Skin surface temperature of the mammary gland, measured by infrared thermography, in primiparous Girolando cows fed diets containing different lipids sources

Alysson M Wanderley Luís CV Ítavo, Geraldo T dos Santos, Camila CBF Ítavo, Alexandre M Dias, Rodrigo G Mateus, Luiz C Pereira, Ariadne B Gonçalves, Endyara S Kohl and Celso RC Lima

INTRODUCTION

The quality of milk in Brazil varies widely as result of different production systems, with a low number of qualified farmers and a large number of farmers with little or no expertise, mainly regarding the nutritional management of herds (Gabbi et al. 2013). Milk quality primarily comprises the centesimal evaluation of fat, protein, and total solids, but health-related factors such as the Somatic Cell Count (SCC) to detect mastitis are also evaluated (Vargas et al. 2014). Besides indicating sanitary problems, a high SCC also results in nutritional depreciation of the milk. Malic et al. (2018) reported a negative correlation between SCC and milk yield, as well as changes in lactose, fat, protein and total solids, which may in some cases render the milk unfit for human consumption.

According to Voltolini et al. (2001), the use of SCC is not enough for adequate detection of mastitis because SCC is based on leukocytes and epithelial cells, which makes it incapable of characterizing an infection of the mammary gland by itself. Hovien et al. (2008) demonstrate that the temperature measurement can be used as a method of mastitis detection as a result of the increased blood flow and redness caused by this infection. Milk quality can be improved by modifications in cow's diet (Pecka et al. 2013). For instance, the supply of oilseeds in the ruminant diet leads to better-quality milk fat, which can help prevent some types of cancer, obesity, diabetes and cardiovascular diseases (Kratz et al. 2013; Lahlou et al. 2014).

Deitary supplementation, aiming at increasing livestock productivity, leads to different physiological responses in animals as a function of factors such as lactation stage and genotype (Horan et al. 2005). Supplementing dairy cows with lipid sources provides better efficiency of energy use, due to the reduction of the caloric increment and increase of the productive efficiency of milk by the direct incorporation of the fat of the diet into the milk (NRC, 2001; Palmquist e Mattos, 2011). This supplementation increases the energy density of the diet due to the content of the total dry extracts being favorable for food efficiency of animals in a state of limited consumption, as in caloric stress, late third of gestation or beginning of lactation, moments in which a nutritional energy deficit occurs (Paula et al. 2012). In this sense, the use of oilseed grains in dairy cows has an important role in controlling the temperature of the mammary gland. According to Hammami et al. (2015)

cows under thermal stress remain for longer time in order to control the temperature of the body and with this increase the contact of the ceilings with soil soils becoming more susceptible to intramammary diseases, in addition, high temperatures of the mammary gland are favorable to the proliferation of pathogenic microorganisms (Das et al., 2016).

For successful livestock production, physiological parameters must be monitored for detection of slight changes that impacts animal health and welfare. The quality of animal products depends on the farmer's ability to react to changes in physiological parameters in livestock. Among the physiological data, temperature is easy to measure, and it correlates with several body functions such as nutrition, reproduction, stress and sanity. Consequently, the thermal radiation emitted by the body varies as a result of changes in blood flow and metabolism (Roberto et al. 2014; Sellier et al. 2014).

The variation in body temperature may be related to the productivity of the cows; lactating dairy cows are less efficient in dissipating heat because they require higher dry matter intake, increasing nutrient metabolism (Kadzere et al. 2002). There are several methods for measuring the body temperature of lactating cows. However, Leão et al. (2015) stated that non-destructive and non-invasive methods of temperature measurement can generate reliable data without the need for direct contact, thus avoiding stress. Therefore, infrared thermography becomes a potential tool in livestock production for diagnosis, prevention, and association with characteristics of clinical and economic interest. Several studies have demonstrated the efficiency of using this tool in studies of production and well-being in beef cattle, dairy cattle, goats, and sheep (Digiacomo et al. 2014; Silva et al. 2004). The aim of this research was to evaluate the influence of diet, mammary quarter position and milking process on the temperature of teats and udder of cows fed diets with different lipids sources.

MATERIALS AND METHODS

The experiment was carried out at the Experimental Farm of the Dom Bosco Catholic University, Campo Grande, Brazil, from August to October 2016. This study was approved by the Ethics Committee on Animal Use under the protocol nº 011/2016. The analyses were performed at the Biotechnology Laboratory Applied to Animal Nutrition - Dom Bosco Catholic University, Laboratory of Applied Nutrition - Federal University of Mato Grosso do Sul and Laboratory of the Dairy Herd Improvement Association of Paraná - Paraná Holstein Breeders Association.

Animals, Housing, and Feeding

Five Girolando primiparous cows with an average body weight of 422 kg were tagged, drenched and vaccinated at the beginning of lactation and were kept in individual pens with free access to water and mineral supplementation. Cows were fed corn silage, concentrate and a source of lipid. The offered was estimated on an intake of 3.5% of the body weight and adjusted to allow 5% of leftovers. The cows were distributed in a 5 × 5 Latin Square experimental design with five animals and five treatments (diets) for five periods of 12 days, totaling 60 days. The cows went through a pre-experimental period of 12 days for adaptation to the diet and management. The treatments consisted of diets containing different oilseeds (sunflower, soybeans, and cottonseed), a diet containing soybean oil and a reference diet (without additional lipid source) (Table 1).

Diets were formulated according to meet NRC (2001) recommendations for a dairy cow producing 18 kg of milk per day. The experimental diets were isonitrogenous and isolipidic, targeting an ether extract content of 70 g/kg of dry matter (DM). The cows were weighed after 16 hours of fasting on the first day of each period. The diets were supplied as total mixed ration after milking at 6 and 16 h.

Milk yield and Milk Somatic Cell Count

Cows were milked twice a day at 5 and 16 h using a mechanical milking machine set at 40 kPa. Milk yield measurements were performed in the last five days of each period. These values were obtained by weighing the milk produced by the cow in each milking (morning and afternoon). Then, the daily milking was calculated. Sampling for milk analysis was performed on the last two days of each experimental period. The milk samples were sent to the Central Laboratory of the Dairy Herd Improvement Association of Paraná - Paraná Holstein Breeders Association for analyzing the composition and somatic cell count (SCC).

Image Collection

The thermographic images were obtained on the last day of each experimental period using the infrared camera Flir SC 620. This camera converts the radiation emitted by the animal's skin to a wavelength of 8-12 mm in an electrical signal that is then processed to a pattern of skin temperature variation, with accuracy up to ±1°C. The camera was calibrated each day of sampling for room temperature and relative humidity. The emissivity used was 0.98 as recommended by the manufacturer for biological tissues. Five images were taken per cow and the image with the best focus and exposure of the mammary gland was chosen. The distance between the camera and the point where the image was captured was standardized at one meter. The images were analyzed with FLIR QuickReport 1.2 software to demarcate the largest possible area of the udder and teats to obtain the average temperature.

Variables and Statistical Analysis

Milk yield, somatic cell count (SCC), mean udder and teat temperatures were analyzed using the ExpDes.pt package from the software R. The Shapiro-Wilk test was used to determine the normality of the data and Bartlett's test to verify the homogeneity. After meeting assumptions, an analysis of variance of a 5 × 5 Latin square was performed. The Dunnett's multiple comparison test was applied to compare means at a significance level of 5% according to the mathematical model $Y_{ijk}=\mu+A_i+P_j+T_{k\ (i,j)}+e_{ijk}$, where: Y_{ijk} = value of the dependent variable; μ = overall mean; A_i = effect of the cow; P_j = effect of the period; $T_{k(i,j)}$ = effect of the treatment nested within each cow and period; e_{ijk} = experimental error.

The surface skin temperatures of the fore quarter, rear quarter, front teat, rear teat, udder before milking, udder after milking, teat before milking and teat after milking were analyzed using the ExpDes.pt package from the software R. An ANOVA was performed for a 2 × 5 factorial design in a randomized block design (2 sites - fore or rear quarters and 5 diets), in which the blocks were the periods and the cows were the replicates. The same was performed to evaluate the position of the teat and mammary quarter. For the comparison of means, the Tukey's test was used at 5% significance according to the mathematical model $Y_{ijk}=\mu+B_i+T_j+V_k+T_jxV_k+e_{ijk}$, where Y_{ijk}= value of the dependent variable; μ = overall mean; B_i= effect of block; T_j = effect of diet; V_k= effect of the position (fore and rear quarters) or milking (before and after); T_jxV_k= interaction between diet and position or milking; e_{ijk}= experimental error.

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