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# SHORT COMMUNICATIONS

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## Jejunal Mucosal Lactase Activity from Birth to Three Weeks in Conventionally Raised Calves Fed an Electrolyte Solution on Days 5, 6 and 7 Instead of Milk

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### ABSTRACT

The purpose of this study was to evaluate the effect of withdrawal of lactose from the diet for 72 hours on lactase activity in the jejunal mucosa of conventionally raised calves. The descending portion of the duodenum of six Holstein calves < 24 hours old was cannulated. The calves were fed milk except on days 5, 6 and 7 when they were given the same volume of an electrolyte solution. Sequential biopsy specimens of the proximal jejunal mucosa were obtained for three weeks and the lactase activity determined. Lactase activity was highest on day 1 and a trend toward decreased lactase activity from birth until three weeks was observed. Mean lactase activity was significantly ( $p < 0.05$ ) higher for days 1, and 3 compared to days 9, 13 and 17. The withdrawal of milk and replacement by an electrolyte solution during three days had no significant effect on jejunal mucosal lactase activity in neonatal calves.

### RÉSUMÉ

Le but de cette expérience était d'évaluer l'effet d'un retrait du lait

pendant trois jours sur l'activité de l'enzyme lactase chez des veaux naissants élevés de façon conventionnelle. Le duodénum descendant de 6 veaux naissants a été cannulé. Les veaux ont reçu du lait à l'exception des jours 5, 6, et 7 où un volume identique d'une solution d'électrolytes a été donnée oralement en remplacement. L'activité de l'enzyme lactase a été déterminée suite à des biopsies séquentielles de la muqueuse du jéjunum durant trois semaines. L'activité de l'enzyme lactase était à son niveau maximal au jour 1 et une diminution progressive de l'activité de l'enzyme a été observée de la naissance à trois semaines. L'activité de l'enzyme lactase était plus élevée aux jours 1 et 3 comparativement aux jours 9, 13 et 17. Aucun effet significatif de l'activité de l'enzyme lactase a été noté suite au remplacement du lait par une solution d'électrolytes pendant 3 jours chez de jeunes veaux.

### INTRODUCTION

Neonatal diarrhea occurs commonly in calves due to a variety of management conditions and in-

fectious agents (1). The methods of treatment and control of neonatal diarrhea in calves are varied and controversial. Many herdsmen and veterinarians recommend that calves with diarrhea be deprived of milk for 48 to 96 hours and fed a comparable volume of an electrolyte solution (1). The justification for the withdrawal of milk has been the demonstration of decreased lactase activity associated with diarrhea (2,3). Continued feeding of milk could aggravate the diarrhea by providing additional substrate for the pathogenic bacterial growth and/or, by causing higher osmotic pressure within the lumen, increasing the movement of fluids into the intestine.

One rationale for continued milk feedings to calves with diarrhea is that calves fed electrolyte solution may lose their ability to produce lactase. It is thought that newly repopulated epithelial cells may not synthesize normal quantities of lactase if milk is withdrawn from the diet. If this is true, treatment of diarrheic calves should include milk to avoid problems of maldigestion. Additionally, calves receiving commercial electrolyte solution as a replacement for milk are

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This report represents a portion of a thesis submitted by the senior author to the Graduate School as partial fulfillment of the requirements for the MS degree.

Submitted April 10, 1990.

in a negative energy and protein balance as long as these solutions are the only nutrient source (4).

The sequential determination of proximal jejunal mucosal lactase activity from birth to three weeks in conventionally raised calves fed whole milk has been reported previously (5). Lactase activity was highest at day 1 (164 international units [IU]/g of protein) and decreased (31 IU/g of protein) at 3 wk. The purpose of this study was to determine sequentially the proximal jejunal mucosal lactase activity in six conventionally raised calves from birth to three weeks of age fed an electrolyte solution for 72 h on days 5, 6 and 7. This study investigated the effect of withdrawal of lactose from the diet for 72 h on lactase activity in the jejunal mucosa of conventionally raised calves.

## MATERIALS AND METHODS

### CALVES AND SPECIMEN COLLECTION

Six male Holstein calves were acquired from local dairy farms that had a low incidence of neonatal diarrhea and on which *Escherichia coli* bacterins were not used for the adult herd. All calves were obtained within 24 h after birth and were fed colostrum (5% of the body weight at birth). Cannulation of the descending portion of the duodenum was performed before calves were 24 h old using a technique previously described (5). Biopsy specimens of the proximal jejunal mucosa were obtained by passing an alligator type biopsy instrument (Olympus FB 15K, Olympus Corp, Medical Instrument Division, Strongsville, Ohio) through the cannula. The distance from the cannula to the proximal portion of the jejunum was determined at surgery. Jejunal biopsy was performed every other day for 3 wk with the exception of daily biopsy on days 5, 6 and 7. Each calf was housed in an individual pen without restraint. The calves were fed whole milk at 10% of their body weight divided between two feedings except on days 5, 6 and 7, when they were given an equal volume of an electrolyte solution (Biolyte, Upjohn Company, Kalamazoo, Michigan).

Hay, concentrates and water were available at all times. Digestive contents of each calf for viral and bacterial detection were aspirated via the cannula at day 7. Calves were observed for evidence of systemic disease, soft stool or diarrhea. The experiment followed the guidelines of the Guide to the Care and Use of Experimental Animals of the Canadian Council on Animal Care.

### LACTASE ASSAY

Jejunal mucosa biopsy specimens were sealed in aluminum foil and were frozen using liquid nitrogen (-195°C). Specimens were then stored at -20°C until analyzed. Frozen mucosal specimens were thawed and homogenized, and lactase activity was determined by the method of Dahlqvist (6). Protein content of mucosal specimens was determined using a dye-binding assay (Bio-Rad Protein Assay, Bio-Rad Chemical Division, Richmond, California) with bovine albumin as a standard. Lactase enzyme activity was expressed as IU per g of protein. One

IU represents 1  $\mu$ mol of lactose hydrolyzed/min at 37°C. The lactase activities in six control calves which were fed milk continuously over the same period have been published previously (5).

### DATA ANALYSIS

Because variances were not equal, data were transformed to a logarithmic basis prior to statistical analysis. Data were analyzed using computer assisted (General linear model procedure, Statistical Analysis Systems, Cary, North Carolina) analysis of variance. The Tukey studentized procedure was used to determine differences over time. A value of  $p < 0.05$  was considered significant.

## RESULTS

Lactase activity was highest at day 1 and decreased with age (Fig. 1). Mean lactase activity was significantly higher for days 1 and 3, compared with that on days 9, 13 and 17. Mean lactase activity was not significantly different

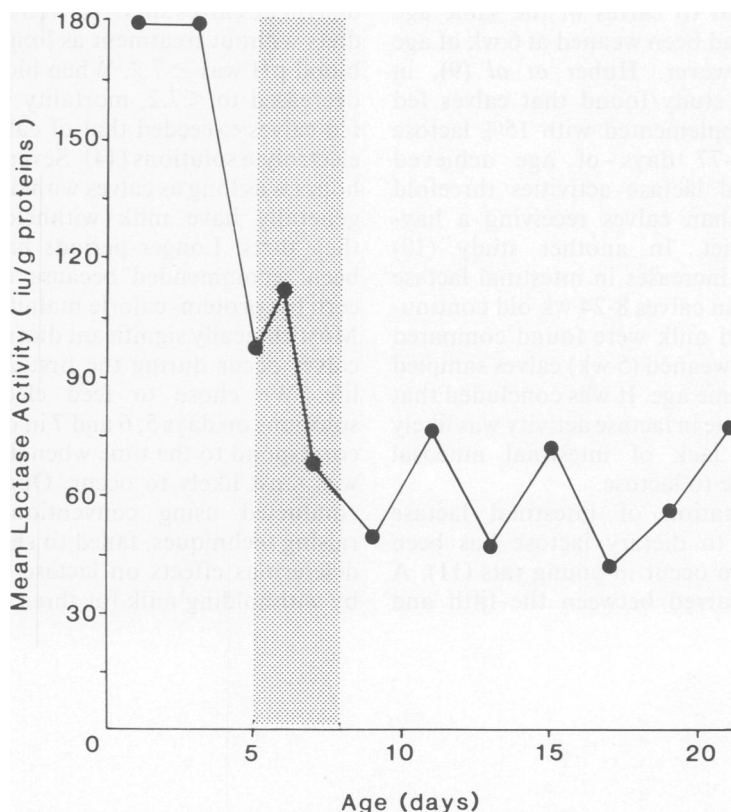


Fig. 1. Mean jejunal mucosal lactase activity of six calves from birth to three weeks of age fed an electrolyte solution on days 5, 6 and 7 (dotted area) instead of milk.

from that in the control calves which were fed milk continuously (5). Calf 1 had soft stool from days 5 to 10. Calf 2 had soft stool for days 4 to 6. Rotavirus and coronavirus were isolated from calves 1 and 6. All calves maintained normal appetite and diarrhea was not observed during the study.

## DISCUSSION

Our results indicate that withdrawal of milk and replacement by an oral electrolyte solution during days 5, 6 and 7 in conventionally raised neonatal calves exerted no significant effect on lactase activity. Perhaps the difference in the quantity of lactose in the diet and/or the period of adaptation were insufficient to induce changes in lactase activity.

Huber (7), feeding calves either whole milk plus 3% lactose or whole milk plus 2.5% sucrose and 0.5% corn starch, was unable to show any change in lactase activity up to 44 days of age. Siddons also found no marked difference in lactase activity in four month old calves fed only milk compared to calves of the same age which had been weaned at 6 wk of age (8). However, Huber *et al* (9), in another study found that calves fed milk supplemented with 15% lactose from 3-77 days of age achieved intestinal lactase activities threefold higher than calves receiving a hay-grain diet. In another study (10) marked increases in intestinal lactase activity in calves 8-24 wk old continuously fed milk were found compared to early weaned (5 wk) calves sampled at the same age. It was concluded that the decline in lactase activity was likely due to lack of intestinal mucosal exposure to lactose.

Adaptation of intestinal lactase activity to dietary lactose has been shown to occur in young rats (11). A rise occurred between the fifth and

tenth week of exposure to the lactose-containing diet. It has been suggested that feeding lactose may either increase the production of lactase or decrease the rate of breakdown of the enzyme (12). Withdrawal of lactose from the diet of young rats for 8 wk was accompanied by a decline in lactase activity (11).

The isolation of both rotavirus and coronavirus in calves 1 and 6 is not unusual because the prevalence of these viruses is high in the clinically normal bovine population (13). In our study mortality and diarrhea were not associated with the viruses isolated.

Neonatal calves have minimal fat reserves which can be depleted in seven days by feeding only electrolyte solutions (4). Death from starvation occurs when fat stores have been depleted (1). No one has determined how long a calf with diarrhea can survive being fed only electrolyte solutions. Radostits (1), in a trial conducted on calves with undifferentiated diarrhea, was unable to show any benefit from withholding milk from the diet of affected calves, yet this is still a recommended practice. Booth and Naylor (14) also found that diarrhetic calves survived well on milk diets without treatment as long as the blood pH was  $\geq 7.2$ . When blood pH decreased to  $< 7.2$ , mortality in milk fed calves exceeded that of calves fed electrolyte solutions (14). Seventy-two hours is as long as calves with diarrhea generally have milk withheld from their diets. Longer periods have not been recommended because of concern for protein/calorie malnutrition. Most clinically significant diarrheas in calves occur during the first 2 wk of life. We chose to feed electrolyte solutions on days 5, 6 and 7 in order to correspond to the time when diarrhea was most likely to occur. Our study, conducted using conventional calf raising techniques, failed to show any deleterious effects on lactase activity by withholding milk for three days.

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