PROMOTING SUSTENABILITY IN FAMILY-SIZED DAIRY FARMS FROM NORTH-EAST OF ROMANIA - USE OF THERMOGRAPHY FOR MONITORING UDDER HEALTH AND IMPROVEMENT OF MILK QUALITY (PRELIMINARY STUDY)

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Abstract

Romania is a country with a lot of potential for high-quality food production. However, despite rising demand for milk and dairy production, the production has been declining in recent years and Romanian milk farmers face growing competition from other farms on a national and international basis in terms of production and milk quality. The aim of the present study was to assess the potential use of a phone-connected infrared camera, as a potential non-invasive tool for the monitoring of udder health and control of bovine subclinical mastitis in family-size farms. The somatic cell count (SCC) (r=0.79) was positively correlated with the udder skin surface temperature (USST), a difference of 1.4 °C being observed between healthy and mastitis affected quarters. Infrared thermal imaging using phone-connected camera could be used as a potential noninvasive, quick cow-side diagnostic method for monitoring udder health and improvement of milk quality in family-sized farms.

Key words: bovine mastitis; milk quality; thermovision camera; somatic cell count;

Introduction

Romania is a country with a lot of potential for high-quality food production. However, despite rising demand for these goods, milk and dairy production has been declining in recent years. The foundations for milk production are favorable, but a lack of comprehension regarding current agricultural production methods appears to be a challenge, especially for the family-sized farms. According to the estimates, in Romania, there are about 1,190,000 dairy cows, 604,000 dairy farms, the average herd size being 2.4 cows per farm. The average annual production per cow is around 2,500 liters. Around 4 millions tones of milk are produced, but only one quarter is being processed by the dairies (Dairy Focus Report, 2019). The rest is consumed on-farm or sold directly to consumers. Dairies receive about 1 million tones of milk, which is mostly processed into dairy products such as yogurt, kefir, cheese and butter (Figure 1).

Although the cattle population is comparable to other EU states, Romania is among the last in terms of annual production, mainly due to the rather low average milk yield per cow per year, which is around 3 000 kg. In our country, there is a dual animal husbandry, with large industrial units and intensive operation and smaller units, the so called family farms, most of which are not modernized, thus this farmers face growing competition from other farms on a national and international basis. The vast majority of the family-sized farms produce milk and meat at high costs compared to other European countries but the milk price in Romania is currently lower comparative with other countries from which milk is imported such as Poland. However, these types of units are an important source of good quality agri-food products, therefore they represent a priority in the Romanian rural economy. To ensure the sustainability of the family farms it is imperative to support dairy farmers to produce milk according to E.U standards, in order to obtain an advantageous, competitive price for it. This objective may be achieved by improving the current agricultural technologies and by improving udder health and implicitly the quality of milk. In Romania, the incidence of bovine subclinical mastitis is still high and recurrence of mastitis is very common (Rosca et al, 2008). In contrast to clinical mastitis, which is defined by obvious symptoms of inflammation and milk abnormalities, subclinical mastitis is defined by subtle changes in milk composition and quality, with no evidence of gross inflammation or abnormalities. Dairy farmers must improve their expertise in order to improve production costs, milk quality and lower the quantity of antibiotics used in farms. Farmers' needs

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for knowledge and their feeling of necessity for acquiring new knowledge differs greatly. The majority of the younger age farmers have visited farms in other countries or extensively documented themselves, which has influenced their perceptions regarding the potential use of technology to improve both productivity and animal health.

The aim of the present study was to assess the potential use of a phone-connected infrared camera, as a potential non-invasive tool for the monitoring of udder health and control of bovine subclinical mastitis in family-size farms.

Figure 1. **Romanian dairy sector in number**

MATERIAL AND METHOD

Investigations were carried out in 4 family-size farms from Iasi and Vaslui counties. A total number of 13 of cows, at second to fourth lactation were included in the study. Over a time period of five days, thermograms and samples of milk from of all quarters (n=52) were taken in each morning, before milking. For each cow, three thermal images were acquired using a phone-connected thermovision camera (Flir One Pro, USA), corresponding to the right and left front and rear udder.

The total number of somatic cells from the milk samples was assessed using the FTIR CombiScope (Delta instruments, USA), in the Laboratory of Food Safety and Animal Biology of the Research and Development Station for Cattle Breeding Dancu, Iasi.

ANOVA was used to compare the findings of healthy cows and cows with subclinical mastitis in terms of udder skin surface temperature (USST) and somatic cell count (SCC). A Pearson's test was used to determine the relationship between the USST and the SCC. Correlations less than 0.3 were considered weak, those between 0.3 and 0.7 were considered moderate, and those more than 0.7 were regarded strong. The regression model was used to correlate USST with SCC as an indication for healthy cows and mastitis-infected cows.

RESULTS AND DISCUSSIONS

udder health. Monitoring udder health is essential for the early detection and successful control of bovine subclinical mastitis.

For the early identification of changes in milk associated with bovine subclinical mastitis, many methods and biomarkers are available. Somatic cell count (SCC) is an essential indicator for milk hygiene and animal health. An increased SCC level in milk is usually used as an indication for udder infection (mastitis) in lactating cows. However, this diagnosis techniques is rather laboratory-oriented, requiring well-trained personnel and expensive equipment (Narayana et al., 2018). The somatic cell count threshold for identifying cases of subclinical mastitis varies between studies, from $100x10^3$ cells (Sumon et al., 2020) to $310x10^3$ somatic cells/ml of milk (Jadhav et al., 2018).

Precision dairy farming is now focusing on automated approaches for the early and efficient detection of bovine subclinical mastitis (Chakraborty et al., 2019). The temperature of udder skin surface was proposed as an useful marker for

the diagnosing diseases and assessing the physiological status of cows (Machado et al., 2021), although further refinements are needed. IRT (infrared thermography) is a fast, inexpensive, on-shown that IRT may be used to identify subclinical mastitis and clinical mastitis in both large and small ruminants (Costa et al., 2014; Metzner et al., 2014). Skin surface temperature is an indicator of the tissue metabolism and blood circulation, thus aberrant thermal patterns might indicate regions of surface inflammation or circulatory dysfunctions. In mastitis, the inflammatory reaction is primarily accompanied by an increase in the udder surface temperature. The surface heat emitted as infrared radiation may be detected by a thermal camera, which captures infrared radiation and produces visual pictures based on the amount of heat emitted (Figure 2). On the thermograph, the warmest areas are bright yellow or white, whereas the coldest areas appear dark blue or violet.

farm, and noninvasive technique that enables the detection of surface heat under the form of infrared radiation, subsequently generating visual pictures (thermograms). Several studies have

In this current study, the diagnostic usefulness of IRT as an indirect marker of bovine subclinical mastitis was compared to Automated Somatic Cells Count (SCC).

The individual cutoff for for subclinical mastitis was set at 200x103 cells per ml of milk, in accordance with national and international good practice recommendations (Narayana et al., 2018). The SCC (r=0.79) was positively correlated with the udder skin surface temperature (Figure 3). In cows with subclinical mastitis (n=8), the mean ± standard deviation USST was 38.0±0.3°C, individual values varying between 37.7 and 38.5°C) while in healthy cows, the mean ± standard deviation USST was (36.6 ±0.3°C), individual values ranging from 35.4 and 37.3°C) (Table 1).

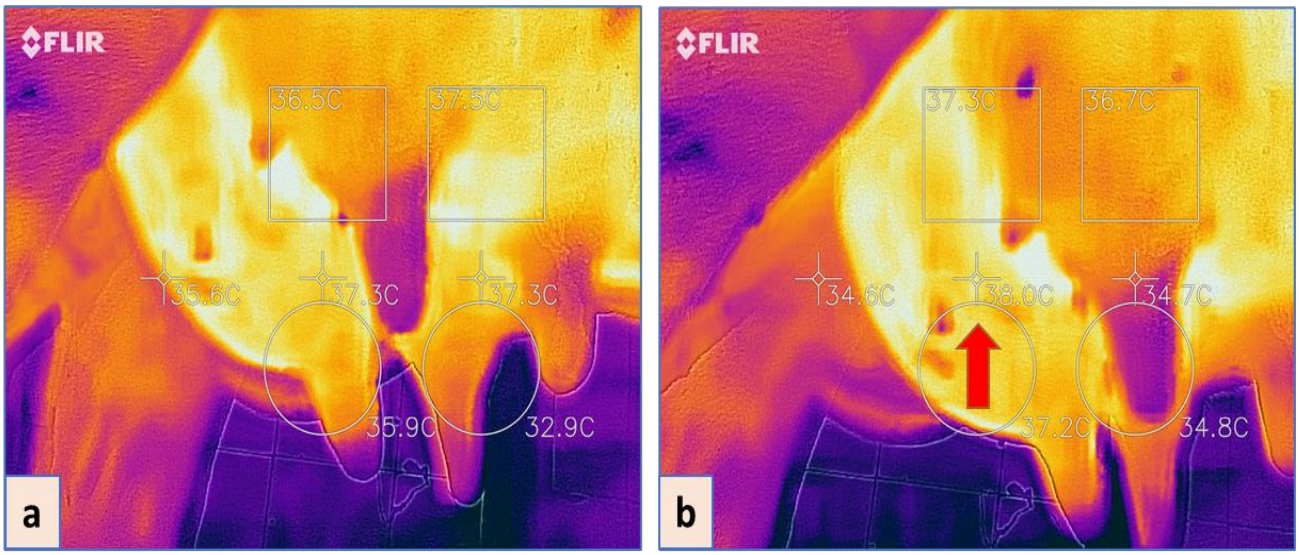

Figure 2**. Infrared thermogram of udder quarters from the lateral side. Red arrows indicates elevated temperature (38°C)**

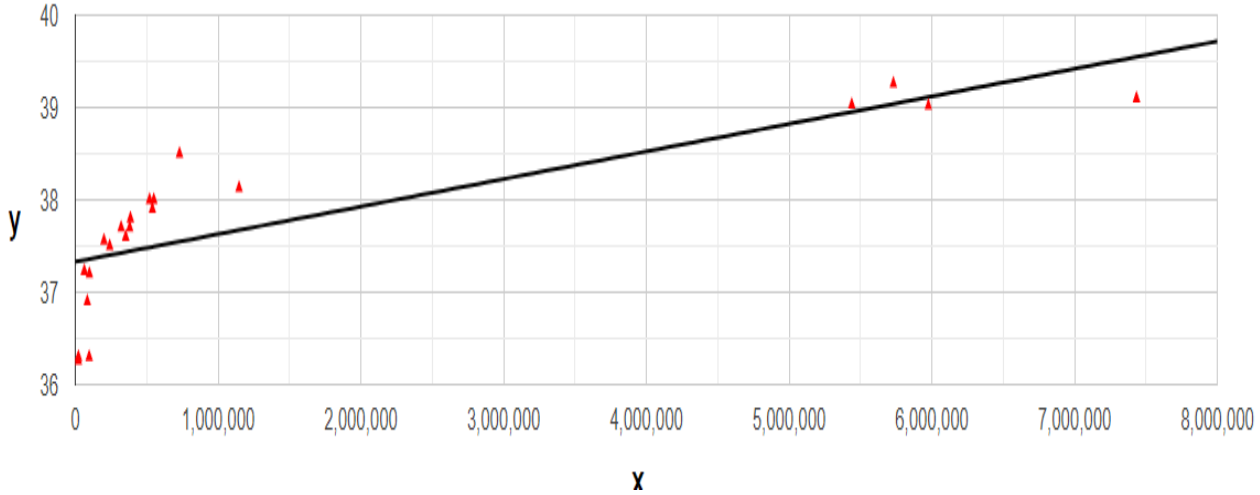

Figure 2**. Linear regression relating udder skin surface temperature with somatic cell count (SCC)**

Table 1

Descriptive statistics of the USST (°C) and SCC

Statistical parameters	Negative (n=24)		Positive (n=28)	
	SCC	USST (°C)	SCC x 10^3/ml	USST (°C)
Minimum	21	35.4	200	37.7
Maximum	98	37.3	7434	38.5
Mean	64	36.6	1989	38
SD	35	0.3	254	0.3

According to a studies carried out by Scott et al., 2000, Hovinen et al., 2008, the USST is progressively increasing 3 days before the instalment of clinical signs, in both natural and experimental induced mammary infections.

In the present study, a phone-connected thermovision camera was used to assess the USST, a difference of 1.4 °C being observed between healthy and mastitis affected quarters. Among the advantages of this thermal imaging camera are the ease of operation and the possibility of using it for other purposes as well (e.g. assessing the thermal stress of farm animals or the health of the hooves). Further studies are needed to refine the methodology for image prelevation and interpretation, taken into consideration other variables such as environment, type of animal coat.

CONCLUSIONS

Infrared thermal imaging using phone-connected camera could be used as a potential noninvasive, quick cow-side diagnostic method for monitoring udder health and improvement of milk quality in family-sized farms.

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