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# Ultrasound evaluation of the mammary gland tissue structure in preparturient heifers

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ABSTRACT

The tissue structure of the mammary gland was examined with an Aloka SSD-500 ultrasound device (Aloka Co., Ltd., Japan). The ultrasound images were binarized and the brightness level was determined on a gray scale. Pixels with brightness values of 0 to 127 were assigned to the adipose tissue, and pixels with brightness values of 128 to 255 were assigned to the secretory tissue. The results were recorded with regard to the percentage of gray area in the total area. Highly significant correlations were found between the percentage of secretory tissue and the milk yield of primiparous cows.

KEY WORDS: heifers, mammary gland, ultrasound device

## INTRODUCTION

Ruberte et al. (1994) used the ultrasound measurement technique to measure the mammary gland in small ruminants. Caja et al. (1999) in sheep and Wójtowski et al. (2002) in goats, showed the usefulness of US technique for measuring milk cisterns. However, there is a shortage of studies on the use of ultrasound for assessing tissue structure of the udder in heifers and for predicting their later productivity on this basis.

The aim of this study was to determine the suitability of the US technique for assessing the mammary gland tissue structure in heifers prior to calving. The method

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involves the estimation of secretory and adipose tissue content of the udder based on US images, which may help to predict the milk yield of primiparous cows.

## MATERIAL AND METHODS

Ultrasound tests were made on 25 Black-and-White (62.5-92.1% HF), 25 Red-and-White (53.5-87.5% HF Red) and 25 Simmental heifers between 15 and 7 days prior to the predicted time of calving. USG measurements were made with an Aloka SSD-500 ultrasound device (Aloka Co., Ltd., Japan), equipped with a 3.5 MHz linear array transducer with a 120 mm field of view. Measurements were taken in a barn in stalls, within 2-3 h of the morning feeding. The lubricated transducer was placed across the front right quarter of the udder, ensuring that the edge of the emission area was at half-height of udder attachment. Ultrasound images were transmitted through a CSS Video Fost Frame Grabler card into a computer and stored in the form of disk files (bitmap). The percentage of secretory and adipose tissue in the parenchyma was measured on previously saved USG images, using Multi Scan® ver. 8.08 software. An area with a portion devoid, as far as possible, of artifacts was delimited in each US image (Figure 1). Using the software, each recorded US image was binarized according to a predetermined level of saturation and the brightness level was determined on a gray scale in the luminance range of 0-255. Pixels with brightness values of 0 to 127 were assigned to adipose tissue (hypoechogenic), and pixels with brightness values of 128 to 255 were assigned to secretory tissue (hyperechogenic) of the udder quarter. In the predetermined image area, the fields of bright and gray images were determined and the percentages of bright and gray areas in the total area were calculated.

Milk performance was evaluated based on maximum production (MP) obtained during the first 100 days of lactation and total milk yield. Milk outputs obtained from each cow were measured daily with TRU-TEST milk meters.

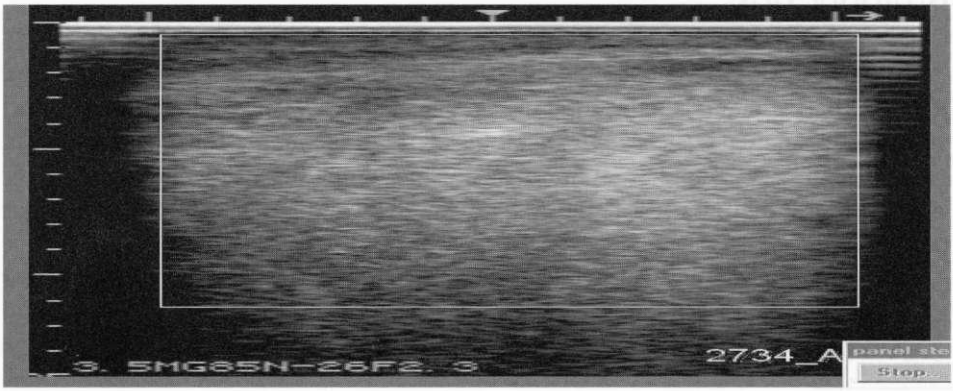


Figure 1. Field of USG image without artefacts

The animals were fed according to IZ-INRA allowances (2001).

Statistical calculations of the production indicators were made with one-way analysis of variance using the GLM procedure of SAS software (1989), while the correlation coefficients between secretory tissue (ST) percentage in the mammary gland and subsequent yield milk (MY) were estimated with the CORR procedure.

## RESULTS

Milk yield was highest in Black-and-White heifers and the lowest in Simmentals (Table 1). Within each breed, animals with a higher milk yield were characterized by a higher ST percentage in the udder quarter tested.

TABLE 1

The udder structure and milk yield of primiparous cows

| Item | Breeds[1] | | | | | |
|---|---|---|---|---|---|---|
| | BW × HF | | RW × HF Red | | Simmental | |
| | level of production | | | | | |
| | lower | higher | lower | higher | lower | higher |
| Reading diagram of udder, mm[2] | 1110.3 | 1042.7 | 1110.2 | 1176.8 | 968.5 | 1106.0 |
| Secretory tissue content, % | 33.73 | 44.53 | 23.90 | 40.43 | 23.00 | 27.11 |
| Fatty tissue content, % | 66.27 | 55.47 | 76.10 | 59.57 | 77.00 | 72.89 |
| Total milk yield, kg | 2637.2 | 2878.4 | 2491.1 | 2720.4 | 1531.3 | 1707.9 |
| MP [2], kg/day | 29.0 | 30.41 | 28.5 | 30.2 | 18.3 | 19.1 |

[1]BW-Black-and-White, RW-Red-and-White, HF-Holstein-Frisien, [2]peak of milk production

The correlation coefficients, estimated for each breed between ST percentage in the tested udder quarter and YPM during the first 100 days of lactation ranged from 0.802 to 0.855 (Table 2).

TABLE 2

Relationship between the secretory tissue content in the udder (ST) and milk yield (MP) in 100-day lactation

| Breed | Secretory tissue content in the udder % | Regression equations Y a + b x | Correlation coefficient r level of statistical significance P≤0.0001 |
|---|---|---|---|
| Black-and-White | 35.89 | MP 2070.5 + 17.13 ST | 0.855 |
| White-and-Red | 31.99 | MP 2090.7 + 15.38 ST | 0.826 |
| Simmental | 24.65 | MP = 911.8 + 28.00 ST | 0.802 |

## DISCUSSION

The obtained US images obtained were not always of good quality, which was mainly due to the behaviour of animals. When a heifer was uneasy and moving

during the tests, the measurement had to be repeated several times to obtain a clear picture suitable for further processing. The higher ST percentage in the right quarter of the heifers mammary gland and their later higher-yielding supports the conclusion that the applied method of assessing the mammary gland structure can be used for predicting the milk yield in primparous cows. This is attested to by the high correlation coefficient between the percentage of ST in the tested quarter of the udder and YM of the primparous. However, the question arises if a heifer's productivity can be predicted from the US measurement of the mammary gland structure of only one udder quarter. Possibly, it might be worthwhile to determine the structure of all udder quarters and the relationship between ST content in each udder quarter and the milk yield of primiparous cows.

## CONCLUSIONS

Ultrasound images allow for assessment of mammary gland tissue structure. The use of the US technique enables noninvasive determination of udder tissue structure and, on this basis, the milk yield of primiparous heifers. The testing technique should be continually improved.

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## STRESZCZENIE

**Ultrasonograficzna ocena struktury tkanki gruczołu mlekowego u jałówek przed wycieleniem a wydajność krów pierwiastek**

Strukturę tkanki gruczołu mlekowego określano przy użyciu ultrasonografu Aloka SSD-500 (CO., Ltd., Japonia). Uzyskane obrazy USG binaryzowano i określano stopień jasności w skali szarości. Założono, że dla tkanki tłuszczowej podporządkowane są te punkty obrazu, których jasność mieści się w zakresie 0-127 pikseli, natomiast dla tkanki wydzielniczej badanej ćwiartki wymienia te punkty obrazu, których jasność mieściła się w zakresie 128-255 pikseli. Wyniki zapisywano uwzględniając procent pola szarego w stosunku do całej powierzchni. Stwierdzono wysoce istotne współzależności między procentową zawartością tkanki wydzielniczej w gruczole mlekowym a wydajnością mleczną krów pierwiastek.