.I., Zhurba V.A., Lapina V.A. Treatment of purulonecrotic processes on cow hooves and digits. *Veterenary*, 2004. - № 3. p. 39-41.
[3] Eliseev A.N. Treatment of laminitis and pododermatitis in bovine cattle. *Systemic studies in science and education. Kursk,* 2008. p. 63-65.
[4] Eliseev A.N., Stepanov A.A., Tolkachev V.A. Combined approach to the treatment of cows with rot and purulonecrotic lesions of digits that are kept in dairy farm complexes. *Journal of Kursk SAA,* 2012, V.1, p. 112-113.

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020

[5] Izdepskiy A.V. Protein and carbohydrate metabolism in plasma of cows with laminitis. *Modern issues of Veterinary Surgery, Vitebsk*, 2016. p. 46-48.
[6] Kirilov A.A. Complex approach to the treatment of cows with purulent pododermatitis. *Dissertation* (16.00.05), SPb, 2007, p.16.
[7] Koziy V.I., Rublenko S.V., Babeniyuk S.P. Etiologic factors of the diseases of extremities in highly productive cows. *International Journal of Veterinary*, 2009.-№4. p.40-41.
[8] Konovalenko K.I., Mikhailova I.I., Leschenko T.R., Ilchenko V.I., Mikhailova O.N. Complex approach to the treatment of bovine cattle with digital ulcers. *Innovation in science, education and business is the basis of the efficient APC development*, 2011, *Persianovskiy: DonSAU*, 2011. - V. 3. p.176-177.
[9] Mikhailova I.I., Leschenko T.R., Ilchenko V.I., Mikhailova O.N., Finageev E.Y., Ilchenko V.D. Conventional method of treatment of bovine cattle with digital diseases. *Modern technologies in agricultural production and priorities in agricultural science development. Persianovskiy: DonSAU*, 2014. p. 167-172.
[10] Evglevskiy A.A., Evglevskaya E.P., Mikhailova I.I., Eryzhenskaya N.F., Mikhailova O.N., Suleimanova T.A. Kormovye mitotoksikozy korov v promyshlennom zhivotnovodstve: prichiny, posledstviya i effectivnye podkhody profilaktiki i lecheniya. *Veterinary Pathology*, 2018.- № 1 (63), p. 47-53.
[11] Mazhukha E.P., Khabuzov I.P., Ilchenko V.I., Leschenko V.I., Mikhailova I.I. Treatment of bovine cattle with digital diseases. *Issue of Veterinary*, 2005.-№3.- p. 65-67.
[12] Mikhailova I.I., Leschenko T.P., Ilchenko V.I., Mikhailova O.N., Finageev E.Y. Economic approach to the treatment of bovine cattle with ulcers. *Veterinary Pathology*. 2014.-№1 (47). p. 80-87.
[13] Ostrovskiy N.S. Prevention of the digital diseases in bovine cattle. *Veterinary*. 1981. - №1. p. 65-67.
[14] Evglevskiy A.A., Mikhailova I.I., Evglevskaya E.P., Mikhailova O.N. Patent 2563237 of the Russian Federation, MPC (51) A 61K 31/194, A 61K 31/375, A 61K 31/14, A 61K 47/26, A 61K 3/00. Energy metabolism enhancement composition for normalization of biochemical processes in the treatment of alimentary acidosis, hepatosis and mycotoxicosis in cows. *Patent holder Kursk Scientific and Research Institute;* published on 20.09.2015. Issue №26. p. 8.
[15] Evglevskiy A.A., Skira V.N., Symoeva A.B., Mikhailova I.I., Evglevskaya E.P., Eryzhenskaya N.F., Vanina N.V. Patent RUS 2620557 of the Russian Federation. Energy metabolism enhancement composition for the preventive therapy of metabolic acidosis, ketosis and iodine deficiency in cows. *Patent holder Kursk Scientific and Research Institute,* published on 17.11.2015.
[16] Mikhailova I.I., Leschenko T.R., Ilchenko V.I., Mikhailova O.N. Spread of the digital articular diseases in bovine cattle in the Republic of Adygea. *Issues and tendencies in the development of APC and agricultural education on Russia. Persianovskiy: DonSAU*, 2012. -v. 3. – p. 161-163.
[17] Rukol M.V., Zhurba V.A., Veremey E.I. Technological requirements to the veterinary service for bovine cattle and prevention of surgical pathology in dairy complexes. *Vitebsk VGAVM*, 2011. p. 28.
[18] Stekolnikov A.A., Semenov B.S., Veremey E.I. Technological conditions of dairy complex maintenamce. *International Journal of veterinary*.-2009.-№4. – p. 8-9.
[19] Chekhodaridi F.N. Iodinol application in the treatment of cows with purulonecrotic lesions of digits. *Stavropol: Stavropolskiy SAI*, 1991. p.99.
[20] Chekhodaridi F.N. Prevention and treatment of purulonecrotic lesions of digits in bovine cattle. *Vladikavkaz*, 1993. p.77-76.
[21] Chekhodaridi F.N. The efficiency of treatment of purulonecrotic lesions of digits in cows. *Scientific and practical conference of GTAU. Vladikavkaz*, 1995. p.11-13.
[22] Chekhodaridi F.N. Prevention and treatment of digital ulcers in. *Journal of Veterinary*, 2002. - №2. p. 43.
[23] Chekhodaridi F.N., Konstantinovskiy A.A., Bryukhno V.V., Kalitsev S.E. Treatment of purulonecrotic lesions of digits with chlorophyllite solution. *Journal of Veterinary.* 2003. - №2(26). p. 39-44.
[24] Capion N. Infection dynamics of digital dermatitis in first-lactation Holstein cows in an infected herd / Capion N., M.
[25] Boye, C. T. Ekstrøm, T. K. Jensen // *J. Dairy Sci.* – 2012. – V. 95. – P. 6457–6464.
[26] Cha E. The cost of different types of lameness in dairy cows calculated by dynamic programming / E. Cha, J.A. Hertl, D. Bar, Y.T. Gröhn // *Preventive Veterinary Medicine.* – 2010. – V. 97. – P. 1–8
[27] Cramer G. Herd-level risk factors for seven different foot lesions in Ontario Holstein cattle housed in tie stalls or free stalls / G. Cramer, K.D. Lissemore, C.L. Guard, K.E. Leslie, D.F. Kelton // *J. Dairy Sci.*. – 2009. – V. 92 P. 1404–1411.
[28] Dhawi A. Bovine digital dermatitis and severe virulent ovine foot rot: a common spirochaetal pathogenesis / A. Dhawi, C.A. Hart, I. Demirkan, I.H. Davies, S.D. Carter // *Vet J.*. – 2005. – V. 169(2). – P. 232-41.

DOI: 10.37200/IJPR/V24I5/PR2020168
Received: 10 Mar 2020 | Revised: 28 Mar 2020 | Accepted: 06 Apr 2020