CONCENTRATIONS OF SOME ELEMENTS IN DAIRY COWS WITH REPRODUCTIVE DISORDERS

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Abstract

Serum Ca, P, Mg, Zn, and Cu concentrations in cows affected with reproductive disorders were determined. A possible relation between serum concentrations of these elements and reproductive diseases was evaluated. In total, 109 Holstein cows ageing between 3 and 9 years were investigated. Thirty-six cows showed postpartum anoestrous, fifty-six were repeat breeders, and seventeen cows served as controls. The mean concentration of Ca in cows with repeat breeding was found to be significantly higher (P<0.01) than that in the control and anoestrous group. The P concentration in cows with repeat breeding and anoestrous was significantly lower (P<0.01) than in the control group. The mean Mg concentrations were almost identical for these three groups. Although the levels of Zn and Cu in cows with repeat breeding and anoestrous were lower than in the control group, the variations were not statistically significant. As the aetiology of the reproductive diseases is very broad, even a slight decrease in serum levels of Zn and Cu may induce or predispose animals to repeat breeding and anoestrus. In the light of these findings, the rations of animals with reproductive disorders are recommended to be supplemented with Zn, Cu, and P.

Key words: dairy cow, reproductive disorders, trace elements.

Because of their role in the endocrine system and in tissue integrity, minerals may have a beneficial role to play in the resumption of follicular growth and fertility in dairy cows. Reproductive failure may be induced by deficiencies of single or combined elements and by their imbalances.

Essential trace elements are required for normal growth and development of animals. The nutritional requirements for these elements are small; however, these nutrients can greatly affect reproduction (17). Trace elements are required for the synthesis of many proteins and activation of a vast array of enzyme systems (17). Metalloenzymes, of which essential trace elements are constituents, are important in bone formation (25), lipid metabolism (9, 17), glucose utilisation (21), iron transport (32), DNA synthesis and transport (36), and free radical metabolism (10). Through one or more of these mechanisms, the trace elements may directly affect embryonic and foetal development.

Average dairy herd fertility is declining, with more services per successful conception, extended calving intervals, and increased culling due to repeat breeding, all adding significant costs to milk production (4). Cows failing to conceive after a defined number of inseminations (generally, three or more) with fertile semen have been classified as repeat breeders (2, 3). Postpartum anoestrus is also the single major cause of reproductive failure. Although mostly it is due to unobserved oestrus, it could be also due to failure to exhibit oestrus (all else is normal) and other pathological conditions (13). The repeat breeding and postpartum anoestrus are worldwide major sources of economic losses in dairy herds (2, 3). Both these diseases contribute to lower dairy profit due to wasted semen and insemination costs, increasing intervals to conception, veterinary treatments (including calving induction in seasonal calving areas), increased culling and replacement costs, and loss of genetic gain through the increased generation intervals (2).

It is well known that deficiencies of vitamins and minerals induce or predispose animals to repeat
breeding and anoestrus (6, 8, 12, 13, 19, 20, 22, 27). In the present study, we intended to monitor the serum concentrations of Ca, P, Mg, Fe, Zn, and Cu in dairy cows with repeat breeding and postpartum anoestrus, as well as in healthy animals.

**Material and Methods**

The study was carried out with a Holstein-Friesian dairy herd. The study period started at January 2005 and ended at February 2006. One hundred and nine cows, clinically healthy, aged between 3 and 9 years, and calved at least once, were used in the study. Almost all cows were housed in free-stall barns. The cows were milked twice a day and were fed a total mixed ration three times a day. The average amount of daily feed intake consisted of 9–10 kg of concentrates and 15–18 kg of maize silage per cow. Hay and clover were provided ad libitum. The concentrates were distributed by feed distributing tractors so that each animal received 4.5–5 kg (twice a day). Average 305-d milk production was approximately 7 400 kg per cow. All cows in this study either following parturition or during the postpartum period were examined for retained foetal membranes, body condition score (BCS), reproductive tract status and reproductive disorders. The BCS was measured by the method reported by Ferguson et al. (14). The BCS in the cows ranged from 2.5 to 3.25. The cows with the reproductive disease were divided into subgroups based on repeat breeding and anoestrus. Thirty-six cows showed postpartum anoestrus, fifty-six - were repeat breeders, and seventeen cows were controls.

Blood samples were collected from the jugular vein 3 months after calving. The samples were allowed to stand 2 h at room temperature to allow proper clotting. Then the samples were centrifuged at 5 000 rpm for 10 min and the serum samples were stored at -20°C until analyses. The serum concentrations of Ca, P, Mg, Zn, and Cu were detected using the commercial available kits (Spinreact, Santa Coloma, Spain). The analyses were carried out according to the manufacturer’s instructions.

The statistical analysis of the differences between groups was determined with ANOVA, and the significance of differences with Duncan’s test. The differences versus control group were considered statistically significant when P<0.05. All values were presented as mean ± SEM.

**Results**

The results of average serum Ca, P, Mg, Zn, and Cu concentrations in cows with repeat breeding, postpartum anoestrus, and in the control group have been presented in Table 1. It was determined that the mean serum P concentration in the repeat breeders and anoestrous groups were significantly lower (P<0.01) than in the control group. On the other hand, serum Ca concentrations in the repeat breeders group were significantly higher (P<0.01) than that in the anoestrous and control groups. No significant differences were observed in serum Mg concentration between these groups. The serum Zn and Cu concentrations of the cows with repeat breeding and anoestrus were found lower than in the control group. However, regarding serum Zn and Cu concentrations, there were not statistically significant differences (P>0.05) between healthy and diseased animals.

**Discussion**

Elements such as Ca, P, Zn, Mg, and Cu are essential for the growth and reproduction and are involved in a large number of digestive, physiological, and biosynthetic processes within the body (19, 27, 34). The most obvious function is to be components of body organs and tissues and to provide structural support. In addition, they act as electrolytes, as constituents of body fluids, and as catalysts in both enzyme and hormone systems. Therefore, they fulfill several important functions for the maintenance of animal growth and reproduction as well as the health status (6).

**Table 1**

Mean serum Ca, P, Mg, Fe, Zn, and Cu concentration in the dairy cows with and without repeat breeding and anoestrus

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Anoestrous cows (n=31)</th>
<th>Repeat breeders (n=56)</th>
<th>Control (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca (mg/dL)</td>
<td>8.50 ± 0.85&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.10 ± 0.59&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.45 ± 0.65&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>P (mg/dL)</td>
<td>4.50 ± 0.22&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.19 ± 0.22&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.30 ± 0.23&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mg (mg/dL)</td>
<td>2.20 ± 0.10</td>
<td>2.21 ± 0.10</td>
<td>2.14 ± 0.10</td>
</tr>
<tr>
<td>Zn (mg/L)</td>
<td>0.70 ± 0.06</td>
<td>0.82 ± 0.12</td>
<td>0.87 ± 0.03</td>
</tr>
<tr>
<td>Cu (mg/L)</td>
<td>0.65 ± 0.03</td>
<td>0.59 ± 0.04</td>
<td>0.75 ± 0.06</td>
</tr>
</tbody>
</table>

The difference between the values marked with various letters in the same line is statistically significant (P<0.01).
Zn is an essential trace element found to be an integral component of over 300 metabolic enzymes (11). The element plays a critical role in the repair and maintenance of the uterine lining following calving, speeding the return to normal reproductive function and oestrus. Inadequate Zn levels have been associated with decreased fertility, abnormal oestrus, and abortion (5, 18, 22, 26, 27). Furthermore, Zn is involved in the formation of prostaglandins because Zn enzymes control the arachidonic acid cascade (7, 35, 37). Prostaglandins are required for the maintenance of pregnancy because PGF$_2\alpha$ secretion into the uterine lumen, and away from the uterine vasculature, is increased in pregnant pigs and inhibition of PGF$_2\alpha$ synthesis affects the establishment of pregnancy in mice and swine (23, 24). Thus, Zn may enhance conceptus development through its effects on pregnancy in mice and swine (23, 24). Furthermore, Zn is involved in the synthesis of prostaglandins because Zn enzymes control the arachidonic acid cascade (7, 35, 37). Prostaglandins are required for the maintenance of pregnancy because PGF$_2\alpha$ secretion into the uterine lumen, and away from the uterine vasculature, is increased in pregnant pigs and inhibition of PGF$_2\alpha$ synthesis affects the establishment of pregnancy in mice and swine (23, 24). Thus, Zn may enhance conceptus development through its effects on pregnancy in mice and swine (23, 24).

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The importance of Cu as an essential trace element has been recognised for over 70 years, with the early discovery that Cu was necessary for normal haemoglobin synthesis in young rabbits and rats. Since that time, the importance of Cu for normal growth and production and reproductive performance has been established. The biological role of Cu is exerted through a number of Cu-containing proteins including ceruloplasmin and superoxide dismutase (31). When Cu is inadequate in animals, the physiological and metabolic functions related to Cu-enzymes may be impaired. Common copper deficiency symptoms in cows include delayed or suppressed oestrus, impaired ovarian function, decreased conception, increased incidence of retained placentas, infertility, and early embryonic death (8, 16, 18, 28). In the present study, we detected a slight decrease in serum Cu levels in cows may lead to such problems as abnormal ovarian development, disruption of oestrus cycle, impaired synthesis/secretion of FSH and LH, which can cause reproductive diseases.

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