TRACE ELEMENTS IN THE UDDER LYMPH OF HEALTHY AND SICK COWS

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Abstract

The investigation of 15 healthy and 50 ill cows proved, that the concentrations of Se, Cu, Zn, Fe, and Mn were markedly less in the lymph of the udder than in blood. In healthy cows, the following concentrations occurred in the lymph: Se = 0.29 ± 0.11, Zn = 1.66 ± 0.25, Cu = 3.77 ± 0.35, and Fe = 7.80 ± 0.78 µmol/l. These values were only 16 (Zn) up to 50 (Se) per cent of the concentrations in blood. Ill cows showed the following concentrations of trace elements in the lymph: Se = 0.38 ± 0.18, Zn = 1.75 ± 0.17, Cu= 2.98 ± 0.40, and Fe = 7.26 ± 0.64 µmol/l. But only the value of the Cu concentration was significantly less in the lymph than in blood, the Zn and Fe concentrations tended to be low.

Key words: cattle, lymph, trace elements, mastitis, abomasal displacement.

The lymphatic system is composed of lymphoid tissue and transportation pathways of tissue fluid/lymph and lymphoid cells. The system can be divided into peripheral (from the interstitial space to nearest lymph node), and central (effferent lymphatics, cysterna chyli, and thoracic duct).

The main tasks of the lymphatic system are:
– to regulate the tissue fluid volume and chemical composition and transport to blood circulation of macromolecular parenchymal cell products,
– to transport antigens from tissues to lymphoid organs in a soluble form or by immune cells,
– to induce immune reactions to penetrate foreign antigens while maintaining tolerance to self-antigens.

The morphologic and molecular structure and function of the lymphatic system is not yet completely understood. Thus, any observation, however minor, can change our understanding of the role of this system in the body homeostasis (4).

No other organ has so many well organized lymph vessels as the mammary gland of dairy cows. The gland lymph vessels are grouped into subcutaneous -, parenchyma-, and teat vessels (Fig. 1). The subcutaneous lymph vessels (5), draining the supramammary lymph gland, are easily accessible and afferent lymph can be collected from them.

Fig. 1. Udder lymph vessels of a cow (5).

Little is known about the consistency of afferent udder lymph of healthy lactating cows. There is no scientific knowledge about the content of trace elements in the lymphatic system of healthy and ill cows. Therefore, we investigated the concentrations of Se, Fe, Cu, Zn, Mn in blood and lymph serum of healthy and ill cows.

Material and Methods

Blood and lymph serum samples from high yielding dairy Black-and-White German Holstein cows, aged 2-6 years, were analysed. The samples were taken from 15 healthy cows in a commercial farm near Leipzig and from 50 patient cows in large animal clinic for internal medicine in Leipzig during August 2003 and March 2004. The ill animals showed signs of displaced abomasum, mastitis, endometritis/placental retention, and claw diseases.
Table 1
Trace elements in blood and lymph serum from healthy and ill dairy cows

<table>
<thead>
<tr>
<th>Trace element</th>
<th>Blood serum / µmol/l</th>
<th>Lymph serum / µmol/l</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>physiological values</td>
<td>healthy cows</td>
</tr>
<tr>
<td>Se</td>
<td>0.50-0.88</td>
<td>0.86±0.18</td>
</tr>
<tr>
<td>Zn</td>
<td>12-25</td>
<td>10.4±0.50</td>
</tr>
<tr>
<td>Cu</td>
<td>12.5-32.8</td>
<td>15.4±0.90</td>
</tr>
<tr>
<td>Fe</td>
<td>13-33</td>
<td>27.4±2.08</td>
</tr>
<tr>
<td>Mn</td>
<td>&gt;0.36</td>
<td>0.87±0.15</td>
</tr>
</tbody>
</table>

\* a = < 0.05 blood: lymph; \* = < 0.05 healthy: ill.

Table 2
Trace elements in blood and lymph serum of all ill compared with mastitis cows

<table>
<thead>
<tr>
<th>Trace elements</th>
<th>Blood serum / µmol/l</th>
<th>Lymph serum / µmol/l</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>all ill cows</td>
<td>mastitis cows</td>
</tr>
<tr>
<td>Se</td>
<td>0.83±0.21</td>
<td>0.87±0.18</td>
</tr>
<tr>
<td>Zn</td>
<td>9.38±0.61</td>
<td>6.70±3.50</td>
</tr>
<tr>
<td>Cu</td>
<td>16.50±0.66</td>
<td>17.90±5.50</td>
</tr>
<tr>
<td>Fe</td>
<td>24.80±1.61</td>
<td>23.80±10.70</td>
</tr>
<tr>
<td>Mn</td>
<td>0.92±0.10</td>
<td>1.2±0.80</td>
</tr>
</tbody>
</table>

Results

Table 1 summarizes the blood and lymph results of ill and healthy cows in contrast to normal reference values (1). Statistically significant findings are marked in the table with numbers or letters, respectively.

The concentrations of trace elements in blood differ significantly from those in lymph serum; all trace elements have higher values in blood serum. The blood values concur x 2 with the reference values (Table 1).

In general, lymph serum has low trace element concentrations: there are no reference values. The values of the blood are generally higher in comparison to the lymph values: the Se concentrations are exactly 3 - (healthy) and 2 times (ill), Zn concentrations 6 times, Cu concentrations 4 - (healthy) and 5.5 times (ill), and Fe 3.5 times higher than in the lymph. Comparing the test result of healthy and ill animals (Tab. 1), Fe concentrations decreased insignificantly in blood and lymph serum, Zn concentrations only in blood and Cu was significantly decreased in lymph serum. However, Cu and Mn concentrations increase only in blood, but Se and Zn concentrations increase in lymph serum of ill cows. Table 2 summarizes the results that were taken from 9 cows with mastitis and compared with the values of all ill cows.

Discussion

The trace elements Se, Zn, Cu, Fe, and Mn, analysed in our study, have many vital functions in the metabolism, haematopoiesis, immunological processes, but are also important for the general performance, growth, gravidity, and lactation. Until now, no investigations on trace elements in the lymph were undertaken. But also analyses of other components and cells in the lymph are rare.

The lymph can simply be taken from superficial vessels of the udder in lactating cows. The consistency of the udder lymph is representative for the udder tissue itself, but not for the central lymph. The afferent udder lymph of cows regularly contains erythrocytes and the following number of leukocytes: 1.3 ±1.7·10⁹ l⁻¹ in healthy cows and 2.1 ± 19·10⁷ l⁻¹ in cows with mastitis (3).
For the concentrations of metabolites and macro elements it holds true that their concentration in the lymph mainly depends on the protein bond. In contrast, unbound blood metabolites, for example glucose, creatinine or urea, have the same concentration in the lymph. Pure protein content (albumin, globulin) in the lymph it found to be 7-10 times lower (2). Bilirubin and Ca concentrations, for example, occur in 50 per cent less in the lymph than in blood, which correlates to the proportionate protein bond. Similarly, the concentration of trace elements in the lymph seems to depend on the elements bond to the transport protein in the blood, hence only a certain part, 16 (Zn) up to 50 (Se) per cent, of the trace elements is able to pass the blood vessels.

In all ill cows (mastitis, puerperal disorders, claw diseases, abomasal displacement), the concentration of trace elements was neither noticeably changed in the blood, nor in lymph (Table 1). Zn, Cu, and Fe concentrations tend to be reduced in the lymph of ill cows; however x 2 this could only be statistically proven for Cu. Because Cu is important for the immunological processes, this might also be of pathophysiologic value, still this hypothesis needs to be verified in further studies. In cows with mastitis the Fe and Cu concentrations in blood are more decreased compared with ‘all ill cows’ (Table 2). Cows with mastitis have the lowest Fe concentration in the lymph serum.

References