

# Efficacy of dried colostrum powders in the prevention of diarrhea in neonatal Holstein calves

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**Abstract** One hundred and twenty healthy Holstein calves were assigned randomly at birth to one of four groups; each group contained 30 calves and the calves were received as follows: group A, 85±5 g of lyophilized colostrum powder dissolved in 3 kg of whole milk; group B, 85±5 g of spray-dried colostrum powder dissolved in 3 kg of whole milk; group C, 750 ml frozen and thawed colostrum in 3 kg of whole milk, and group D, only 3 kg of whole milk without colostrum supplement. Each group was subdivided into 3 sub-groups of 10 calves as follows: calves fed colostrum supplement at 24 or 48 or 72 h after birth. All calves fed fresh colostrum within 6 h after birth at the amount of 5% of BW by bottle. Calves which were fed lyophilized colostrum supplement had a significant lower incidence of diarrhea in comparison to control calves. In addition, calves were received lyophilized colostrum supplement at 24 h after birth showed less incidence of diarrhea than calves fed

the supplement at 48 and 72 h. According to the results of present study providing lyophilized colostrum supplement at 24 h after birth might have been preventive effect on calf diarrhea. The spray-dried colostrum supplement had not the same effect.

**Keywords** Calf · Diarrhea · Colostrum · Lyophilized · Spray-dried

## Introduction

Transfer of passive immunity in newborn calves occurs through the oral consumption and subsequent absorption of immunoglobulin (Ig) soon after birth (Bush and Staley 1980). Prevalence of failure of passive transfer (FPT) in calves has been reported to range from 11 to 31% in North America (Perino 1997). Klaus et al. (1969) reported that 30% of calves that consumed colostrum remained hypogammaglobulinemic. A recent survey by the USDA reported that 41% of 2,177 calves sampled between 24 and 48 h of age failed to attain serum IgG concentrations of or above 210 g/l (Center for Animal Health Monitoring 1993).

The relationship between neonatal morbidity or mortality and FPT of Ig has been demonstrated in numerous epidemiological studies (Boyd 1972; Davidson et al. 1981; Naylor et al. 1977).

The interval after birth to colostrum consumption and Ig concentration of colostrum bears the greatest influence on subsequent attainment of passive immunity in newborn calves (Arthington et al. 2000).

Many attempts have been made to artificially augment the ability of calves to attain passive immune support, such

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as stored surplus colostrum (Foley and Otterby 1978), injectable Ig solutions (Quigley and Welborn 1996), dried colostrum (Morin et al. 1997; Garry et al. 1996), and concentrated milk whey (Mee et al. 1996). However, none of these methods have proven to provide adequate passive immune support.

The purpose of this study was to test the value of lyophilized and spray-dried colostrum as a colostrum supplement on the incidence of neonatal calf diarrhea.

## Materials and methods

The study was carried out in a commercial dairy farm in the south of Tehran. The herd had a recent history of neonatal calf diarrhea. One hundred and twenty first-milking colostrum samples were collected in plastic containers from cows that have just given birth. The samples were immediately frozen at  $-20^{\circ}\text{C}$ . To select high-tittered colostrum against *Escherichia coli* K<sub>99</sub>, rotavirus, and corona virus, competitive ELISA test was done using an ELISA diagnostic kit (Biox, Belgium).

Colostrum lyophilization was performed using Epsilon-1-12D apparatus (Martin Christ, Germany). Freezing time of the samples was 4 h at  $-30^{\circ}\text{C}$ . The required time for vacuuming samples was 19 h at a negative pressure of 1.03 mbar.

Spray-drying of colostrum was performed using Mini spray-dryer-B-191 (Buchi, Switzerland). The maximum applied temperature was  $50^{\circ}\text{C}$  and the pressure was 5–8 mbar. The required time for powdering 1 l of colostrum was 5 h.

One hundred and twenty healthy Holstein calves were assigned randomly at birth to one of four groups; each group contained 30 calves as follows: group A,  $85\pm 5$  g of lyophilized colostrum powder dissolved in 3 kg of whole milk; group B,  $85\pm 5$  g of spray-dried colostrum powder dissolved in 3 kg of whole milk; group C, 750 ml frozen and thawed colostrum in 3 kg of whole milk; and group D, only 3 kg of whole milk without colostrum supplement. Each group was subdivided into three subgroups of ten calves as follows: calves fed with colostrum supplement at 24, 48, or 72 h after birth. Mean $\pm$ SD body weight (BW) of calves at birth was  $42.45\pm 9.75$ . All calves were fed fresh colostrum, 5% of BW by bottle, within 6 h of birth. They were separated from dams immediately after receiving first colostrum and were kept in individual calf pens. Alfalfa hay and concentrates were added to daily feeding at 14 days after birth.

The incidence of diarrhea, consistency of feces, and concurrent disease with diarrhea was evaluated through the first 30 days after birth. In addition, weight of calves at the age of 1 month was measured.

Statistical analysis was done with ANOVA, independent Student's *t* test, and Chi-square test (SPSS for Windows). A *p* values less than 0.05 was considered as significant.

## Results

All the colostrum samples (100%) had antibodies against rotavirus, 111 samples (92.5%) against corona virus, and 7 samples (5.8%) against *E. coli* K<sub>99</sub>.

Only one diarrheic calf from the control group died throughout the study. Calves that were fed lyophilized colostrum supplement had a significantly lower incidence of diarrhea in comparison to control calves (Table 1). In addition, calves that received lyophilized colostrum supplement at 24 h after birth showed less incidence of diarrhea than calves fed with the supplement at 48 and 72 h (Table 2). Calves were classified into four groups related to the interval of birth and diarrhea occurrence: 1–7, 8–14, 15–21, and 22–30 days. On the basis of the interval of birth and diarrhea incidence, there was no significant difference between the colostrum-type groups (Table 3).

There was no significant difference between groups on the basis of body weight at birth or at 30 days after birth (Table 4).

## Discussion

In spite of high diarrhea morbidity rate in this herd, only one calf died throughout the study. It seems that colostrum ingestion within 6 h of birth affected the mortality due to diarrhea rather than morbidity. On the other hand, failure of passive transfer of immunity is only one of the factors determining disease occurrence. Population density, general sanitation (Paré et al. 1993; Larson et al. 1998), and dam vaccination status (Radostits and Acres 1983; Perino 1997) are management factors to consider when investigating morbidity in newborn calves.

**Table 1** Relative and absolute frequency of diarrhea in calves fed with three types of colostrum supplement and control groups

Colostrum supplement type	Diarrhea		Non-diarrhea		Treatment vs control
	No.	%	No.	%	
Spray-dried	16	23.2	14	27.5	NS
Lyophilized	13	18.8	17	33.3	S**
Frozen and thawed	18	26.1	12	23.5	NS
Control	22	31.9	8	15.7	
Total	69		51		

S Significant, NS nonsignificant

\*\**p*<0.01

**Table 2** Relative and absolute frequency of diarrhea in calves fed with three types of colostrum supplement and control groups at different times (24, 48, and 72 h after birth)

Colostrum supplement type	Diarrhea incidence	24h	48h	72h
Spray-dried	Diarrhea	7	4	6
	Non-diarrhea	3	6	4
Lyophilized <sup>a</sup>	Diarrhea	2	5	6
	Non-diarrhea	8	5	4
Frozen and thawed	Diarrhea	6	5	7
	Non-diarrhea	4	5	3
Control	Diarrhea	8	8	6
	Non-diarrhea	2	2	4
Total	Diarrhea	22	22	25
	Non-diarrhea	18	18	15

<sup>a</sup> Calves fed with lyophilized colostrum supplement had a significant ( $p < 0.01$ ) decrease of diarrhea incidence in comparison with control calves.

The calves that received lyophilized colostrum supplement had a lower incidence of diarrhea in comparison with control group. There were no significant differences among the four groups for BW gain or the interval from birth to diarrhea occurrence.

Previous researches have indicated that colostrum supplements derived from milk are less effective than maternal colostrum in providing adequate passive immune support in neonatal calves (Zaremba et al. 1993; Garry et al. 1996; Mee et al. 1996; Morin et al. 1997). This is often attributed to the low concentration of IgG offered in most commercial supplements and poor absorption kinetics (Haines et al. 1990). Zaremba et al. (1993) showed that administration of 85 g of dried colostrum powder did not lead to significantly higher IgG concentrations 24 h after birth than administration of 3 kg of colostrum. Morbidity and mortality rates were not significantly different among

**Table 4** Comparison of body weight (kilograms) at birth and 30 days after birth in four groups of calves on the basis of colostrum type supplement

	Colostrum supplement type	Mean	SD	
BW at birth	Spray-dried	43.63	4.88	NS
	Lyophilized	42.55	6.43	
	Frozen and thawed	41.20	6.26	
BW at 30 days	Control	42.41	6.25	NS
	Spray-dried	45.85	4.65	
	Lyophilized	45.31	6.31	
	Frozen and thawed	45.15	4.67	
	Control	44.81	5.45	

NS Nonsignificant

groups. However, the first group of calves that were fed with colostrum supplement alone did not receive fresh colostrum after birth in the study of Zaremba et al. (1993). This is contrary to our study in which all calves were fed with fresh milk within 6 h of birth, and dried colostrum was used as a supplementary feeding at least 24 h after birth.

Fresh maternal colostrum feeding at the early hours after birth is not replaceable with other forms of processed or dried colostrum in providing efficient passive immunity (Zaremba et al. 1993; Morin et al. 1997). However, according to the results of the present study, providing lyophilized colostrum supplement at 24 h after birth might have exerted a preventive effect on calf diarrhea. The spray-dried colostrum supplement did not have the same effect. The reason for this is not clear, but it is possible that immunoglobulin may be degraded by spray drying method.

The major criticism of this study was the inability to measure IgG levels of the calves on the day of birth and at 30 days of age. Further research is needed to determine any relationship between lyophilized colostrum supplement feeding and IgG and solids in the supplement and IgG absorption.

**Table 3** Comparing the different age groups of calves on the basis of time of diarrhea incidence

Colostrum supplement type	Age of calves at diarrhea incidence <sup>a</sup>							
	1–7 days		8–14 days		15–21 days		22–30 days	
	No.	%	No.	%	No.	%	No.	%
Spray-dried	3	18.8	12	30.8	2	15.4	0	0
Lyophilized	3	18.8	6	15.4	4	30.8	0	0
Frozen and thawed	4	25	10	25.6	4	30.8	0	0
Control	6	37.5	11	28.2	3	23.1	1	100
Total	16	100	39	100	13	100	1	100

<sup>a</sup> Nonsignificant

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