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Effect of oral α-tocopherol and zinc on plasma status, IGF-I levels, weight gain and immune response in young calves

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ABSTRACT

Thirty newborn calves were supplemented with α-tocopherol (vit. E) (n=10), zinc (Zn) (n=10) or nothing (control) (n=10) for 8 weeks. All calves were vaccinated against tetanus at week 5. Plasma Zn and α-tocopherol were significantly increased in the Zn and vit. E groups, respectively. Plasma IGF-I levels generally increased from birth to week 8, but were not affected by Zn or vit. E. Daily weight gain was highest in the Zn group, but this was not related to an increased IGF-I level. The vit. E group responded earlier than the Zn and control groups to the tetanus vaccination.

KEY WORDS: calves, α-tocopherol, zinc, immune response, growth, IGF-I

INTRODUCTION

Calves are born with low or moderate levels of zinc (Zn) and without detectable level of vitamin E (α-tocopherol) in plasma and tissues. However, vitamin E and Zn play an important role in development and maturation of the immune system. Furthermore Zn is important in order to maintain normal growth and organ development (Shankar and Prasad, 1998; Underwood and Suttle, 1999; Hatfield et al., 2002). The Zn and α-tocopherol (vit. E) contents of whole milk are often below the recommended level of 40 mg and 50 IU per kg dry matter (DM), respectively (NRC,

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2001). Early signs of Zn deficiency are reduced feed intake and growth. In piglets serum IGF-I (Insulin-like Growth Factor I), feed intake and weight gain increased with increasing dietary Zn (Carlson et al., 2004).

The objectives of the present experiment were to study the effect of supplementary Zn and α-tocopherol on plasma levels, growth rate, feed intake, IGF-I and immune response in young calves.

MATERIAL AND METHODS

Thirty newborn Holstein calves were randomly allocated in three experimental groups: control, vit. E and Zn, for an experimental period of 8 weeks. All calves were given colostrum (2×3 L per day) the first three days of life. From day four the basal diet was whole milk, 2×3 L per day until day 14, and thereafter 2×4 L per day. All calves had free access to water and hay. Starter was allocated *ad libitum* up to max 0.5 kg per day. From day four, calves in the vit. E group were supplemented with 2×250 IU α-tocopherol (Natur E Micelle, Pharmalett) in the milk per day, whereas the Zn group was supplemented with 0.35 mM Zn in the milk (180 mg Zn per kg milk DM as $ZnSO_4$). At day 35 all calves were vaccinated against tetanus (Equilis Tetanusvaccine Vet. Intervet).

Individual feed intake and weight gain was registered. Plasma IGF-I, α-tocopherol, Zn levels and anti-tetanus antitoxin antibodies levels in serum were measured during the experimental period (DEFT, 1971; Frystyk et al., 1995; Kristiansen et al., 1997; Jensen et al., 1999). The effect of treatment on weight gain and plasma levels of Zn, α-tocopherol and IGF-I were analysed using General Linear Models Procedure (SAS Institute Inc., 1999). The effect of treatment on antibodies was analysed by GraphPad Prism 4.00 software.

RESULTS AND DISCUSSION

Two calves were discarded from the dataset due to general and unspecified poor growth. The natural content of α-tocopherol in milk and starter was 0.74 and 102 mg per kg feed, respectively. The natural content of Zn in milk and starter was 29 and 77 mg per kg feed DM, respectively. Table 1 shows that plasma Zn was at a normal to high level in the control group (Underwood and Suttle, 1999; NRC, 2001), but was increased to a significantly higher level in the Zn group. Plasma α-tocopherol was at a low level in the control group, but was increased to a significantly higher level in the vit. E group. The plasma Zn and α-tocopherol levels were raised within two and one weeks of supplementation, respectively (data not shown). Plasma IGF-I levels generally increased from birth to week 8, but were not affected by Zn or α-tocopherol supplementation (Table 1). Daily

Table 1. Feed intake, growth rate and plasma levels of Zn, α-tocopherol and IGF-I (±SEM)

Group	Feed intake g DM day^{-1}		Weight gain	Plasma Zn mg l^{-1}		Plasma α-tocoph. mg l^{-1}		Plasma IGF-I ng ml^{-1}	
	milk	starter	g day^{-1}	week 1	week 8	week 1	week 5	week 1	week 8
Control	971	148	822 ± 53^{ab}	1.8 ± 1.6	1.7 ± 0.3^{b}	0.6 ± 0.3	0.9 ± 0.2^{b}	112 ± 32	184 ± 52
Vit. E	958	155	777 ± 87^{b}	1.1 ± 0.5	1.7 ± 0.5^{b}	0.5 ± 0.2	6.8 ± 1.7^{a}	103 ± 27	192 ± 58
Zn	970	177	856 ± 72^{a}	1.6 ± 1.4	2.7 ± 0.4^{a}	0.6 ± 0.3	0.6 ± 0.3^{b}	117 ± 35	184 ± 52

Different letters in superscript indicate significant difference between groups (P≤0.05)

weight gain was highest both absolute and per MJ net energy intake (data not shown) in the Zn group, but this was apparently not related to an increased IGF-I level in this group. Weight gain in the Zn group was significantly different from the vit. E group (P=0.02), whereas the difference from the control group was non-significant (P=0.13). The α-tocopherol content in plasma measured at week 1 was below the level of 3-4 mg l^{-1} considered adequate for optimal immune function (Reddy et al., 1986). This low level was maintained throughout the experimental period for the control group and the Zn group, whereas plasma α-tocopherol in the calves supplemented with extra vitamin E was raised to 6-8 mg l^{-1}.

The response to the tetanus vaccination was followed by measurement of anti-tetanus antitoxin antibodies (Figure 1). Two calves in the vit. E group and one calf in the Zn group had for unknown reasons no measurable antibody response to the vaccination, and these calves were excluded from the dataset. Figure 1 shows that the vit. E group responded with higher OD (optical density) values than the Zn and control groups. The effect of vit. E supplementation on the development of antibodies was significantly different from that of the control group (P=0.034)

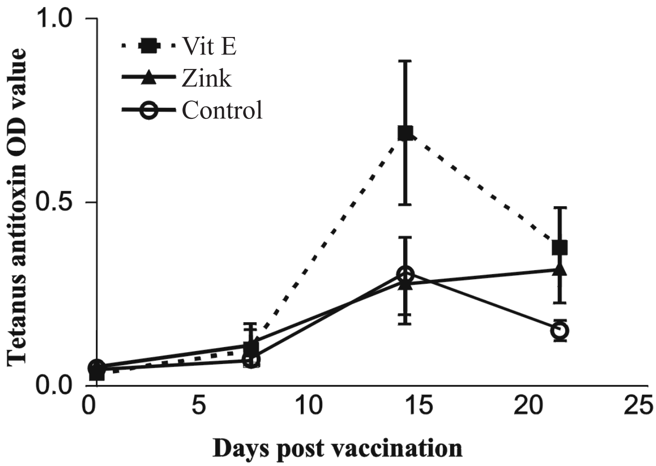

Figure 1. Development of antibodies in serum (optical density = OD) against tetanus toxin subsequent to vaccination

and the Zn group, while no effect of Zn supplementation was observed relative to the control group.

CONCLUSIONS

The plasma Zn and α-tocopherol levels in the 2 days old calves were normal and low, respectively, but were significantly raised by oral supplementation with $ZnSO_4$ and α-tocopherol in the milk, respectively. Weight gain and feed conversion tended to be highest in the Zn supplemented group, but this was apparently not related to plasma IGF-I levels. Following tetanus vaccination the vit. E group responded with significantly higher levels of antibodies than the Zn and control groups. While the selected immune parameter was significantly effected by α-tocopherol supplementation, this was not related to changes in IGF-1 levels or increased weight gain.

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