BODY SURFACE TEMPERATURE OF COWS IN THE STABLE

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Nowadays there are many technological ways how to measure the surface temperature of the animals. One of the possibilities is a surface temperature measurement using a thermographic camera. This method of contactless scanning surface temperature is very easy and quick. Its disadvantage is the accuracy of measurement, which depends on many factors. Besides accurate shooting settings of thermographic camera are important properties of scanned surfaces, e.g. colour, contamination, shading etc. As well the state of microclimate of environment and the emissivity (the ability to emit infrared radiation) play an important role in the scanning. This experiment was carried out in a commercial dairy farm located in the Central Bohemia region of the Czech Republic. Surface temperatures were recorded from three different parts of the selected dairy cows: the surface of the core body, the eyes and the udder. At the same time was measured rectal temperature of these cows using a digital rectal thermometer. The thermographic camera TESTO 875 was used for sensing the surface temperatures and measurements were made during 2014. The aim of this study was to assess the suitability of this method for contactless sensing the surface temperature of stabled animals and its application in practice.

Keywords: surface temperature, stable, dairy cows, thermographic camera, rectal temperature

INTRODUCTION

Within the survey methods that allow objective and scientific evaluation of the conditions of animal welfare, for some time a few research centers [2] have begun to examine the possibility of using non-invasive methods to monitor any conditions of stress (Redaelli et al., 2014). Thermal cameras are passive sensors that capture the infrared radiation emitted by all objects with a temperature above absolute zero (Gade and Moeslund, 2014). Humans and most other mammals produce excess body heat which has to be lost to the environment. Infrared thermography (IRT) is a non-invasive diagnostic tool for visualizing and analysing local and temporal changes in surface temperatures. The result is a thermogram, in which each pixel relates to a temperature value (Metzner et al., 2014, Calkosiński et al., 2015).

Zotti et al. (2011) dealt by observing the distribution of surface temperature by infrared thermography (IRT) as an alternative method for investigation of environmental and physiological processes associated with the thermal comfort. They diagnosed with the thermal imager the area of limbs as the best indicator of thermal comfort. Method thermography has found many applications not only in the industry, but also in human and veterinary medicine, particularly for diagnostic purposes (Embaby et al., 2002; Markel and Vainer, 2005; Knížková et al., 2007, Vadlejch et al., 2010). It has been used less frequently for research body livestock, specifically changes in the vascular circulation as a result of an increase or decrease in temperature of the tissue, as a measuring method for the assessment of these areas (Harper, 2000).

Using IRT can detect changes in peripheral blood flow and consequent changes in heat loss, so this method can be a useful tool for measuring stress to the animals (Pavlidis et al., 2002; Stewart et al., 2007).

Berry et al. (2003) used a thermal imager to examine the effects of environmental factors on the daily temperature fluctuations udder. They found that the thermal imager has potential as a tool for early detection of mastitis when combined with monitoring of environmental factors. Because the skin temperature reflects the basic blood circulation and metabolism of tissue, some types of mastitis may cause an increase in skin temperature udder (Polat et al., 2010), especially in the case when mastitis is accompanied by fever (Hovinen et al., 2008). Also WILLITS (2005) and Kennedy (2004) confirmed that the surface temperature of udder caused by mastitis infection rose before other clinical symptoms.

Contactless temperature mapping uses a portion of the electromagnetic spectrum in the wavelength range 0,4 μm to 1 mm. When choosing a non-contact thermometer is crucial thermometer optics (optical resolution), the possibility of setting emissivity factor and temperature range of thermometer (Fuka, 2011).

Technique of measuring using IRT in animals is advantageous because due to handling and holding in animals increases stress, causing rising surface temperature (Soerensen and Pedersen, 2015). This contribution deals with the possibility of measuring surface temperatures of the animals as a possible indicator of health status. Premise of this work is that the assessment of the health status can help even regular temperature measurements of body surface of animals and thus immediately react to the first signs of illness.

MATERIALS AND METHODS

This experiment was conducted in the agricultural cooperative in central Bohemia in the Czech Republic. The experiment was carried out in stables with free boxing barns. Measurements were carried out in the stable where the cows were fixed in the box. It was evaluated three different groups.

Measurements were carried out in the period from January to July, 2014. During each measurement it was measured 36 dairy cows which were divided by 12 pieces into three groups. In the first group were cows and heifers from the second day to two months after calving. The second group consisted of cow 4 to 5 months after birth. The third group was made up of cows in the seventh to eighth month after calving.

The surface temperature were taken with a thermal imager Testo 875 with the record in the memory (detector resolution 160x120 pixels, viewing angle of 32° or 9°, thermal sensitivity of <0.08 °C or 0.05 °C, the automatic recognition of hot-cold point temperature range: -30 to +350 °C). This thermocamera is equipped with a digital camera for easy documentation.

Temperatures were recorded from three different body parts of animals (core body, eye and udder). Of these parts thermal images were taken (Fig. A, B, C), which were evaluated and tabulated. The average temperature of body parts of animals from the individual measurements were given in correlation with the rectal temperature which was measured by using a digital rectal thermometer.

The resulting values were processed into graphs using Microsoft Excel.

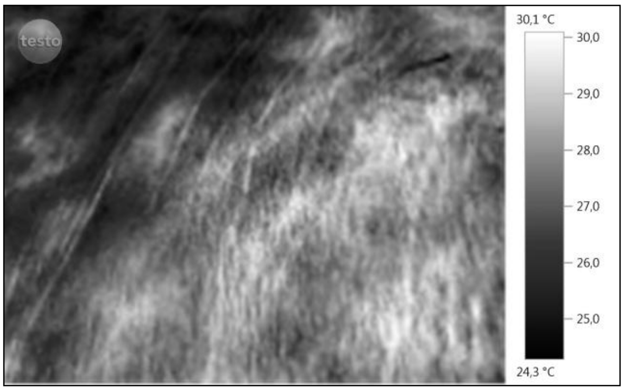

Fig A. Thermal imager of the body core

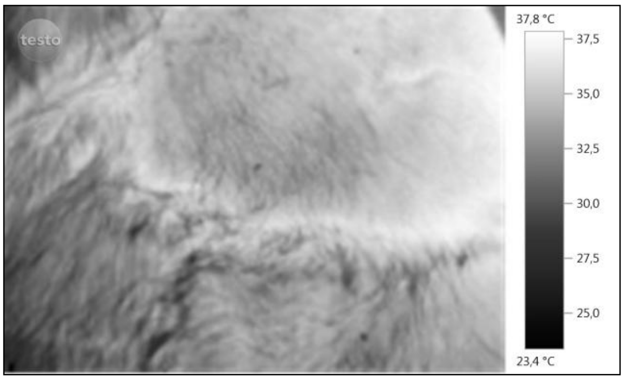

Fig B. Thermal imager of the udder

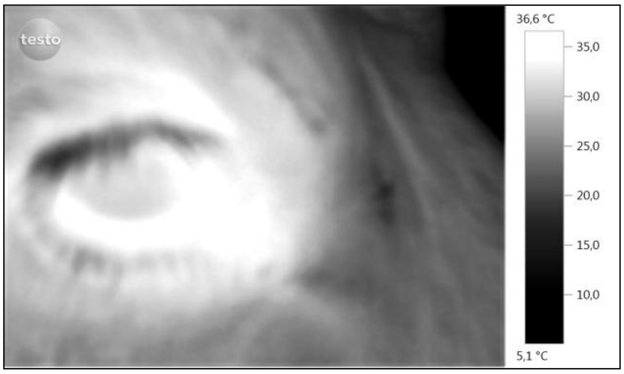

Fig C. Thermal imager of the eye

RESULTS

Table 1. Dependence of rectal temperatures at each surface temperatures

		Rectal temperature (°C)	Temperature of the body (°C)	Temperature of the udder (°C)	Temperature of the eye (°C)
Group 1	**Rectal temperature (°C)**	1	0,565939343	0,557116828	0,658751175
Group 2	**Rectal temperature (°C)**	1	0,692313252	0,671341181	0,752280899
Group 3	**Rectal temperature (°C)**	1	**0,854232862**	**0,819539525**	**0,849531367**

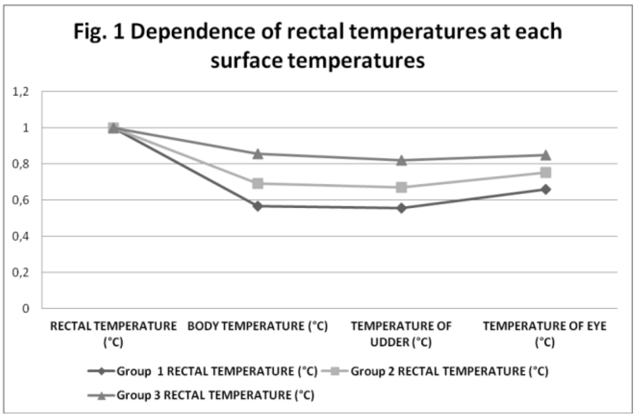

Fig 1. Dependence of rectal temperatures at each surface temperatures

Based on the data obtained using thermovision camera have been calculated correlation. This paper focuses on capturing rectal temperature, depending on the selected surface temperatures (Tab. 1). Rectal temperature was the highest in the period of high ambient temperatures, ie. during the spring and summer, when they were captured by the highest surface temperature of the animals. Sensing temperature in this period, however, they were very influenced microclimate conditions in the barn (ambient temperature, ventilation equipment, spraying). Average rectal temperature of measurements animals ranged between 37 and 38.5 °C. On the basis of the actual measurement indicates Bukvaj (1986) rectal temperature fluctuation in dairy cows by 36.9 to 39.1 °C. Temperatures above 39.5 °C by Knížková (2003) has been considered as reaction to the high temperature environment.

The most significant correlations were found in rectal temperatures, depending on the surface temperature of the eye (Fig. 1,2). It is generally stated that the highest temperatures are measured in the eye. Nehasilová (2011) argues that due to the measurement of the eye is possible to determine whether the animal is stressed or not. It showed Canadian and New Zealand scientists in the research, whose objective was to determine whether infusion andrenalinu can affect the temperature of the eye in calves. Also studies of Cook et al. (2005) and Pavlidis et al. (2002) showed that the temperature of the eye can be a good indicator of stress. Specifically, the temperature of a small area around the rear edge of the lid and *curuncula lacrimalis* having ample amount of capillaries innervated by the sympathetic system responds to changes in blood flow (Stewart, 2007). Shaefer et al. (2004) used the infrared camera for the identification of bovine viral diarrhea in calves. They found that elevated temperatures of eyes were more consistent than in other areas. Significant changes in the temperature of the eye occurred several days before other clinical symptoms.

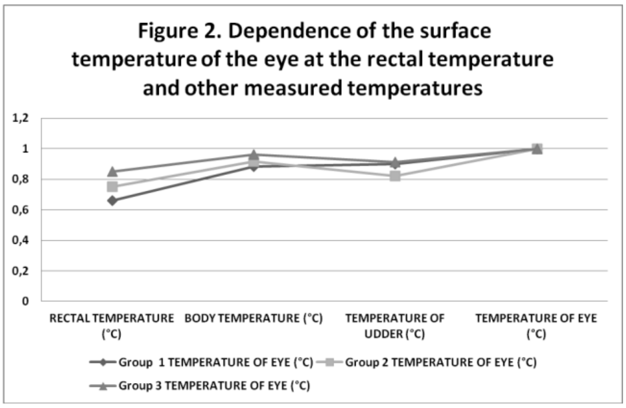

Figure 2. Dependence of the surface temperature of the eye at the rectal temperature and other measured temperatures

As regards the effect of high temperatures on the welfare of dairy cows, according Dolejš (2005) in the range 16 to 21 °C there is no significant change in performance, animal behavior and the quality of their products. As well as Vokřálová and Smith (2005) report that thermoneutral zone for dairy cows are shown in the range of -5 to + 24 °C, and for high yielder cows are moved to the upper limit of 21 °C. Increased heat load causes behavioral and physiological responses including an increase in body temperature and respiration activity reduction, food intake and milk production. Significant differences in measured values rectal temperatures, especially in summer, were located at the 3rd group of dairy cows. In this group were found dairy cows at the highest levels of lactation compared with the previous group, because fluctuations were most pronounced in rectal temperature values. According to Dolezal et al. (2010) are particularly vulnerable to thermal stress high yield dairy cows at the top of lactation, due to its narrowly focused production function, high efficiency of feed utilization, and thus high metabolic heat production. In a herd of dairy cows to heat stress are more susceptible cows with high milk yield than cows with low milk yield and dry cows.

Dependence rectal temperature on the surface of the body core temperature and udder were no less significant. However, these parts of the body are most affected by external influences such as light, temperature and air flow. Also by the properties such as structure, color and dirt of hair, construction and structure of the udder (especially hair and pollution) play a very important role. Finally, it depends on the correct setting of the thermoimager, the distance of the subject and its emissivity (emissivity).

CONCLUSION

This experiment confirmed the assertion that the highest surface temperature is measured in the eye. The surface temperatures are in the sensing infrared camera most influenced by external environmental conditions (temperature and flow of air, light, moisture). Big influence on the resulting surface temperatures also have surface properties such as emissivity particular, structure, color, and contamination of hair. During the measurement, there was no significant response of the animals to high temperatures, nor significant signs of heat stress. The animals were checked by veterinary services and livestock operations, which were compared with the current state of the animal. Premise of this work is that the assessment of the health status can help even regular temperature measurements of body surface of animals and thus immediately react to the first signs of illness. Final outputs could serve businesses that are breeding dairy cattle and employing electronic control systems zootechnical records and herd management. It might be developed a control software. We can expect an increase in people interested in farming management practices resulting from the increasing demands for quality and economy of production, animal welfare and livestock production impact on the environment. Also increased comfort will be important for users.

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