Technological factors affecting the occurrence of foot diseases in high-producing cows

Rukol V. M., Medvedeva E. G., Kochetkov A. V., Solyanchuck P. V., Borisik Roman Nikolaevich

Educational establishment "Vitebsk State Academy of Veterinary Medicine"

Abstract. In conditions of intensification of dairy cattle breeding, limb diseases in highly productive cattle are widespread. On the farms under investigation, diseases of digital and hoof diseases range from 60.5 to 85.6%. Based on the work we have done, we consider that the main causes that lead to the development of hoof diseases in cows are failures associated primarily with feeding cattle, non-compliance with zoohygienic standards and technological factors (design features of premises and recreation areas, mismatch of floors and floor coverings of premises, lack of isolated rooms for medical care and maintenance of operated cows with purulent-necrotic diseases). The lack of daily orthopedic work on functional hoof trimming, care and treatment of cows with digital and hoof diseases. Improper technological use of preventive foot baths also affects the spread of limb diseases, reduces the period of production use of animals and leads to their premature loss.

1. Introduction
Currently, a new large-scale commercial agricultural production has been formed in the Republic of Belarus. The ongoing transformations in the agro-industrial complex imply the creation of large agro-industrial enterprises. For successful organization of work on dairy enterprises (farms and complexes), one should correctly understand the physiological features of life of cattle during technological process. Industrial milk production is based on a close connection between organizational, technical, socio-economic and biological systems. The link that ensures their organic unity is the biological system – the animal body. High-producing cows are the most complex dairy laboratory. To get a large amount of high-quality milk it is necessary to provide comfort for animals [1, 4, 5, 6, 7, 8, 9].

At the 5th all-Belarusian Assembly, new plans for the development of the entire country and the agricultural complex, in particular, were adopted. Despite all the difficulties, our Republic is dynamically developing dairy cattle breeding. There is no alternative to the development of export-oriented dairy cattle breeding in Belarus due to the specific nature of environmental conditions and the situation on world food markets. So, our soil and climate potential is ideal for the production of full-fledged grass feeds, which allows to obtain high-quality dairy products that are competitive in the domestic and foreign markets. This requires genetically sound cattle, its proper feeding, and taking care of the hooves of cows. However, if there is a sick hoof, there is no walking of the animal, no feed consumption, and, as a result, there will be no large supply of high-quality milk. Caring for the hooves of cows is the primary responsibility of the owner, it requires professional knowledge not only of the anatomical and topographic structure of the hooves, but also sound knowledge of the biomechanical and biophysical properties of hooves and hoof horn. Only such conditions will allow for professional care of hooves to be taken [1, 4, 7, 8, 9, 10].

The widespread use of new feeding and maintenance technologies for dairy cattle, when the main production processes are mechanized, leads to an increase in the number of animals with clinical signs
of lameness, and spreading of foot diseases, in particular, hoof lesions. Various changes in the hoof horn affect not only the health of cattle, but also their behavior [1, 2, 3].

Science and practice have found that dairy performance of cows with deformed hooves lessens by 5 to 20%, though there are no signs of lameness shown. Limb diseases cause the performance of cows to be reduced by 50% or more. In addition, a service period in affected cows is longer, the offspring deficiency makes about 17 calves per 100 cows, the rotation of the herd increases [1, 2, 4].

2. Materials and methods of research

This article is based on the results of monitoring and prophylactic orthopedic examination of two farms in the Vitebsk region. It presents the results of observations and analyzes errors occurred on farms. Nosology of orthopedic pathology was determined on the basis of functional hoof trimming and orthopedic treatment provided for lame cows.

3. Research results

Of 333 animals under investigation on the first farm there were identified 285 (85.6%) cows with clinical signs of surgical disease etiology including: laminitis – 71, deep purulent pododermatitis – 67, Rusterholz ulcer – 206, digital ulcer – 153, ulceration of digital torus – 21, tyloma – 52, coronet ulceration – 1, aseptic pododermatitis – 28, digital phlegmone – 4, necrosis of the hoof bone – 2, purulent osteoarthritis of the hoof joint – 1, horn crack – 5, purulent osteoarthritis of the knuckle joint – 1, necrosis of the 4th claw – 8, ulcer of the 4th claw – 1, necrosis of the 2nd claw – 7, ulcer of the 2nd claw – 1, hoof horn pinch – 18, claw wound – 1, ulceration of the arch of the hoof cleft – 3, necrosis of the deep flexor tendon – 1, necrosis of the 4th claw – 1, arthritis of the knuckle joint – 1 (total 651 diagnoses).

As a result of the prophylactic orthopedic examination of 294 heads of the cattle belonging to the second farm it was found that 60.5% of the animals showed clinical signs of deformities and lameness of various degrees. 294 animals were subjected to anatomical functional orthopedic hoof trimming and trimming of the overgrown hoof horn. Of the 294 examined animals 178 cows and heifers were detected as having clinical signs of diseases of surgical etiology including: laminitis – 72, deep purulent pododermatitis – 61, Rusterholz ulcer – 82, digital ulcer 92, ulceration of digital torus – 26, tyloma – 27, coronet ulceration – 3, aseptic pododermatitis – 61, digital phlegmone – 6, necrosis of the hoof bone – 5, horn crack – 11, purulent osteoarthritis of the knuckle joint – 4, purulent arthritis of the hoof joint – 3, ulcer of the 4th claw – 1, ulcer of the 2nd claw – 3, hoof horn pinch – 22, ulceration of the arch of the hoof cleft – 10 (in total 489 diagnoses).

As a result of the prophylactic orthopedic examination, the main technological causes leading to deformities of the hoof horn and the occurrence of foot diseases in highly productive cattle were identified. The first cause (one of the main ones) is faulty nutrition (poor-quality feeds, the infringement of technologies of mixing feeds and feeding of animals). On the farms under investigation feeding mainly consists of a mixed silage-haylage mass and compound feed. The prepared feed mass was heavily ground, and it should be cut about 3-5 cm in size. Highly productive cows are very demanding to the composition of the diet and quality of feed, so the increase in milk productivity in feed units is compensated by introducing concentrated feeds into the diet, the rest of the diet being replaced by silage or haylage. Feeding with a low-quality silage and haylage leads to an increase in butyric and propionic acids in the rumen, while the content of acetic acid is reduced. This leads to the injury of the ruminal wall, the formation of micro lesions of the mucous membrane accompanied by growth of conditionally pathogenic microflora. Feeding a large amount of concentrated feed leads to an increase in the level of histamine in the bloodstream. The excessive amount of histamine settles down in the capillaries of the terminal arch of the distal portion of limbs, causing disorders in blood circulation between the bone tissue and the horn cover at corium, and based on this, pododermatites and laminites develop. Feeding of a large amount of concentrates on a background of sugar deficiency in feeds is accompanied by disorders in ruminal digestion (rumen acidosis), dystonia of forestomach, the development of ketosis, pathologies of the liver and kidneys, disorders in protein and mineral as well as vitamins A and D metabolism. In these cases, fusobacteria show their vital activity. Under such conditions, the number of fusobacteria significantly increases, which causes their penetration into the blood stream through the mucosa and leads to the development of the clinical picture in the liver, in particular, causes lesions in skin, hooves, and mucous membranes. This leads to a more intensive course of metabolic processes, and to the growth of the hoof horn, in particular.
Feed intoxication may occur due to the predominance of concentrates in the diet and feeding poor-quality feed (with signs of spoilage). After intaking contaminated feed, after death of gram-negative bacteria endotoxins are released, the amount of histamine increases, which causes blood circulation in the hooves to be disrupted. A sharp transition from a diet with a high content of bulky feeds to a diet with a high content of concentrates is the cause of the acidosis. During the transfer of the acid-base balance of the body in the direction of increasing the acidity of the rumen, toxins are formed that activate metalloproteinase (MPT), which, in its turn, destroys the bonds between the epidermis of the hoof wall and the soft tissues of the corium, which causes the development of laminitis, pododermatitis, sole ulcers and the white line defects.

When feeding cattle, mixed feeds should comprise premixes added with taking into account the actual composition of feeds on the farm, the necessary level and the main ratio of trace elements and vitamins for cows and heifers. The lack of minerals and vitamins aggravates metabolic disorders, reduces the intensity of ruminal digestion, synthesis of connective proteins, and contributes to the development of foot diseases.

The second cause for the occurrence of mass foot diseases is faulty maintenance of highly productive cows. During the prophylactic orthopedic examination a low quality of the floor surface has been defined, the surface was too smooth, and the flooring had significant irregularities. When walking, the animals stumbled, and injuries of the hooves and foot joints occurred as a result. When examining animals we also took into account the correct distribution of the weight bearing between the hooves. On both farms the cows were kept on a hard flooring (concrete), the animals had an incorrect concentration of weight on the outer wall of the hoof, and the inner wall did not participate in the supporting mechanism at all. The excessive weight bearing was one of the factors determining the risk of deformities, which led to disruption of normal function of the hoof, discomfort, lesions and lameness. Based on previous research, we recommend for cows be kept on soft flooring. In this case, the outer edge of the horn wall and digital cushion enter the soft base of the bedding or soil, thus the weight bearing is redistributed to the inner wall of the hoof. As a result, the weight bearing is evenly spread over the entire surface of the sole and the hoof does not experience excessive load on its certain anatomical parts. At the same time, on the soft surface the weight bearing is properly balanced over the lateral and medial claws.

The third cause for the occurrence of mass foot diseases is that resting places (boxes) do not meet the needs of animals. On the farms under consideration the cows were in a standing position for a long time instead of lying. On average, the cows were laying for 8.9±0.58 hours, while according to the requirements they should be lying for at least 12 hours. During this period, blood flow through the udder increases by 25-30% (respectively, more milk is produced), and at the same time the joints and claws "have a rest".

The fourth cause is the moist environment and dryness in the cowshed, which is of significant importance. During the prophylactic orthopedic examination, we found that the moist environment was predominant in the cowshed of the first farm, the removal of manure was experienced once a day. Moisture promoted the softening of the horn, and, as a result, the claws could only bear light weights, and became more susceptible to bacteria, which led to various diseases. On the second farm, conditions of increased dryness were also marked, although cleaning of premises and removal of manure was carried out twice a day. At the same time, the hoof horn lost its elasticity, and the risk of cracks and crackles increased.

The fifth cause – a lack of exercise. The animals of the two farms did not walk. In such animals the physiology of blood circulation was disturbed. It means that the slow flow of the blood and very thin capillary walls create favorable conditions for the exchange processes between the blood and tissues. Water, salts etc. pass across capillary walls. At the arterial end of the capillaries, these substances are filtered from the blood into the tissue spaces. In the venous part, on the contrary, their reverse absorption from the tissues into the blood is performed. All this is due to the difference in the values of oncotic and hydrostatic pressure in tissues and blood vessels. Hydrostatic pressure at the arterial end of the capillary promotes the release of fluid from the blood into the tissue, and oncotic pressure in the venous part of the capillary keeps the fluid in vessels and partially returns it from the tissues to the blood. In this case, the abundance of blood and lymph supply to the limbs, and peculiarities of the outflow of blood and lymph from the limbs should not be forgotten. The third and fourth finger in cattle are fed by the dorsal metatarsal artery, the digital artery proper, and the terminal arterial arch which form a dense capillary net at the corium. Similarly, the outflow of blood occurs through the venous network. It should be noted that veins on the limbs have semilunar valves, which are located at a distance of 1.5-2.5 cm from each other, and their leaflets are directed towards the heart. Thus, the blood can not flow in the reverse direction. The vein has a poor muscle layer, and contractions of the wall to push blood into the caudal vena cava are carried out due to the muscle contraction
during active exercise (active motion) of animals. Besides, the hoof mechanism is activated — the digital cuchion (“second heart”), which helps to push the venous blood and lymph. Thus, about 20% of the flowing venous blood supply is inhausted by the heart. The rest of the blood (80%) and lymph moves due to muscle contraction and the hoof mechanism.

One of the main causes of mass limb and hoof diseases in highly productive cattle is also ultraviolet radiation of the animal. On the farms under investigation, cows were not turned out to barn yards and natural solar radiation exposure did not occur. Biochemical blood tests showed hypoglycemia in most animals. With a physiological norm of 2.2–4.4 mcmol/l, the blood samples of animals from the first farm contained 1.23±0.591 mcmol/l, and the blood from animals of the second farm demonstrated 1.36±0.415 mcmol/l. With physiological indicators of carotene in the blood serum of cows – 0.3–1.5 mg%, laboratory examination found a deficit of this parameter in almost 100% of the animals from which blood samples were taken. On the first farm 0.21±0.002 mg%, on the second – 0.27±0.011 mg%. There was also a decrease in the calcium level in the blood serum. At the same time, if the normal level of calcium should be in the range of 2.5–3.0 mmol/l, then on the first farm it made 2.0±0.143 mg%, and on the second it was 1.95±0.432 mg%/%. There was also noted a calcium-phosphorus imbalance.

Without the sun light insolation, highly productive cows were marked in a state of mineral and vitamin metabolism disturbance. Calcium deficiency in animals was a particularly dangerous predisposing factor. The cells deformation took place, the permeability of the membranes was disturbed, and the tissue disintegration occurred, including the skin of the distal portion of the limbs. The calcium balance in animals is controlled by three hormones: calcitonin, parathyroid hormone, and the hormone-active form of vitamin D3. This vitamin optimally performs its functions only in a healthy body of herbivores. Even with small pathological changes in the gastrointestinal tract, and without a daily exposure of animals to natural solar radiation, the body absorption of calcium from feed slows down sharply. Therefore, we recommend that at least once a quarter a biochemical examination of blood and feeds should be undertaken. And taking into account the results obtained, the rations of cows should be balanced by mineral and vitamin components, depending on the age, period of pregnancy and season of the year.

For hooves to be healthy, and milk yields high, then it is necessary to define the causes of the destruction of the hoof horn, and use the techniques that promote the formation of strong and disease-resistant hooves. These include, first of all, the introduction of horn-strengthening supplements in the diet. The presence of zinc-methionine, selenium-methionine and selenium-cysteinate stimulates horn formation and strengthens the hoof horn. Horn of good quality contains 90% of high – molecular protein – keratin. Which is based on the sulfur-containing amino acid, cystine. This amino acid is used by the body to build skin derivatives, including the hoof horn. The structure of keratopolymers of the horn of the hoof depends on it. If there is enough cystine in the body, then a strong multi-dimensional keratopolymer formation with a dense network is formed, in the free cells of which macro- and micromineral salts are formed, which cement the hoof horn. New synergistic sulfur-containing vitamins take part in keratinization: vitamin H (Biotin), B1 (thiamine) and vitamin U (methylmethionine sulfonium chloride).

Under the conditions of modern dairy farming, it is necessary to include into the diets complex preparations of macro- and microelements. Recently, the most promising direction is the use of minerals in chelate form. Chelate compounds (minerals encapsulated by a protein molecule, protected from negative environmental factors) allow high therapeutic results at a low concentration of minerals. The copper contained in the preparations possesses an antibacterial effect and is of a great importance for the hardness of the horny part of the hooves, and zinc helps restore the skin and also has an antibacterial effect. Our clinical trials of chelate drugs applied for digital and hoof diseases have shown a positive effect of their use.

An important cause for the incidence of mass foot diseases is the lack of permanent professional care for hoofs, performed by highly qualified specialists. In the Veterinary and Sanitary Regulations for dairy farms approved by the Ministry of Agriculture and Food of the Republic of Belarus of 17.03.05, Chapter 5, p. 61 and the Republican regulation "Organizational and Technological Requirements for the Production of Milk in Industrial-type Dairy complexes” (2014) mandatory requirements are defined for organizational and technological measures for the prevention of foot diseases and finding specially trained orthopedic specialists for trimming the overgrown hoof horn in animals.

According to our studies, functional hoof trimming should be performed 4-6 months after insemination of heifers and before transferring the first heifers to the milking parlour. In dairy cows professional functional hoof trimming should be performed at least 3 times a year. On the farms under investigation, functional hoof care and trimming of overgrown hoof horn was not carried out permanently.
On the first farm it was done once a year, and on the second one it was performed once every year and a half. All veterinary work for the prevention and treatment of foot and digital diseases should be carried out in a specially designated room (veterinary unit). There must be warm and cold water, sewerage, conditions for sterilizing instruments, preparing solutions, a table for tools, a place for working clothes, etc. There must be an orthopedic trimming chute with electric or hydraulic elevators for limbs, for fixing the head, etc., which ensures complete safety and protection of the veterinarian and the animal itself. By our research it was found that the most appropriate for the functional hoof care and economically justified is the use of electric machines ORTOPED-PROFI (made in Belarus) or TOP-5 (made in Austria).

The next cause for the occurrence of mass foot diseases is a failure to permanently use, or sometimes complete absence of foot baths. When performing research, we found that the territories of both farms are not equipped with foot baths grounds. The use of foot baths is not technologically proper. According to our numerous studies and literature data, the length of the bath should be at least 5-8 meters, the depth 25-30 cm. For effective and economical use of disinfectants and horn-strengthening solutions the bath should be equipped with screens at a height of 15 cm above the bottom. They are installed in order that manure that enters the bath when animals pass could not form a suspension, but could settle down on the bottom. In these cases, the efficiency of the solution will be maintained for a long time. At the bottom of the bath, a drain hole should be provided for the used solution to be discharged. It is necessary to have two baths located in succession. In this case, the first bath is filled with water, and the second - with disinfectant. Between them a platform (elevated) should be installed for hoof drying. In this case, the animals are driven into the first bath with water (at least 5 meters), then they proceed on the platform for drying hooves (at least 5 meters), and then enter the bath with disinfectant (at least 5 meters). For the treatment and prevention of limb and hoof diseases in cows, foot baths should be used with application of veterinary drugs (Biochelate concentrate, 5-10% formalin solution, 5-10% copper sulfate solution, 10% zinc sulfate solution, and others).

If it is not possible to organize the foot baths, we recommend that the distal parts of the limbs be treated with a sprayer 1-2 times a week with a 5-10% solution of copper sulfate, 3-6% (depending on the spread of orthopedic pathology) with a solution of hydrogen peroxide, Biochelate concentrate, or others.

In winter, at sub-zero temperatures, we recommend using "dry" baths, in particular, copper sulfate powder (copper sulfate) or with quicklime in a ratio of 1:9 with sawdust.

4. Conclusion

In conditions of intensification of dairy cattle breeding, limb diseases in highly productive cattle are widespread. On the farms under investigation, diseases of digital and hoof diseases range from 60.5 to 85.6%. Based on the work we have done, we consider that the main causes that lead to the development of hoof diseases in cows are failures associated primarily with feeding cattle, non-compliance with zoohygienic standards and technological factors (design features of premises and recreation areas, mismatch of floors and floor coverings of premises, lack of isolated rooms for medical care and maintenance of operated cows with purulent-necrotic diseases). The lack of daily orthopedic work on functional hoof trimming, care and treatment of cows with digital and hoof diseases. Improper technological use of preventive foot baths also affects the spread of limb diseases, reduces the period of production use of animals and leads to their premature loss.

Breeding of highly productive livestock will be cost-effective and profitable only if the natural requirements of the animal body are optimally met in the environment, and medical work is carried out completely and efficiently in accordance with the modern requirements of prevention for purulent-necrotic diseases, not to mention diseases of other pathologies. It should be borne in mind that the higher is the animal performance, the more animals will be exposed to various diseases, in particular, purulent-necrotic pathology, unless permanent medical and preventive care is maintained.

5. References

[1]. Active motion of cattle on dairy complexes and farms: recommendations / E. I. Veremey, V. M. Rukol, V. A. Zhurba, V. A. Komarovskiy, V. A. Khovailo, A. P. Volkov; Vitebsk State Academy of Veterinary Medicine, Department of General, Specialized and Operative surgery. – Vitebsk : VGAVM, 2013. – 16 p.

[2]. Veterinary measures at dairy complexes: manual (production - practical edition) / E. I. Veremey, V. A. Zhurba, V. M. Rukol. – Minsk: Belarusian agriculture, 2010. – 28 p.
[3]. Gimranov, V. V. Justification and development of complex methods of diagnosis, treatment and prevention of purulent-necrotic lesions in digital area in cattle: dis. ... doctor of Veterinary Sciences: 16.00.05 / V. V. Gimranov. – Kazan, 2006. – 300 p.

[4]. Ermolaev, V. A. Etiology, spreading of hoof diseases in cattle in the winter-stable period / V. A. Ermolaev [et al.] // Agrarian science and education at the present stage of development: experience, problems and ways to solve them: materials of the International scientific and practical conference. – Ulyanovsk: Ulyanovsk State Agricultural Academy, 2009. – Vol. 3. – P. 49-52.

[5]. Rukol, V. M. The relationship between exercise and limb diseases in animals / Rukol V. M., A. P. Volkov // Innovative technologies for the production and processing of agricultural product: proceedings of the International scientific and practical conference, December 21-22. – Vladikavkaz, 2012. – P. 174-175.

[6]. Rukol, V. M. Measures for surgical pathology of cattle on dairy complexes of the Gomel region: recommendations / V. M. Rukol, V. A. Zhurba, E. I. Veremey; Vitebsk State Academy of Veterinary Medicine. – Vitebsk: VSAVM, 2011. – 28 p.

[7]. Rukol, V. M. Prevention and treatment of cows with limb diseases / V. M. Rukol, A. A. Stekolnikov // Veterinary science. – Moscow, 2011. – No. 11. – P. 50-53.

[8]. Rukol, V. M. Technological bases of veterinary services for dairy cattle with surgical diseases in the Republic of Belarus: dis. ... Doctor of Veterinary Sciences: 06.02.04: defended 22.02.13 / Rukol Vasily Mikhailovich – Saint Petersburg, 2013. – 461 p.

[9]. Rukol, V. M. Stress and traumatism in cattle / V. M. Rukol // Veterinary business. – 2014. – № 4 (34). – P. 28-32.

[10]. Rukol, V. M. Technological bases of veterinary services on dairy complexes for mass surgical pathology: guidelines / V. M. Rukol, A. A. Stekolnikov, E. I. Veremey; Saint Petersburg State Academy of Veterinary Medicine, Vitebsk State Academy of Veterinary Medicine. – Saint Petersburg: FSOU VPO SPbSAVM, 2012. – 27 S.