

Using infrared thermography to detect teat tissue changes after machine milking in dairy COWS

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Introduction

Mastitis is among the costliest diseases affecting dairy cows, partly due to its permanent reduction of the quantity and quality of milk produced. Most mastitis cases involve pathogenic organisms entering the cow's mammary gland through the teat canal. The teat canal has natural defenses against these pathogens that can be disrupted during milk harvesting. Some of these disruptions of the teat tissue morphology, also known as short-term changes (STCs), can be diagnosed through visual inspection and palpation. Infrared thermography (IRT) has previously been shown to produce precise and consistent measurements of skin temperatures on cows' hind teats. Our primary objective was to determine if IRT could distinguish between presence and absence of STCs to eventually create an automated monitoring system. Our secondary objective was to describe the variability in the teat skin surface temperatures (SSTs) before and after machine milking.

Materials and methods

This observational study was carried out at the Teaching Dairy Barn at Cornell University, College of Veterinary Medicine (Ithaca, NY) in July 2021. Two trained investigators recorded the presence or absence of STCs, cow characteristics, and obtained thermographic images of both hind teats from 147 cows immediately before and after machine milking. Thermographic images were obtained with a portable thermography camera at a standardized distance from the cow, and environmental conditions (that would affect the obtained temperatures) were documented. Average SSTs were determined within rectangular zones at the proximal, middle and distal aspects of the teat with a standardized protocol in an adjunct software program. Area average SSTs were preferred over point or linear SSTs to obtain a more representative temperature at each region of the teat. To examine whether SSTs could serve as a proxy for STCs, we fitted logistic regression models and calculated the area under the curve values (AUC) from receiver operator characteristic (ROC) curves. We calculated least squares means from general linear mixed models to describe the SSTs at the proximal, middle and distal teat aspects pre- and post-milking.

Results

Receiver operator characteristic curve analyses for SST post-milking, the difference (pre-milking minus post-milking values), and the relative change (compared with the pre-milking value) in average temperatures yielded AUC values of ≤ 0.57 suggesting poor discrimination between the presence or absence of STCs. The teat SSTs were higher post-milking, potentially due to friction with the milking liner, conduction of heat from milk flowing through the teat end, or changing metabolic activity or blood flow velocity. Least squares means (95% CI) of SSTs pre- and post-milking, respectively, were 33.6 (33.5-33.8) °C and 35.4 (35.3-35.5) °C at the proximal aspect, 33.2 (33.1-33.4) °C and 35.2 (35.1-35.3) °C at the middle aspect, and 32.3 (32.1-32.5) °C and 34.0 (33.9-34.1) °C at the distal aspect of the teat.

Significance

We conclude that average SSTs pre-milking and post-milking as determined by IRT were unable to discriminate between the presence or absence of STCs of the teat tissue as detected by visual inspection and palpation. The measured differences in SSTs pre- and post-milking at all 3 aspects of the teat suggest that some of the variability in SSTs is attributed to the milking event. Future research is warranted to investigate the biological relevance of SST changes assessed with IRT during machine milking.

