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SHORT COMMUNICATION

Effects of Addition of Vitamin E to Colostrum on Serum α-Tocopherol and Immunoglobulin Concentrations in Neonatal Calves

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Holstein calves (n = 45) were used to evaluate the effects of the addition of vitamin E (0, 100 or 1000 IU) to colostrum on absorption of α-tocopherol and immunoglobulin in neonatal calves. Colostrum (2 l) was fed to calves as soon as possible after birth and 12 h later. The mean colostral α-tocopherol concentration was 2.9 μg ml^{-1} (SE = 0.4). The cows were not given vitamin E supplements prior to parturition. Increasing supplementation of α-tocopherol increased serum α-tocopherol at 12, 24 and 48 h after birth. Addition of 1000 IU at the first calf feeding caused maximal serum α-tocopherol concentrations by 12 h (2.12 μg ml^{-1}); no increase in serum α-tocopherol was observed thereafter. Serum IgG at 12 and 24 h tended to be lower when 100 IU of vitamin E were added; serum IgM was unaffected by treatment. No effects were observed on body weight gain, intake, feed efficiency or scours from birth up to 35 days of age. Under the conditions of this study, addition of vitamin E increased the absorption of α-tocopherol, but did not affect the absorption of immunglobulins.

Keywords: *Immunoglobulins, colostrum, vitamin E, calves*

INTRODUCTION

Placental transfer of α-tocopherol in dairy cattle is limited (Van Saun *et al.*, 1989). Consequently, calves are born with limited reserves of α-tocopherol. Colostrum contains large amounts of vitamin E and is the primary source of this substance for neonatal calves (Stowe *et al.*, 1988; Weiss *et al.*, 1990; Mahan, 1991; Mechor *et al.*, 1992). Inadequate consumption of colostrum or low colostral α-tocopherol concentration may prolong vitamin E deficiency and influence immunoglobulin absorption.

The objectives of this study were to measure colostral α-tocopherol concentrations and determine whether supplementation of colostrum with vitamin E would affect α-tocopherol or immunoglobulin absorption in calves.

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MATERIALS AND METHODS

Holstein calves ($n = 45$) were assigned randomly at birth to treatment in a completely randomized experimental design. Vitamin E was added in concentrations of 0, 100 or 1000 IU to maternal colostrum and was fed as soon as possible after birth and 12 h thereafter.

Cows were grazed on mixed grass pasture (fescue and bermudagrass) prior to parturition, and were not supplemented with vitamin E. Colostrum was collected from the dam as soon as possible after parturition. A 50-ml sample was frozen ($-20°C$) prior to the analysis of IgG and IgM by single radial immunodiffusion (VMRD, Pullman, WA, USA), vitamin E and total protein analysis (Sigma total protein kit, Sigma Chemical Co., St Louis, MO, USA). Vitamin E was assayed by the method of Hidiroglou (1989), except that hexane and isopropanol were substituted for heptane and absolute ethanol respectively.

Calves were fed as soon as possible after birth and 12 h later. The mean age at the first feeding was 1.9 h (SE = 0.1). On days 2 and 3, calves were fed transition milk from the dam on an a.m./p.m. schedule. Commercial milk replacer and calf starter were fed from days 3 to 35. Water was available at all times.

Calves were weighed at birth and weekly thereafter up to day 35. Incidence of scours and fecal consistency was scored at the a.m. feeding by the method of Larson *et al.* (1977). Approximately 10 ml of jugular blood was collected immediately prior to the first feeding and 12, 24 and 48 h thereafter. Serum was separated by centrifugation ($3000 \times g$) and analyzed for IgG, IgM, vitamin E and total protein.

Data were analyzed by analysis of covariance as a randomized complete block experimental design. The body weight at birth and intake of IgG and vitamin E were used as covariables in analyses.

RESULTS AND DISCUSSION

The mean colostral α-tocopherol concentration was 2.9 $\mu g\ ml^{-1}$ (SE = 0.4), and ranged from 0.5 to 12.1 $\mu g\ ml^{-1}$. This is somewhat higher than the 1.9 $\mu g\ ml^{-1}$ in colostrum reported by Hidiroglou (1989), but lower than values reported by others (Weiss *et al.*, 1990; Mechor *et al.*, 1992). Weiss *et al.* (1990) suggested that differences in methodology may account for some differences in means.

The mean consumption of colostrum at the first two feedings was 1.7 and 2.4 l (SE = 0.1) respectively. Therefore, the mean intake of IgG in the first 24 h after birth was 277 g (SE = 115). The calves consumed 1.6–33.9 mg of α-tocopherol from colostrum (mean = 10.9 mg; SE = 6.8). The addition of 100 or 1000 IU of vitamin E in each of two feedings increased the vitamin content of colostrum by approximately 10 and 100 times respectively.

The mean serum α-tocopherol concentration prior to colostral consumption was 0.1 $\mu g\ ml^{-1}$ (SE = 0.01), and ranged from 0.0 to 0.2 $\mu g\ ml^{-1}$. The minimal concentration of α-tocopherol in calves prior to colostral consumption has been documented (Cipriano *et al.*, 1982; Stowe *et al.*, 1988). Addition of 100 or 1000 IU of vitamin E at each of the first two feedings increased serum α-tocopherol linearly (Table 1), such that serum concentrations were 4.7 and 10.9 times higher than concentrations in calves on the control treatment respectively. At each time period, addition of α-tocopherol increased serum α-tocopherol linearly with increasing supplementation. When calves were fed 0 or 100 IU of supplemental vitamin E, serum α-tocopherol peaked at 24 h after birth, then declined to 48 h. When calves were fed 1000 IU of vitamin E, there was no change in serum α-tocopherol levels after 12 h (Table 1), suggesting that addition of 1000 IU of supplemental vitamin E maximized serum α-tocopherol concentration by 12 h after birth. Addition of a second feeding of vitamin E had no effect on serum α-tocopherol concentration.

Addition of vitamin E appeared to influence absorption of IgG and total protein at 12 and

TABLE 1. Least squares means of serum immunoglobulin, α-tocopherol and total protein in calves fed 2 l of colostrum with or without supplemental vitamin E

Item and concentration at particular times after birth	Vitamin E added (IU)[a]			SE	Contrasts[b]	
	0	100	1000		L	Q
Serum IgG ($g\ l^{-1}$)						
12 h	20.8	14.8	17.2	2.4	NS[c]	[d]
24 h	29.5	21.4	26.3	2.8	NS	[e]
48 h	26.1	23.8	22.4	3.5	NS	NS
Serum IgM ($g\ l^{-1}$)						
12 h	1.4	1.4	1.5	0.2	NS[c]	NS
24 h	1.7	1.7	1.7	0.2	NS	NS
48 h	1.5	1.4	1.5	0.2	NS	NS
Serum α-tocopherol ($\mu g\ ml^{-1}$)						
12 h	0.17	0.56	2.12	0.23	[f]	NS
24 h	0.38	0.84	2.02	0.21	[f]	NS
48 h	0.24	0.71	2.09	0.14	[f]	NS
Serum protein ($g\ l^{-1}$)						
12 h	59.4	53.6	57.1	2.1	NS	[d]
24 h	65.7	60.2	66.1	2.7	NS	NS
48 h	65.7	60.7	61.5	2.5	NS	NS

[a]Treatments: 0, 100 or 1000 IU of vitamin E were added to 2 l of colostrum at the first two feedings after birth.
[b]Contrasts: L = the linear effect of added vitamin E; Q = the quadratic effect of added vitamin E.
[c]$P > 0.10$.
[d]$P < 0.10$.
[e]$P < 0.05$.
[f]$P < 0.001$.

24 h after birth, although the effect appeared greatest when 100 IU of vitamin E were fed (Table 1). The significance of this observation is not clear. Serum concentrations of IgM were unaffected by vitamin E supplementation.

Vitamin E supplementation had no effect on the intake of milk replacer or calf starter, body weight gain, incidence or severity of scours or feed efficiency in this study. Others (Reddy *et al.*, 1987a) have reported improved growth in calves when vitamin E was supplemented continuously or periodically.

CONCLUSIONS

Mahan (1991) suggested that the biological importance of placental transfer of α-tocopherol is dependent upon adequate consumption and absorption of colostral α-tocopherol. The data obtained in this study suggest that α-tocopherol reserves are low in neonatal calves, and that inadequate colostral intake or low colostral α-tocopherol concentration will prolong α-tocopherol deficiency. The importance of α-tocopherol in the proper functioning of the immune system of calves has been well established (Cipriano *et al.*, 1982; Reddy *et al.*, 1985; 1986; 1987a, b; Eicher-Pruiett *et al.*, 1992). Therefore, addition of α-tocopherol to colostrum may be an alternative method of vitamin E supplementation.

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