

# Thermovision diagnostics of the milking equipment impact on the state of mammary glands of cattle

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**Abstract**— A thermovision research of the mammary glands of cattle before and after the milking was performed in order to determine the impact of milking machines of various types on the state of the udder, followed by the determination of the temperature difference at the same points of the mammary gland. The obtained data showed that there are differences between milking machines due to their influence on temperature fluctuations of the teats of the udder; and the method of thermography allows us to predict the temperature variables of the teat before and after the milking. Variables of teats temperature before and after the milking in the form of thermograms can be used as indicators of the quality of equipment on the one hand, and as its impact on the mammary gland, on the other hand. As the milking machines and milking technologies are being improved the lower is the difference in the temperature of the teats before and after the milking. In that case the research, carried out with the help of thermography, confirmed the role of machine milking errors in the pathogenesis of diseases of the mammary gland and in particular the teats of the udder.

**Keywords**— *thermal imager, cattle, milking machine, mammary gland, temperature.*

## I. INTRODUCTION

Preserve the productive longevity of animals and to protect the health of the udder is an urgent task present intensification of the dairy farming industry. It is known that milking machine has a significant effect on the state of the udder. Poor technical condition of the milking equipment and improper operation with it causes damage to the teats and the growth of inflammatory processes in the udder [2, 4, 7].

The level of development of cattles machine milking as one of the basic technological processes largely determines the efficiency of dairy cattle breeding. The significance of this process is difficult to overestimate due to its laboriousness and the effect on the health and productivity of animals [1, 3, 9].

The teats of the mammary gland are in direct contact with the machine during the milking process. Errors in the machine milking technology can be the cause of circulatory disorders in the teat, especially in its tip [5]. One sign of this may be a change in temperature at various points of the teat, measured immediately after the milking process has ended. An increase of the temperature surface during milking is due to a change in blood circulation in its wall, which is caused by a mechanical impact on the teat [8].

The purpose of the research was to test the hypothesis that different milking machine have different effects on the blood circulation in the teats of the udder during milking.

## II. MATERIALS AND METHODS

The research of the influence of milking machine on the temperature of the teats of the udder was carried out on two dairy complexes of the Sverdlovsk region of the Russian Federation. In the first facility milking of cows was carried out using the Russian linear milking machine «ADM-8», and in the second facility - on the «Europarallel» milking machine of DeLaval company.

The technical parameters of the milking machines: vacuum pump, control valve, vacuum line, milk line - were checked before the research.

Compare of milking machine of their influence on the temperature of the teats in the milking process was carried out under normal operating conditions.

The basis of thermography is an increase in the intensity of infrared radiation over pathological foci (due to increased blood supply and metabolic processes in them) or a decrease in its intensity in areas with reduced regional blood flow and concomitant changes in tissues and organs.

The advantage of thermal imaging is the ability to quickly (scan speed less than three seconds) contactless image acquisition of zones of abnormal temperature of the mammary gland, and the method can be used on a large number of animals

Thermography exposed cows without a pathology of the mammary gland, animals were previously investigated for the presence of hidden mastitis and measured rectal body temperature.

Thermography was carried out before milking (before udder treatment) and immediately after milking using the «Irtis-2000 SN». This device is designed for contactless measurement of the temperature distribution of the surface of the body by its own thermal radiation, incorporates an infrared receiving chamber, cooled with liquid nitrogen, which is connected to a computer. The principle of operation is based on the registration and conversion of the heat distribution on a computer's color monitor screen. The size of the displayed surface of an object is determined by the angular field of view of the thermograph (Fig. 1).



Fig. 1. Thermovision diagnostics. Left: Infrared receiving camera; to the right is a thermographic research of a cow.

Thermographic research with the «Irtis-2000 SN» device is recommended to be carried out with its installation on a tripod at a distance of 0.8-1.5 meters from the animal. Scan time on average 3.2 seconds.

The device allows you to create digital images-thermograms, which allows their subsequent analysis using a PC. The temperature of the teats was set at three points: in the area of the base, middle and top.

On the first dairy facility, we obtained and analyzed 82 thermograms of the udder of cows, on the second - 78 thermograms.

### III. RESEARCH RESULTS

The results of measurements of the surface temperature of the udder were presented as the temperature difference between before and after milking time. Since the measurements were performed under the same temperature conditions of the environment, their changes did not affect the result affecting the absolute temperature value; therefore, it was not evaluated separately. Pictures 2 and 3 show examples of thermograms (photo reports), the images show temperature at three points: on the base, in the middle and at the top of the teats.

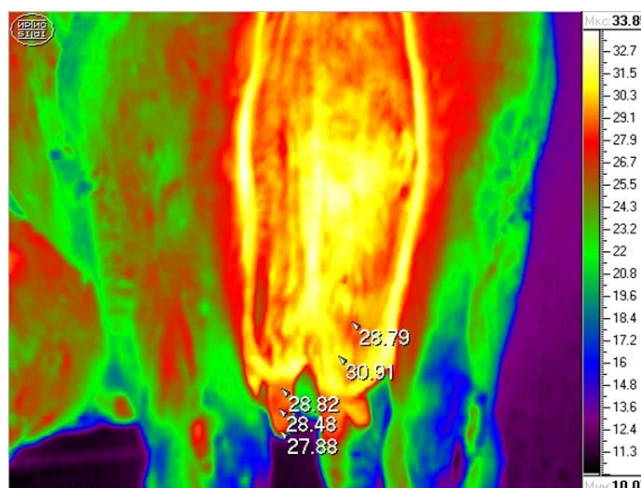


Fig. 3. Thermogram of the mammary gland of a cow after milking

On the basis of the obtained results, it can be concluded that the temperature of the surface of the mammary gland decreases during milking and that of the teats - increases. These results are consistent with studies by foreign authors [6, 8].

The results of the research of temperatures at the beginning and at the end of milking at various points of the teats of the udder are presented in table 1.

TABLE I. THE TEMPERATURE DIFFERENCE AT THE BEGINNING AND END OF MILKING AT DIFFERENT POINTS OF THE UDDER TEATS

Device	n	Temperature difference before and after milking		
		Teat Base	Mid Teat	Teat Top
ADM-8	82	0,42±0,044*	1,75±0,031*	2,26±0,036*
Europarallel	78	1,12±0,026	0,80±0,024	1,28±0,032

\* the difference is significant, P <0.5

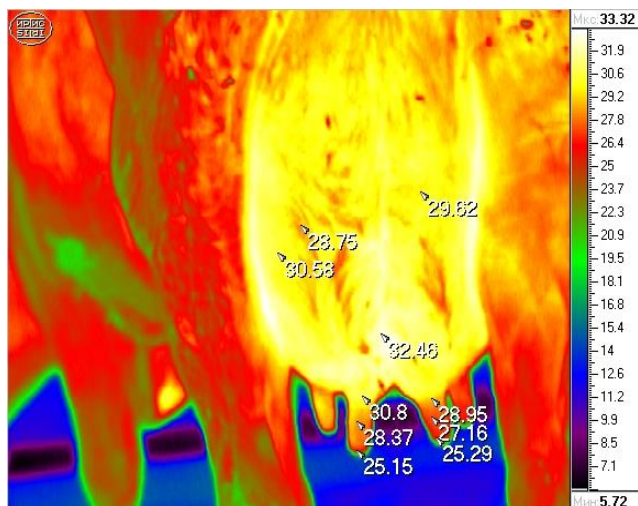


Fig. 2. Thermograms of the mammary gland of a cow before milking

milking at this machine increased by 5.9% -8.7% (1.8-2.9 ° C).

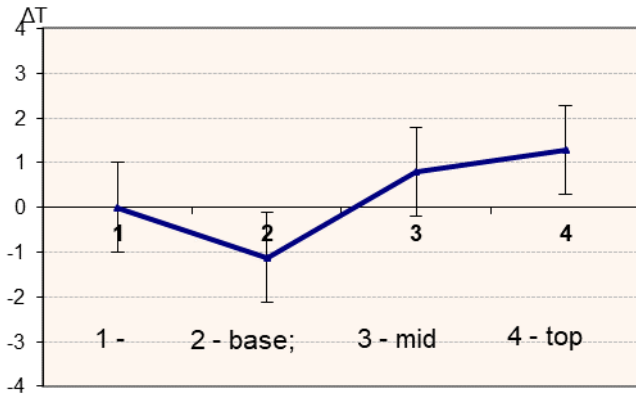


Fig. 4. Average values and standard deviation of the temperature difference at the beginning and end of milking at different points of the teats of the udder («Europarallel» milking machine)

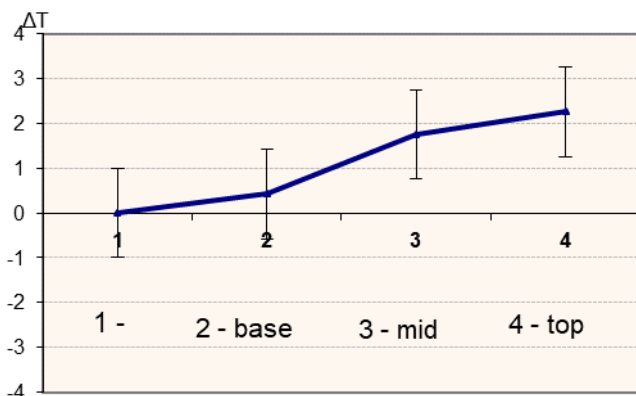


Fig. 5. Average and standard deviation of the temperature difference at the beginning and end of milking at different points of the udder teats (milking machine «ADM-8»)

When milking with the «Europarallel» the temperature increase in the teat apex area was less pronounced and reached only 2.8% -6.0% (0.9-1.9 ° C). The average temperature of the base of the teat was lower by 1.12 ° C compared with that obtained before milking. These data are reflected in Picture 4 and 5, which shows the average temperature differences at the beginning and end of milking at different points of the udder teats when using milking machines and «ADM-8» and «Europarallel».

**Conclusion.** The data obtained allow us to conclude that there are differences between different milking machine to their influence on fluctuations in the teat temperature of the udder, the thermography method allows us to predict the performance of the teat temperature before and after milking.

The obtained results show us that the indicators of the teats temperature before and after milking on thermograms can be used as indicators of the quality of the equipment, and its effect on the mammary gland. Improved the milking machines and the better the observance of the milking technology caused the smaller the difference in the temperature of the teats before and after milking. At the same time, it is known that with significant errors in milking technology, there is a violation of blood circulation in the teat, which is manifested by a decrease in the temperature of the top of the teat.

In research carried out with the help of thermography, the role of errors in machine milking in the pathogenesis of diseases of the mammary gland and in particular the teats of the udder is confirmed.

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