*Short communication*

# Inline changes in lactate dehydrogenase, milk concentration according to the stage and number of lactation periods, including the status of reproduction and milk yield in dairy cows

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## Summary

The aim of the present study was to investigate inline lactate dehydrogenase (LDH) dynamic changes based on different cow factors – different number and stages of lactation, milk yield, and the status of reproduction in clinically healthy dairy cows.

In the Herd Navigator system, LDH activity levels (μmol/min per litre) were measured using dry-stick technology. A total of 378 cows were selected. According to their reproductive status, the cows were classified as belonging to the following groups: Fresh (1 – 44 days after calving); Open (45 – 65 days after calving); Inseminated (1 – 35 days after insemination); Pregnant (35 – 60 days after insemination and pregnant). According to their productivity, the cows were classified into the following groups: <15 kg/day, 15 – 25 kg/day, 25 – 35 kg/day and >35 kg/day. The cows were milked with a DeLaval milking robot (DeLaval Inc. Tumba Sweden) in combination with a Herd Navigator analyser (Lattec I/S. Hillerød Denmark).

In conclusion inline dynamic changes in the milk LDH concentration may increase together with the rise in the lactation period frequency. The highest LDH level determinated in the group of the fresh cows ranged from 5 to 10 DIM, while the highest LDH concentration level was found in the fresh cow milk. Thus, there was a positive relationship between the milk concentration of LDH and the milk yield.

**Key words:** production, herd navigator, mastitis, health

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Table 1. Lactate dehydrogenase concentration (µmol/min) in milk of cows based on their reproductive stage.

| Statistic | Reproductive stage | | | |
| --- | --- | --- | --- | --- |
| | Fresh | Open | Inseminated | Pregnant |
| n | 43 | 78 | 133 | 124 |
| M | 38.50 | 27.68 | 24.51 | 22.85 |
| SEM | 2.6[a] | 1.939[bc] | 1.485[b] | 1.538[bc] |
| 95% PI | 33.365–43.631 | 23.868–31.491 | 21.591–27.428 | 19.827–25.872 |

[abc] Column means with different superscripts differ significantly at p<0.05. M – mean, SEM – standard of error of the mean. 95% PI – confidence interval.

Table 2. Lactate dehydrogenase concentration (µmol/min) in milk of cows based on their level of productivity.

| Statistic | Productivity (kg/day) | | | |
| --- | --- | --- | --- | --- |
| | <15 | 15–25 | 25–35 | >35 |
| n | 151 | 158 | 138 | 31 |
| M | 26.06 | 22.25 | 29.71 | 31.41 |
| SEM | 2.510[a] | 1.426[ab] | 1.526[ac] | 3.273[ac] |
| 95% PI | 21.122–30.994 | 19.445–25.053 | 26.706–32.707 | 24.973–37.844 |

[abc Column] means with different superscripts differ significantly at p<0.05. M – mean, SEM – standard of error of the mean. 95% PI – confidence interval.

## Introduction

In dairy milk, lactate dehydrogenase (LDH) is correlated with somatic cell count (SCC) (Nyman et al. 2016), and is used as a mastitis indicator in commercial herd management (Friggens et al. 2007). Previous studies have found a strong positive correlation between LDH and SCC (Hiss et al. 2007), and LDH is generally accepted as a useful mastitis indicator. However, the challenge of distinguishing between cows with latent infections and healthy cows based on LDH measurements has been described (Hiss et al. 2007). The variation between cows and their immune response to subclinical mammary infection is a great challenge in the detection of subclinically infected cows through the observation of LDH levels (Jorgensen et al. 2016). According to Nyman et al. (2014), further studies are needed to investigate whether the diagnostic properties of LDH will improve with adjustment according to their relationship with other different cow factors when used as a diagnostic tool for finding cows with mastitis. The aim of the present study was to investigate inline LDH dynamic changes based on different cow factors – different number and stages of lactation, milk yield, and the status of reproduction in clinically healthy dairy cows.

## Materials and Methods

Lattec I/S. Hillerød is the fully automated real-time analyzer Herd Navigator that was applied for the detection of lactate dehydrogenase (LDH). However, it was combined with a DeLaval Inc. Tumba (Sweden - DeLaval milking robot). The milking robot automatically takes a representative several milliliter sample of milk from a cow while milking. In total, 378 cows were chosen for the analysis. The animals were classified in accordance with their reproductive status. Consequently, there appeared to be four groups: fresh (from 1 to 40 days after calving); open (from 45 to 65 days after calving); inseminated (from 1 to 35 days after insemination); pregnant (from 35 to 60 days after insemination and pregnancy).

Another classification was based on the productivity of the selected cows. Hence, the following groups were identified: 1. <15 kg/d., 2. 15 – 25 kg/d., 3. 25 – 35 kg/d., 4. >35 kg/d.

The statistical analysis of data was performed using the SPSS 20.0 program package (SPSS Inc., Chicago, IL, USA). Using the descriptive statistics obtained, normal distributions were assessed for all variables by means of the Kolmogorov-Smirnov test. The differences in the mean values of the normal distributed variables were analysed by the Student's t-test. A probability of less than 0.05 was considered significant (p-value<0.05).
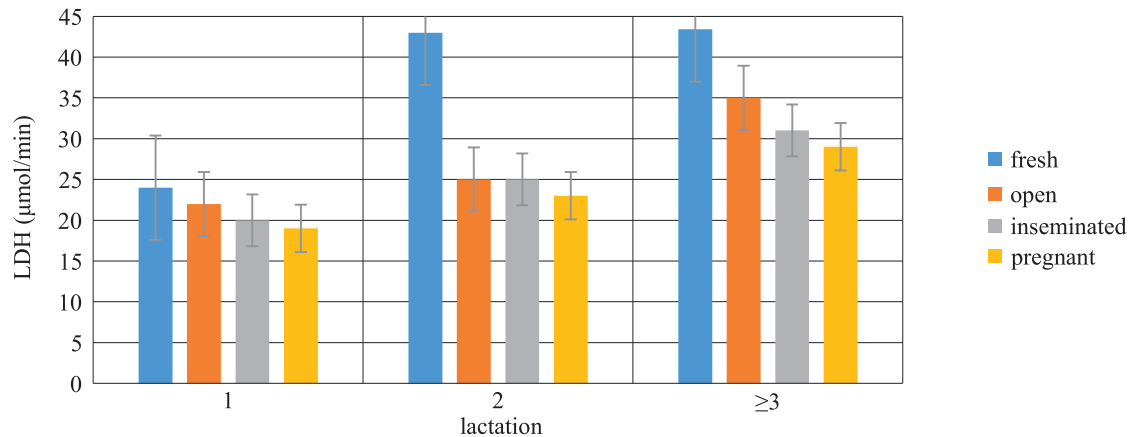
Fig. 1. Lactate dehydrogenase concentration (µmol/min) in milk of cows according to their reproductive stage and lactation.

## Results and Discussion

It was found that the concentration of milk LDH tended to increase alongside the lactation number increase ($y = 6.616x + 13.196$, $R^2 = 0.999$; $P<0.05$). Apart from that, the average concentration of LDH in cows with location ≥3 was higher by 66.93% than during the first lactation, and it was 24.47% higher that in the second one. The LDH level (50.28–57.86 µmol/min) was determined in the cows that belonged to the first group (fresh cows), ranging from 5 days in milk (DIM) to 10.

In addition, the results indicate that there was increase in LDH concentration, ranging from 10 to 60 DIM during lactation (120.96%, $p<0.05$). Further, there was an increase in LDH level from 60 to 110 DIM (60.42%, $p<0.05$) and from 110 to 160 DIM (30.36%, $p<0.05$). Finally, it was found that there was an increase in milk LDH concentration (50.39 %, $P<0.05$) at the end of lactation, ranging from 250 to 305 DIM.

It is worth mentioning that the analysis of the relevant literature indicates that milk enzymes β-glucuronidase and LDH might indicate inflammatory processes. However, the lactation stage and the parity impact on the overall results have to be taken into account during the udder health assessment of dairy goats (Stuhr and Aulrich 2010). The outcomes showed that the highest LDH concentration was in the fresh cow milk, and it was 39.09% higher than in the open cow milk. At the same time, the concentration was 57.08% in the case of the inseminated cows and 68.49% in milk of the pregnant cows ($p<0.05$).

The average LDH concentration characteristics are present in Table 1 and 2. The information is based on the reproductive stages in dairy cows. The LDH concentration comparison in the cow milk shows differences between lactations for all investigated periods considering their reproductive stage ($p<0.05$). Hence, the results indicate that the level of LDH was higher in the group of the fresh cows (Fig. 1). Previous research revealed that the maximum LDH level value in a group of cows during their early periods of lactation compared to the average LDH activity in the blood of the cows during the period of pre-partalnom and during lactation (Krsmanović et al. 2013). In the case of puerperium cows, contributed to the fatty liver degree, hence resulting in dysfunction of organs that are responsible for the hepatocyte enzymes. Therefore, the blood level of LDH and cows' activity experienced a substantial increase. Hence, LDH does not belong to the organ-specific enzymes since it is heavily concentrated in the muscles and such organs as the liver, heart, and kidneys. At the same time, it is released when these organs have acute inflammation. Finally, LDH activities in the blood correlate with the liver fatty infiltration degree (Pechova et al. 2003).

It has been found that the highest LDH concentration (31.41±3.27 µmol/min) was detected in cows with a higher productivity (more than 35 kg), while the lowest (41.17% lower) was found in the animals whose levels of productivity ranged from 15 to 25 kg milk a day ($p<0.05$). Moreover, there is a positive relationship between the cow milk yield and concentration of LDH ($r=0.139$; $p<0.05$). However, the obtained results indicate the highest correlation level between the productivity and LDH in the cows that belonged to the fresh group. At the same time, the lowest correlation coefficient was in the case of the pregnant animals. The analysis of the literature confirms a significant difference in the relationship between LDH and glucose, hence presenting an inverse relationship between lame and healthy cows (Ristevski et al. 2017).

In conclusion inline dynamic changes in the milk LDH concentration may increase together with the rise in the lactation period frequency. The highest LDH level determined in the group of the fresh cows ranged from 5 to 10 DIM, while the highest LDH concentration level was found in the fresh cow milk. Thus, there was

a positive relationship between the milk concentration of LDH and the milk yield.

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