Livestock Science 155 (2013) 114–122

Contents lists available at SciVerse ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Use of ultrasound scanning to estimate teat wall thickness in Murciano-Granadina goats

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ARTICLE INFO

Article history:
Received 9 January 2013
Received in revised form
12 April 2013
Accepted 14 April 2013

Keywords:
Teat condition
Teat thickness
Cutimeter
Ultrasonography
Milking

ABSTRACT

To evaluate the ultrasound technique as a method for estimating the effect of mechanical milking on teat thickness in Murciano-Granadina goats, the following work was carried out with a twofold objective: (1) to study the most suitable ultrasound exploration frequency for this breed and the effect of the operator in applying the technique and (2) to validate the approach, comparing it with measurements taken by another estimation method (cutimeter) and performing ultrasound examinations in cows using the same methodology. To this end, three studies were designed. In the first study, 2 experiments were carried out: (a) the first (E1) tested the frequencies 5, 7.5 and 10 MHz; (b) the second (E2) tested the frequencies 3.5 and 5 MHz. In the second study, 2 different independent operators (OP) performed sonography on the same animals (E3), chose the best image of ultrasound examinations recorded as a video sequence (E4) and carried out measurements on ultrasound images (E5). In the third study, the technique tested in goats was applied in 10 Holstein cows (E6) and, finally, ultrasound scans were performed at 5 MHz frequency and cutimeter measurements taken in 63 goats (E7).

The following variables were measured in the ultrasound scans: teat wall thickness (TWT), teat wall area (TWA) and teat end area (TEWA). The cutimeter was also used to measure teat wall thickness (TT).

From the results obtained, we observed that frequencies of 5 and 7.5 MHz were the most suitable to estimate the teat wall changes brought about by mechanical milking. Moreover, applying the same methodology and frequencies in Holstein cows, the results achieved were similar to those published in the bibliography and the variables measured (TWT, TWA and TEWA) presented a high and significant correlation ($R=0.62$) with the variable (TT) measured by cutimeter. OP experience had an effect on TEWA before milking in all three experiments (E3–E5) and in TWT, TWA and TEWA after milking in E4 and E5. Despite the effects observed for some variables before and after milking, a significant effect was only found for the difference (after–before milking) in TEWA in E3 and TWT in E4.

The ultrasound technique used can serve as a useful tool to evaluate teat wall thickness changes caused by mechanical milking in goats. Nevertheless, it would be appropriate to carry out another study to develop IT tools to minimise the operator effect in the measurement of ultrasound variables.

1. Introduction

Mechanical milking can cause teat status changes in the short, medium or long term (Mein et al., 2001). Short term changes are related with colour modification, excessive

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http://dx.doi.org/10.1016/j.livsci.2013.04.007

opening of the teat sphincter and variation in the thickness (congestion/oedema) of the walls at the teat base and end (Mein et al., 2003). The importance, extent and persistence of the variation in teat wall thickness will depend on the milking duration and the conditions in which it was carried out (Hamann and Mein, 1990).

It has been found that high positive (greater thickness after than before milking) or negative (lower thickness after than before milking) variations in teat end thickness ($>+5\%$ and $>-5\%$) can be a predisposing factor for intramammary infections (Zecconi et al., 1996), as the efficiency of local defence mechanisms may be affected (Hamann and Osteras, 1994). In goats, Fahr et al. (2001) observed that animals with a somatic cell count (SCC) of over 1 million cells/mL presented a greater teat wall thickness compared to those with a lower SCC when measured with cutimeter both before (5.09 mm vs 4.75 mm) and after milking (5.16 mm vs 4.88 mm).

The non-invasive techniques most widely used in cattle to estimate the changes in teat tissues due to mechanical milking are the cutimeter (Hamann et al., 1996), ultrasonography (Neijenhuis et al., 2001) and infrared thermography (Paulrud et al., 2005). Several authors (Hamann and Mein, 1988; Isaksson and Lind, 1992) have established that, in cows, the cutimeter can be used to determine slight changes in teat and thickness with a high degree of accuracy ($\pm 2\%$) and repeatability ($r=0.99$). The cutimeter has been applied in goats to estimate the variation in teat end thickness due to mechanical milking and study in greater depth its relation with other morphological characteristics of the teat (Skapetas et al., 2008), the effect of milk pipeline height (Manzur et al., 2012) and its relation with udder health status (Fahr et al., 2001). This method, by exerting pressure on the teat, could be estimating oedematisation but might be underestimating the congestion caused by machine milking (Hamann and Mein, 1990).

Sonography is a useful tool to assess the changes in teat tissue (congestion and oedema) due to mechanical milking. The exploration frequencies used in bovine varied from 5 to 8.5 MHz (Ambord and Bruckmaier, 2010; Glesson et al., 2002; Hospes and Seeh, 2000; Klein et al., 2005; Neijenhuis et al., 2001). In goats, frequencies of 5 MHz (Fasulkov et al., 2010) and 10 MHz (Fahr et al., 2001; Ślósarz et al., 2010) have been used to estimate the changes brought about in the teat by machine milking, achieving good repeatability. However, some authors point out that the repeatability of the ultrasound method in cows and goats is related with the practical experience of the operator (Klein et al., 2005), as less ample experience significantly affects the measurements (Ślósarz et al., 2010).

To assess the ultrasound technique as a method for estimating the effect of machine milking on teat thick ness in Murciano-Granadina goats, the following work was carried out with a dual objective: (1) to study the most suitable ultrasound exploration frequency for this breed and the effect of the operator in applying the technique; (2) to validate the approach by comparison with measurements taken by another estimation method (cutimeter) and performing ultrasound examinations in cattle using the same methodology, to determine whether the results obtained were similar to those published by other authors.

2. Materials and methods

2.1. Animals, housing and management

The trials were carried out on 3 farms: the Educational and Research Farm of the Escuela Politécnica Superior de Orihuela (EPSO) at the Miguel Hernández University (UMH); Experimental Farm of the Instituto de Ciencia y Tecnología Animal (ICTA) at the Universidad Politécnica de Valencia (UPV); and a commercial dairy farm located in Orihuela (Alicante province, Spain).

The UMH farm herd consists of 200 Murciano-Granadina breed goats. During experiments, animals were kept in free stall housing, with daytime access to the exercise yards. The farm's reproduction rate was one partum/year. The kids were fed artificially from birth, while the goats were milked mechanically once daily, always in the mornings. The milking parlour was "Casse" type with a quick exit stalls, two platforms of 12 places each and 12 low-line milking units ($1\times12\times12$). The milking machine had electronic milk recorders and teatcups with automatic vacuum shut-off valve and silicon liners (Top Flow Z) (Gea Farm Technologies, Bönen, Germany). The milking parameters used were: rate of 90 pulsations per minute, vacuum level of 40 kPa and a 60% pulsation ratio.

The UPV farm is capable of housing up to 100 Murciano-Granadina breed goats, and during the experiments the animals were stabled in permanent housing conditions. The kids were fed artificially from birth, while the goats were machine milked once daily in the morning. The milking parlour was "Casse" type with quick exit stalls, 2 platforms with 12 places each and six midline milking units ($2\times12\times6$). The milking units consisted of a claw (SG-TF80 ML) with manual shut-off key and the teatcup had automatic shut-off by system valve and rubber liner (Almatic G50, DeLaval International AB, Tumba, Sweden). The milking parameters used were: rate of 90 pulsations per minute, vacuum level of 40 kPa and a 60% pulsation ratio.

On both farms, the machine milking routine for the animals consisted of teatcup placing, mechanical milking and teatcup removal. Finally, after milking teats were immersed in an iodine solution.

The commercial dairy farm had 40 Holstein cows housed in free-stall barn. The milking parlour was herringbone (30°), with 2 platforms, 5 places each and 10 low-line milking units ($2\times5\times10$). The milking unit was composed of a 300 mL clow (Classic 300), stainless steel teatcup and silicon liner (ClassicPro) (Gea Farm Technologies, Bönen, Germany). The milking parameters used were: rate of 60 pulsations per minute, vacuum level of 42 kPa and a 60% pulsation ratio. Premilking routine consisted of washing the teats with warm water and drying with paper towels followed by forestripping. Next, the teatcups were attached then removed after milking with machine stripping. Following teatcup removal, the teats were immersed in iodine solution.