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Monitoring Udder Health

Analysis of Sodium and Potassium Ions in the Milk

The udder health of milk cows is an important economic factor in dairy farming. Early detection of changes in udder health is required to react quickly. In addition to the somatic cell count, the electrical conductivity of the milk is a suitable parameter. Since it is influenced by various factors, such as lactation stage, race and sexual cycle, conductivity is of low diagnostic importance in ascertaining mastitis, as a single indicator. ATB is examining the behaviour of the ions which determine the conductivity (sodium and potassium) more closely. They are being investigated parallel to conductivity in a lactation study, with respect to physiological factors.

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The udder health of high yielding cows has been a central question for scientists since many years. Through the intensive research in this field, essential progress could be attained. Presently there are different parameters for the evaluation of udder health of milk cows by applying milk analysis (*Table 1*). Despite constant improvements in mastitis control this is still second main reason behind sterility for an early drop out of lactating cows. Average herd life of high-yield milk cows is less than 3 years worldwide. Every year farmers have costs amounting from 150 to 200 Euro/cow/year due to cows getting mastitis and this sums up to 0.75 to 1 Milliard €.. These costs reflect the potential of possible savings, which can be attained by increasing the useful herd life time of high yielding cows by means of early mastitis detection methods.

The most important parameter for mastitis control for farmers is still the parameter somatic cell count. A first testing of the udder health is sampled from foremilk. Foremilk samples include first stripes of all 4-udder quarters. The foremilk sample will be proved for changes like cords and flakes. If cords or flakes can be seen, an indirect detection of somatic cells using the Schalmtest will be carried out. This is a test based on bacteriological orientation. The main principle is the developing of gel and cords. A colour change of an added pH-indicator will occur, if the amount of somatic cells increases. Other important efficiency data for cows may be obtained by the farmer from the monthly milk-yield-recording. Adversarial is, that such samples are not quarter differentiated milk samples. Single infected quarters may not be detected since all quarter milk samples are mixed for one composite sample. The healthy quarters would possible cover the infected quarter cell counts. The somatic cell count describes the defence process of the body after infection. Therefore somatic cell counts can not be a useful parameter for an early detecting of udder health changes. The electrical conductivity (EC) is also an udder health parameter. EC is based on the concentrations of the anions and cations in the milk. Most influential are the ions chloride, sodium and potassium, which determine the electrical conductivity by 60% [3,8]. The detection of the disease mastitis is based on ion concentration changes in the milk. If the cow gets infected, the blood-milk-barrier becomes more permeable for some substances (lactose, sodium, potassium). The milk component lactose and the ion component potassium move from the milk towards the blood. The osmotic pressure decreases. Chloride and sodium ions move at the same time from the blood into the milk in order to maintain the osmotic pressure balance. Udder changes are there fore characterised by a change in ion concentrations. This process results in decreased lactose and potassium concentrations and increased sodium concentrations and EC in the milk.

Electrical Conductivity new considered

Before using the parameter conductivity as an udder health parameter there is a lack of information about the behaviour of the single ions (sodium, potassium) and information about their dependency during the lactation period. A literature study at the beginning of the project had the aim to find appropriate basic data. The data should present the basis for the sensor set-up regarding information about the upper and lower thresholds as well as mean ion concentrations. Such thresholds and means should be transferable for all cows races. The results of the literature study showed that different starting points had been used and the data material could not reflect a whole lactation period. Several parts of lactation (oestrus, calving, dry period) and different milk samples (foremilk samples, after foremilk samples and milk samples from all quarters together) were used for the investigations, too. The results showed high variations. Those variations were not acceptable for the presented project so that an own field sampling had to be carried out.

Material und Method

Eight cows of Holstein Friesian race were chosen randomly from a herd of 350 cows for the present investigation. Four of those

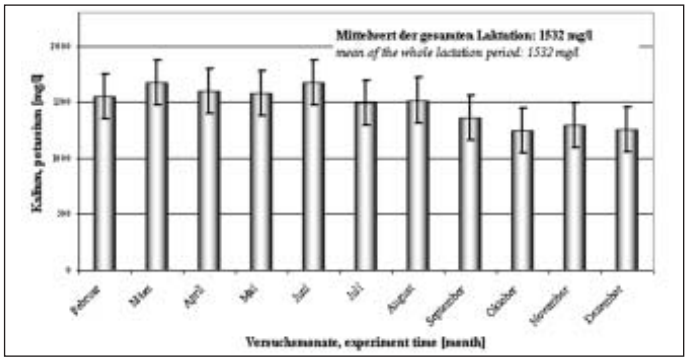

Fig. 1: Mean sodium content in foremilk of all quarters and cows during lactation period

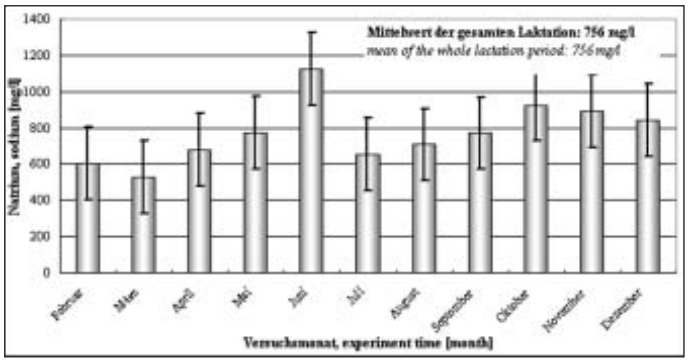

Fig 2: Mean potassium content in foremilk of all quarters and cows during the lactation period

cows were in the first and the other four in the second lactation period. The foremilk samples were taken twice daily over a whole lactation period. 17,000 data sets from eight cows with 32 udder quarters were used for the statistical analysis. The milker identified cords and flakes in the foremilk samples. After the sampling the foremilk samples had to be frozen (-18°C), to make them comparable. For analysis, the samples were thawed and sodium and potassium as well as as EC were measured. Sodium and potassium were analysed with an atomic absorption spectrometer (AAS vario 6, Jena Analytik) and the electrical conductivity with an conductometer WTW (LF, 323/SET). The statistical analysis of the data has been carried out with the statistic program SPSS version 10.0. The effect has been considered with a confidence level of $p < 0.01$. The calculation of the correlation coefficient was done with the two-sites person significant-test.

Results

The results indicate that the ion concentration in the milk is changing with proceeding lactation.

The sodium concentration increases and the potassium concentration decreases.

The average of sodium concentration was 600 mg/l at the beginning of the lactation for all cows and scaled up to an average of 840 mg/l at the end of the lactation. The total mean was found to be 756 mg/l (*Fig. 1*). The percentage increase for all cows during the lactation was 37 %. Without the cows with not diagnosed mastitis, the results for of the statistical calculations was at the beginning of the lactation 558 mg/l and 765 mg/l at the end of the lactation. The percentage increase was 37%, too. The measured values of potassium concentration at the beginning of the lactation were 1563 mg/l and 1282 mg/l at the end of the lactation for all cows. The total mean was found 1532 mg/l with a percentage decrease of 18 % (*Fig. 2*).

By rejecting the data of the cows with not the diagnosed mastitis the average was 1563 mg/l at the beginning of the lactation and 1391 mg/l at the end of the lactation period with a total mean of 1477 mg/l over the whole lactation. The percentage decrease was 11%. The parameter electrical conductivity did not show a constituent trend during the lactation period. The calculated correlation between the electrical conductivity and other parameters (sodium, potassium, sodium : potassium ratio) showed very low coefficients of correlation.

Table 1: Parameters in milk for assessing udder health

Parameter	Healthy	Change trend
Somatic cell count	100000 counts/ml [1],[3]	⇑ > 100000 counts/ml
Chloride	< 1200 mg/l [2]	⇑ > 1200 mg/l
Sodium	< 500 mg/l [2]	⇑ > 500 mg/l
Potassium	> 1400 mg/l [2]	⇓ < 1400 mg/l
Conductivity	4,8 - 6,2 mS/cm (25 °C) [3]	⇑ > 6,5 mS/cm (25 °C)
pH-value	6,5 - 6,8 [6]	⇓< 6,8
Lactose	4,8 - 4,6 % [10]	⇓< 4,6 %
Bacteriological environ mental testing	non pathogen, count per ml ≤ 100000 [1]	⇑ non pathogen, count per ml > 100.000 ⇒ non-specific mastitis pathogen and counts per ml ≤ 100.000 ⇒ latente infection pathogen and counts per ml > 100.000 ⇒ mastitis

Conclusion

The evaluation of the data indicates a typical trend during the lactation period with an increase of sodium by 37% and a decrease of potassium by 18% for the cows without diagnosed mastitis. The parameter electrical conductivity did not have a constituent trend during the lactation period. Thereby the lactation typical trend of an increase for sodium and a decrease for potassium will be overlapped with an additional concentration change in the same direction caused by udder changes due to mastitis. Taking the parameters sodium and potassium into account together with the EC, the EC becomes a more accurate information source and can be applied for early detection of udder changes. The results presented are still first results and can not be generalised yet. Other influencing parameters like ambient temperature or veterinarian treatment have to be considered as well to give a more reliable picture of the process of changing ion concentrations in milk.

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