Milking-related changes of teat temperature caused by various milking machines

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Abstract: The aim of the performed work was to verify the hypothesis that different milking equipments have different influence on the blood circulation in the milk gland during milking. This influence was investigated by measuring the surface temperature of the milk gland using thermography. The influence was monitored of 5 different milking units in total, out of them 2 AMS, on the teat temperature which was scanned and evaluated in the teat tip centre and on the teat base at the same time with the surface temperature of the udder, always at the instant closely preceding the cluster application and then after its removal. It was ascertained that the average temperature of the teat tip after milking was increased in comparison with the temperature before milking practically in all the milking units monitored. At the same time, the average temperature of the teat tip in the milking equipment in parlours increased by about 1.7°C–2.7°C (6.1%–9.0%) as compared to the temperature before milking. At milking in AMS, the temperature rise of the teat tip was smaller and reached only 0.9°C–1.7°C (2.9%–6.0%). At the same time, the temperature of other parts of the milk gland grew commensurately. It was also found that differences exist between different milking units with respect to their influence on the temperature fluctuation of the milk gland. From the monitoring performed up to now and from the results acquired it is possible to apprehend that the monitoring of the teat temperature before and after milking with the help of thermography can become an indicator of the working quality of the milking equipment and its influence on the milk gland. The confirmation of this hypothesis requires, however, further detailed and extensive measuring to be carried out.

Keywords: teat temperature; milking machine; infrared thermography

The milking equipment has a considerable effect on the milk gland health status incorrectly designed and operated milking equipment can cause milk gland inflammation as well as the teat damage. The milk gland is influenced directly by the teat sleeve acting which is controlled by a pulsator. The periodical changing of depression and atmospheric pressure (or even a slight overpressure in the pulsation chamber of the teat cup) generates mechanical action of the teat sleeve on the teat (Weber 1977; Bramly *et al.* 1992; Worstorf 1994, and others). Incorrectly adjusted milking equipment with unsuitable parameters can cause a failure of the teat blood circulation and the body liquids pressure, blood in particular, in the teat tip (Rabold 1974). This can, among others, result in temperature changes in various teat points, indicated immediately after the milking process has finished and the milking cluster is reattached (Kunc *et al.* 2000; Ordolff 2000; Paulrund *et al.* 2005 and others). The temperature increase in the teat surface during milking is due to the circulatory changes in the teat wall induced by the mechanical teat treatment in the teat cup (Isaksson & Lind 1994). For the milk gland surface temperature measurement and recording, the video camera can be suitably utilised.

The goal of the research work performed was to verify the hypothesis that different milking equipments have different influence on the blood circulation in the milk gland during milking, and that the teat monitoring using thermography before and after milking can be an indicator of the working quality of the milking equipment.

MATERIAL AND METHODS

The measurement of the milking machine effect on the milk gland surface temperature was carried out on large dairy farms where the milker normal operation was not affected. Before the measurement, the

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Table 1. Basic parameters of investigated milking equipment

No. investigated milking equipment	Nominal vacuum (kPa)	Pulsation		Claw			
		rate	ratio	weight (g)	claw volume (cm^3)	diameter of short milk tube (mm)	milk inlet to the claw
A	42	60	65:35	1800	360	12	radial
B	42	60	60:40	1250	320	12	tangencial
C	40	60	60:40	2270	90	12	tangencial
D	42.5	60	65:35	350	–	14	–
E	40	53–70	60:40	500	–	9.5	–

A, B, C – herringbone milking parlours; D – AMS, 1 box; E – AMS, 3 box

technical status of the milking machine was checked (vacuum, pulsation rate, liners state).

The milking equipment influence on the milk gland state of health was investigated by measuring the surface temperature of the milk gland using thermography (video thermo camera TERMACAM 545). The temperature was scanned and evaluated on the teat tip, the centre, and the teat base at the same time with the surface temperature of the udder, always at the instant closely preceding the cluster application (before the udder hygiene) and then after its removal.

The measurements were aimed particularly at the udder surface temperature changes evaluated by the temperature difference before and after the milking finishing. Because the measurements were carried out under the same conditions of environment, the results were not influenced by its emissions affecting the measured temperature absolute value which was nevertheless utilised for documentation purposes only and was not evaluated separately.

Under the normal operational conditions, the influence of 5 different milking machines was monitored in total. The milking equipments A, B, C are the herringbone milking parlours, and D–E are automatic milking systems (AMS). All the observed milking machines were equipped with the system of milking low-rate automated monitoring and the automated milking machine removal preventing the blind milking. The measurements were carried out on normal dairy farms in the Czech Republic and Germany. Basic technical data of the milk units monitored are presented in Table 1. All the milking equipments were operated with the alternate pulsation, only equipment C was operated continuously.

RESULTS AND DISCUSSION

The measurement results are summarised in graphs in Figures 2–6. An example of the video-record is presented in Figure 1. Based on the above results, it may be stated that the milk gland surface

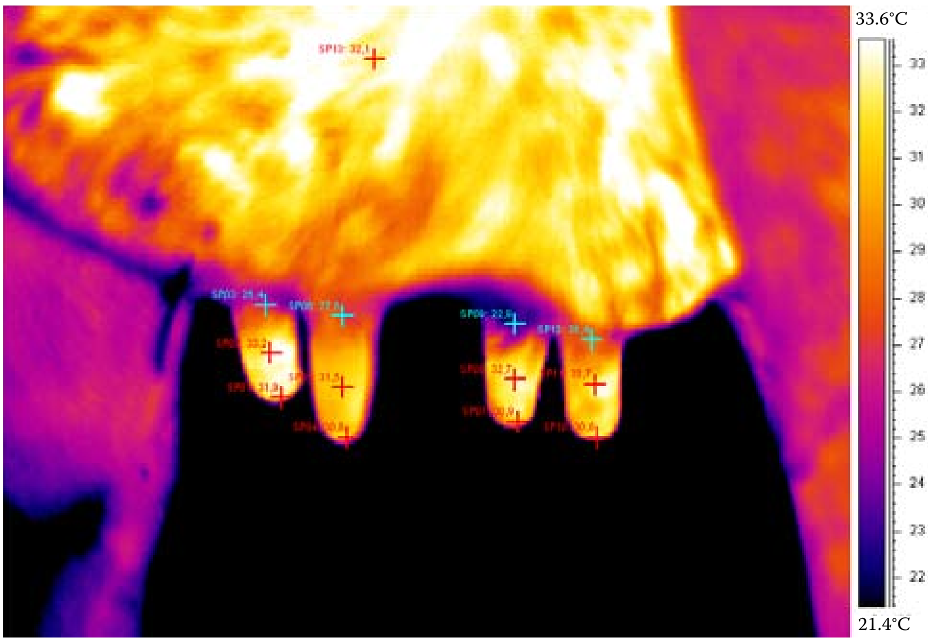

Figure 1. Example of udder temperature video-record

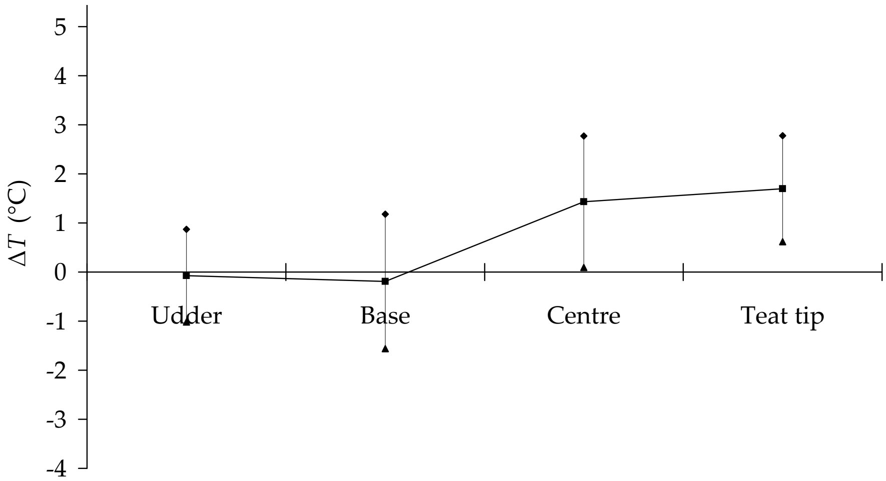

Figure 2. Mean value and standard deviation of temperatures differences at the end and beginning of milking in the different places of udder-milking machine A

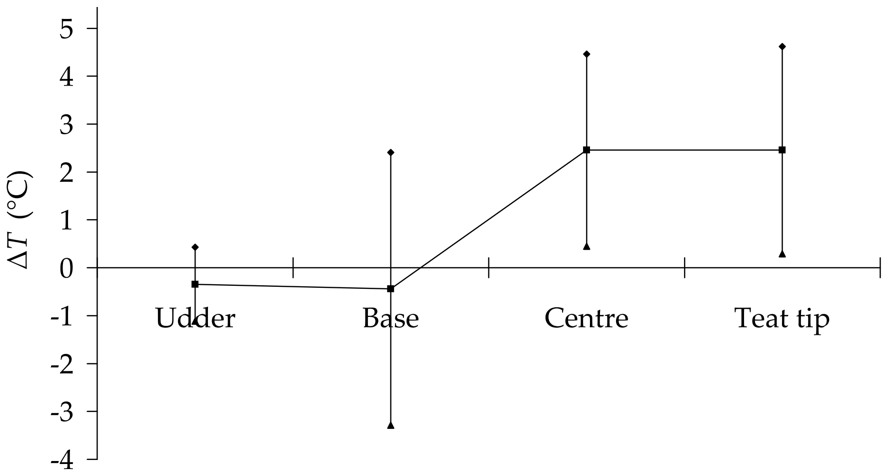

Figure 3. Mean value and standard deviation of temperatures differences at the end and beginning of milking in the different places of udder-milking machine B

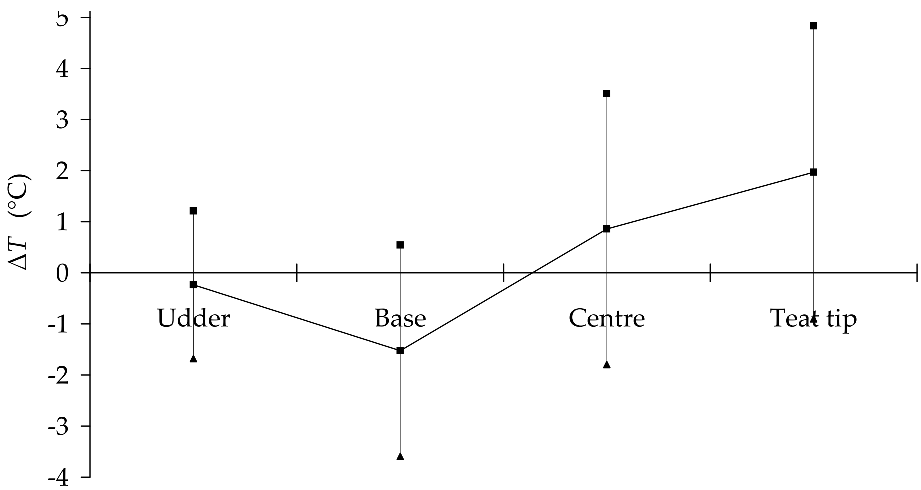

Figure 4. Mean value and standard deviation of temperatures differences at the end and beginning of milking in the different places of udder-milking machine C

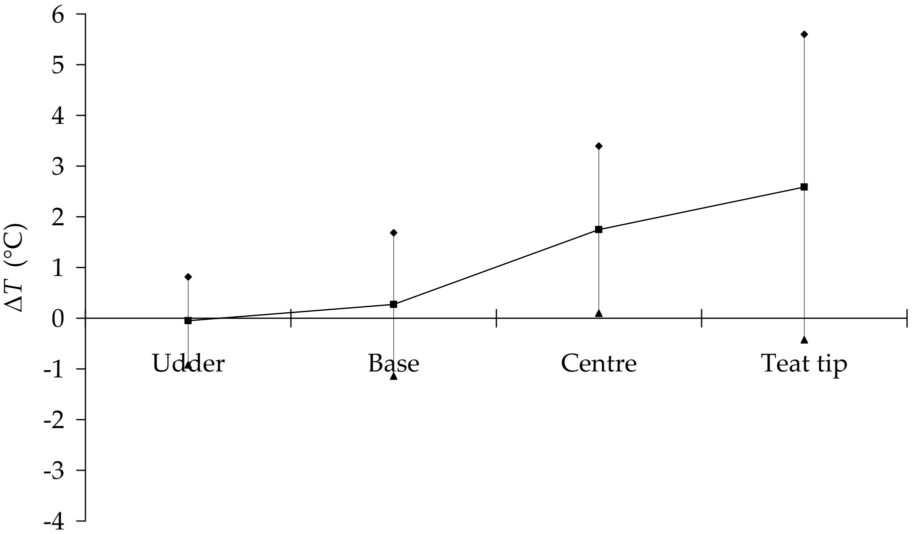

Figure 5. Mean value and standard deviation of temperatures differences at the end and beginning of milking in the different places of udder-milking machine D

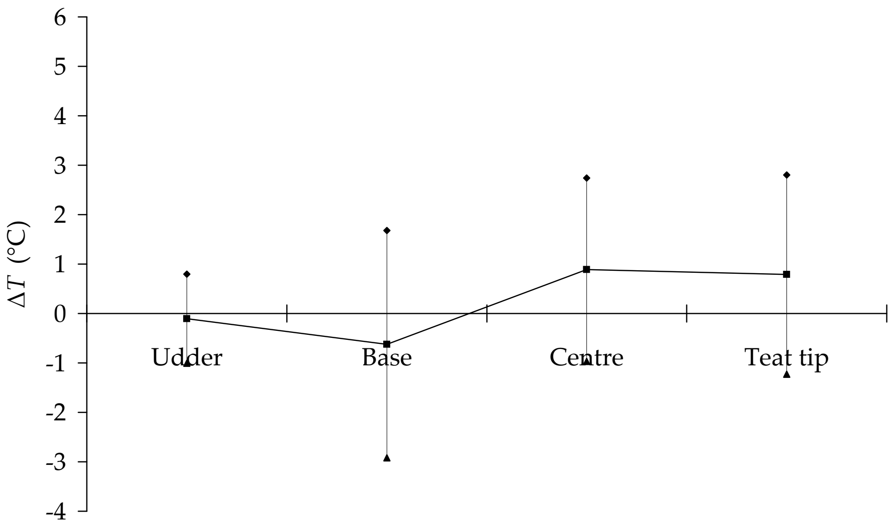

Figure 6. Mean value and standard deviation of temperatures differences at the end and beginning of milking in the different places of udder-milking machine E

temperature increases during milking. This increase was found out at all teat points measured. These results are in compliance with those presented in the literature (Isaksson & Lind 1994; Kunc *et al.* 2000; Barth 2001; Paulrund *et al.* 2005 and others).

It was ascertained that the average temperature of the teat tip after milking was increased in comparison with the temperature before milking. At the same time, the average temperature of the teat tip in the milking equipment in parlor increased by 6.1%–9.0% (1.7°C–2.7°C) as compared to the temperature before milking. In milking in AMS, the temperature rise of the teat tip was smaller and reached only 2.9%–6.0% (0.9°C–1.7°C). The temperature of other parts of the milk gland grew commensurately. It was ascertained that differences exist between different milking units with respect to their influence on the milk gland temperature fluctuation. From the monitoring performed up to now and from the results achieved, it is possible to apprehend that the monitoring of the teat temperature before and after milking by the help of thermography can become an indicator of the working quality of the milking equipment and its influence on the milk gland.

Nevertheless, it is necessary to perform further research work focused on the methodology improvement (e.g. elimination of the udder shape effect, teats dislocation and size, etc.). The discussion should also be oriented on the clarification of the milk gland temperature changes assessment as a consequence of milking. For example, the calf suckling causes the teat temperature increasing significantly, in spite of the fact that the calf suckling can be considered a natural process without unfavourable effects on the milk gland. Some authors (Kunc *et al.* 2000), however, argue that this causes the teat traumatism. On the other hand, it is known that the milking machine can reduce the blood circulation and the body liquid pressure in the teat tip which has an unfavourable effect on its healthy status and is connected with the temperature decrease.

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Abstrakt

Vegricht J., Machálek A., Ambrož P., Brehme U., Rose S. (2007): **Vliv různých dojicích zařízení na teplotu struku během dojení**. Res. Agr. Eng., **53**: 121–125.

Provedené práce ověřovaly hypotézu, že různá dojicí zařízení mají rozdílný vliv na prokrvení mléčné žlázy během dojení. Tento vliv byl zjišťován měřením povrchové teploty mléčné žlázy pomocí videotermokamery. Byl sledován vliv celkem pěti různých dojicích zařízení, z toho 2 AMS, na teplotu struku, která byla snímána a vyhodnocována na hrotu, středu a bázi struku současně s povrchovou teplotou vemene vždy bezprostředně před nasazením dojicí soupravy a po jejím sejmutí. Bylo zjištěno, že průměrná teplota hrotu struku se po dojení zvyšuje prakticky u všech sledovaných dojicích zařízení ve srovnání s teplotou před dojením. Přitom průměrná teplota hrotu struku se vlivem dojicích zařízení v dojírnách zvýšila o 1,7 °C–2,7 °C (6,1 %–9,0 %) proti teplotě před dojením. Při dojení v AMS bylo zvýšení teploty hrotu struku menší a činilo jen 0,9 °C –1,7 °C (2,9 %–6,0 %). Současně se přiměřeně zvýšila teplota ostatních částí mléčné žlázy. Bylo také zjištěno, že mezi jednotlivými dojicími zařízeními jsou rozdíly z hlediska jejich vlivu na teplotní změny mléčné žlázy. Z doposud provedených sledování a získaných výsledků je možné dospět k poznatku, že sledování teploty struků před dojením a po něm pomocí videotermokamery může být ukazatelem kvality práce dojícího zařízení a jeho vlivu na mléčnou žlázu. K potvrzení této hypotézy je však potřebné provést další podrobná a rozsáhlá měření.

Klíčová slova: teplota struku; dojicí zařízení; termografie

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