

# Is diamine oxidase, which is an indicator for disease assessment in diarrheal calves, influenced by the serum copper concentration?

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## Introduction

Diarrhea remains the leading cause of morbidity and mortality in beef calves. Calf diarrhea is problematic because it reduces productivity at the production site.

In the healthy state, the intestinal villi absorb water and glucose, but when the intestinal epithelium is impaired diarrhea develops, and damage to intestinal villi reduces productivity. It is known that diamine oxidase (DAO) is produced by mucosal epithelial cells of the small intestine and is involved in the control of cell proliferation. Therefore, DAO activity has been used as a biomarker of intestinal villi status. However, as DAO is a copper (Cu) -containing enzyme, it may be reduced by copper deficiency. Therefore, the purpose of this study was to investigate the relationship between the serum DAO activity level and Cu concentration in diarrheal calves, and to examine whether DAO can be used to evaluate the pathological condition of diarrhea without being affected by the serum copper concentration. In addition, we examined the sequential changes in serum DAO activity in healthy calves according to the days after birth.

## Materials and Methods

This study investigated the time-course changes in the serum DAO activity in healthy calves at 1 to 21 days after birth, and the relationship between the serum DAO activity and Cu concentration in diarrheal calves. In the former study, blood was collected at 1, 7, 14, and 21 days after birth from 10 healthy Japanese black calves. In the latter study, blood was collected from 67 Japanese cattle with an average age of 11.3 days. Of these cattle, 29 had diarrhea (diarrhea group) and 37 had no abnormalities including diarrhea (control group). The serum DAO activity and Cu concentration were measured by ELISA and particle induced X-ray emission (PIXE) methods, respectively.

The data are expressed as the means  $\pm$  standard deviation. The mean value for each dependent variable was compared by the Tukey method in the former study and by student's t-test or Mann-Whitney U-test in the latter study. The relationships between the serum DAO activity and serum Cu concentrations were evaluated by Spearman's rank correlation coefficient. The significance level was  $p < 0.05$ .

## Results

The relationship between age after birth and DAO significantly varied ( $p < 0.001$ ). The serum DAO activity on the day after birth was the highest at  $388.7 \pm 70.2$  IU/ml, and it stabilized at a low level after the 7th day ( $140.3$ – $180.0$  IU/ml). In contrast, the serum Cu concentration at 1 day after birth was the lowest at  $0.32 \pm 0.03$   $\mu\text{g/ml}$ , as compared with the other days ( $0.50$ – $0.54$   $\mu\text{g/ml}$ ).

Serum DAO and Cu concentrations in healthy calves were  $173.1 \pm 77.8$  IU/ml and  $0.54 \pm 0.15$   $\mu\text{g/ml}$ , respectively. Even if the serum Cu concentration in diarrheal calves ( $0.57 \pm 0.16$   $\mu\text{g/ml}$ ) was not different from that in healthy calves, the serum DAO activity in diarrheal calves was significantly lower than that in healthy calves ( $103.6 \pm 79.8$  IU/ml,  $p < 0.001$ ). The serum DAO activity was not significantly correlated with serum Cu concentration ( $R^2 = 0.001$ ,  $p = 0.38$ ).

## Significance

Our results confirmed that serum DAO activity of diarrheal calves is significantly higher than that of healthy calves without changes in serum copper levels. Therefore, even if Cu is a constituent element for DAO, the results of this study suggested that diarrhea is a factor that significantly decreases the DAO activity level in calves. The decrease in serum DAO activity observed in diarrheal calves was considered to reflect the condition of intestinal villi rather than the effect of serum Cu concentration. In addition, this study showed that the serum DAO activity level is high within 1 week after birth in the calf. Therefore, when serum DAO activity value is used as an index for the evaluation of the pathological condition of calf diarrhea, be sure to consider the age after birth.

In conclusion, serum DAO activity is not influenced by serum Cu concentration, and it is a useful parameter to evaluate the pathological condition due to diarrhea in Japanese black calves.