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MODERN APPROACHES TO DETECTING MASTITIS IN COWS USING THERMOGRAPHIC ANALYSIS

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Summary. The article presents an overview of modern methods for diagnosing mastitis in cows using thermographic analysis. The principles of infrared monitoring systems, which allow detecting changes in the temperature field of the udder as an early marker of inflammatory processes, are discussed. Special attention is given to comparing traditional clinical and laboratory approaches with non-invasive thermovision control methods.

Key words: mastitis, cows, thermography, thermal imaging analysis, early diagnosis.

Formulation of the problem. Mastitis remains one of the most common and economically significant diseases of dairy cattle. Inflammation of the mammary gland leads to reduced productivity, decreased milk quality, and significant treatment costs. According to various studies, mastitis is diagnosed in 25-40% of dairy herds, while subclinical forms often remain undetected at early stages.

Basic research materials. Machine milking of cows is one of the fundamental technological processes in milk production, and the efficiency of dairy farming largely depends on its level of development. The impact of negative factors associated with machine milking is a leading cause of teat damage in high-yielding cattle, resulting in diseases such as mastitis. Up to the present time, the assessment of the milking machine's effect on the condition of teats and udder has been based solely on visual observations. Existing methods and devices for measuring physiological indicators of dairy herds, which monitor the milking process, have limitations in practical application and require excessive time and resources. Furthermore, the further improvement of machine milking technology necessitates the development of new methods for early detection of various forms of mastitis. One of the new methods for studying the mammary gland of cattle is thermography, which is based on capturing a visible image of the body's own infrared radiation using specialized devices, i. e. thermographs [1].

Classical methods for diagnosing mastitis include visual inspection, palpation, somatic cell counting in milk, and bacteriological analysis. These approaches provide accurate results but require time and human involvement. Thermography, on the other hand, can significantly reduce labor and detect pathology in real time.

Traditional diagnostic methods based on clinical signs and laboratory tests are time-consuming and require direct contact with the animal, making them unsuitable for large-scale monitoring. Therefore, increasing attention is being paid to non-invasive technologies that detect physiological changes without causing stress to the animal. One such technology is thermography, which uses infrared radiation to register temperature anomalies. The camera records the temperature distribution and visualizes it as a thermal map. In healthy cows, the udder's temperature profile is symmetrical: individual quarters have approximately the same temperature, with differences not exceeding 0.5-1°C. During inflammation, blood circulation and metabolism in the affected area increase, causing a local temperature rise. This effect is used for early detection of mastitis.

Studies show that an increase in local temperature by 1-1.5 °C compared to adjacent udder quarters can serve as a reliable sign of inflammation. In several experiments, the thermovision method demonstrated sensitivity up to 85-90%, comparable to laboratory tests, but without the need for sampling. Thermography becomes particularly promising when integrated with machine vision systems, which automatically analyze images and provide digital results.

Modern thermal imagers have high sensitivity (up to 0.05°C), allowing detection of even minimal deviations from normal. The imaging procedure takes only seconds and does not require physical contact with the animal, making the method ideal for large herds.

The main advantages of thermography are its non-invasiveness and speed. The study can be conducted without anesthesia, reagents, or laboratory tests. It is safe for both animals and operators. Moreover, thermography allows detecting inflammatory processes at a preclinical stage, when visual symptoms are absent but tissue changes have already begun.

However, the method is sensitive to environmental conditions. Results may be affected by ambient temperature, humidity, lighting, and even udder hygiene. Therefore, thermography requires standardization of observation conditions, i. e. distance, shooting angle, time after milking, etc. For correct data interpretation, preliminary calibration and automatic image correction are often applied.

Thermographic analysis of cow udders represents a promising tool for early mastitis diagnosis. It combines non-invasiveness, speed, and the potential for full automation. Despite dependence on external conditions, the use of machine vision and neural networks minimizes interpretation errors.

Modern thermographic mastitis diagnostic systems are based on sequential image processing and artificial intelligence algorithms. Their operation can be described as a chain of interconnected stages: obtaining a thermographic image, normalization, extraction of informative zones, and subsequent assessment of the udder’s condition based on temperature distribution analysis [2].

The first step is obtaining thermal images of the udder, reflecting surface temperature distribution. These data undergo preprocessing: random noise and artifacts caused by external factors are removed, and images are normalized to a consistent temperature range and scale. This ensures that shooting conditions do not affect analysis results and that data can be used to train intelligent systems.

After image preparation, regions of interest are identified, i.e. areas where the temperature field may indicate inflammation. Normally, the thermal profile of the udder is symmetrical, but during mastitis, local overheating zones appear. These differences are detected by analysis algorithms. At this stage, computer vision methods are applied to automatically locate such areas and extract key features characterizing temperature distribution, mean values, and asymmetry degree.

Once sufficient data are collected, they are used to train a neural network model. The network “learns” to recognize patterns characteristic of healthy and affected animals by correlating thermographic images with clinical outcomes. Later, it can independently evaluate new images, highlight areas where temperature deviates from normal, and classify the udder as healthy or suspicious for inflammation.

Using neural networks significantly increases diagnostic accuracy and stability compared to human visual assessment. The model can simultaneously consider multiple factors such as shape, texture, temperature dynamics and makes decisions based on a combination of features rather than a single indicator. The analysis process takes fractions of a second, enabling continuous farm monitoring.

The most promising approach is integrating thermographic analysis with animal identification and machine vision systems. In this setup, a thermal camera installed in the milking parlor automatically captures each animal, the neural network performs the analysis, and results are stored in a central database. When deviations are detected, the operator is notified and can conduct further inspection or treatment.

Conclusion. Thermography-based systems can become a key element of “smart farms”, where animal health is monitored continuously without human intervention. Therefore, the development of thermal imaging technologies opens new opportunities for disease prevention, productivity improvement, and animal welfare enhancement.

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