# Fat-Soluble Vitamin and Micromineral Concentrations in Preruminant Dairy Calves Fed to Achieve Different Growth Rates

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Brian J. Nonnecke, USDA.ARS, collaborator; Monica R. Foote, graduate student (currently postdoctoral researcher, Cornell University, Ithaca);
Ronald L. Horst, USDA.ARS, collaborator;
W. Ray Waters, USDA.ARS, collaborator;
Bill L. Miller, Tom E. Johnson, and Mike Fowler, Land O'Lakes Inc.

### Summary and Implications

Effects of neonatal growth rate on plasma concentrations of fat-soluble vitamins, zinc, and copper in preruminant calves were evaluated. Calves were assigned to dietary treatments designed to achieve three targeted rates of gain [No-Growth (NG) = 0.0 kg/d, Low-Growth (LG) = 0.55 kg/d, or High-Growth (HG) = 1.2 kg/d] over a 7 wk period. MR intakes needed to achieve specified growth-rates were estimated using the NRC Nutrient Requirements of Dairy Cattle calf model computer program. Calves were fed a 30% CP, 20% fat, MR reconstituted to 14% DM. Because vitamin levels in the MR were based on DM intake of HG calves, NG and LG calves were supplemented with additional vitamins once weekly to compensate for reduced MR consumption. Growth rates for NG (0.11 kg/d), LG (0.58 kg/d), and HG (1.16 kg/d) calves differed throughout the study. Although vitamins A and D, and Zn concentrations were unaffected by growth rate, their concentrations increased and Zn/Cu concentrations decreased with time. Throughout the study their concentrations remained within normal ranges for the preruminant calf. Vitamin E and copper were affected by growth rate. At wk 7, HG calves had lower vitamin E concentrations than LG and NG calves. Copper concentrations were greater for HG calves than LG and NG calves from wk 4 to wk 7. Copper and vitE concentrations, however, remained within ranges considered normal for preruminant calves. These results suggest that growth rate during the neonatal period influences vitE and Cu availability.

### Introduction

Vitamin A functions in vision, growth, bone formation, and immune function; vitamin E acts as a lipid-phase antioxidant; and vitamin D regulates calcium/phosphorus homeostasis and immune function. Newborn calves have low plasma vitamin A (retinol < 40 ng/mL), vitamin E (tocopherol < 200 ng/mL) and vitamin D (17-21 ng/mL) concentrations relative to adults (retinol, 400-700 ng/mL, tocopherol > 500 ng/mL, and 25-hydroxyvitamin$D_3$, 45-80 ng/mL). Producers often administer vitamins A/E/D after birth and calf milk replacers are supplemented with these vitamins to promote adequate status. In 2001, the NRC increased vitamin A (9,000 IU/kg of DM) and vitE (50 IU/kg of DM) requirements for dairy calves. Vitamin D (600 IU/kg of DM) requirements are the same as those recommended by the NRC in 1989. Copper and Zn are cofactors in a variety of important enzymes, some of which are associated intimately with respiration and immune cell function. Serum Cu concentrations of < 0.50 μg/mL are indicative of deficiency. Normal blood concentration range for Zn is considered to be 0.7 to 1.3 μg/mL.

Effects of growth rate on fat-soluble vitamin and micromineral status of neonatal calves have not been described. The objective of this study was to evaluate the effects of three-targeted growth rates on fat-soluble vitamins, and Cu and Zn concentrations in the circulation of preruminant dairy calves

### Materials and Methods

Newborn Holstein calves were fed colostrum within 6h of birth and were housed in individual elevated pens in a temperature-controlled (18°C) barn. Calves were assigned to one of three treatment groups (8 calves/treatment) designed to achieve NG (0.0 kg/d), LG (0.55 kg/d), or HG (1.2 kg/d) in live weight over an 8-wk period. All calves were fed a 30% CP, 20% fat, all-milk protein, MR reconstituted to 14% DM. The composition of the diet ensured that protein was not a limiting nutrient. MR composition is provided in Table 1. The amount of MR fed was adjusted weekly to allow for changes in live weight. NG and LG calves were supplemented weekly with vitamins A/E/D to compensate for their reduced consumption of MR and to assure all calves received similar amounts of A, D, and E. Calves were bucket-fed twice a day (0700 and 1800 h) and offered water ad libitum. Starter grain was not offered. Serum vitamin and mineral concentration were determined weekly. Retinol and α-tocopherol concentrations were analyzed by reverse-phase HPLC and 25-hydroxyvitamin $D_3$ by radioimmunoassay. Serum Cu and Zn concentrations were analyzed by atomic absorption spectrometry. Calf health was monitored and recorded daily.

### Results and Discussion

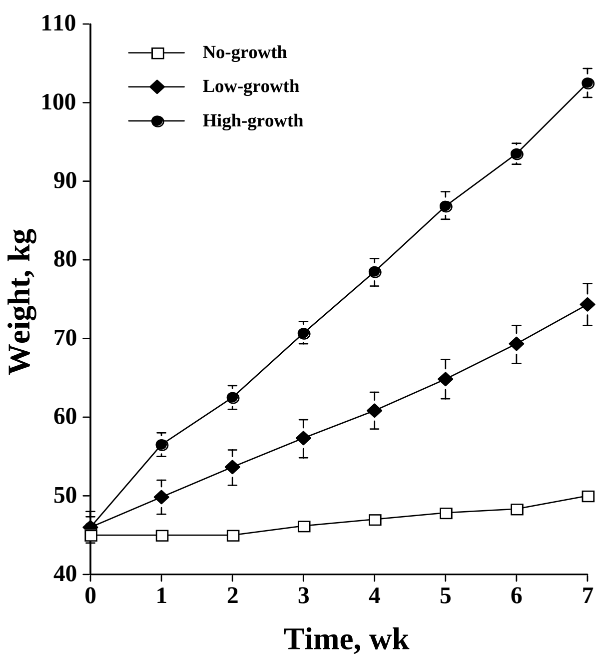
Growth rates for NG (0.11 kg/d), LG (0.58 kg/d), and HG (1.16 kg/d) calves differed during the 7 wk trial (Fig. 1.). Examining the relationship between growth rate and health, five HG calves and two NG calves required treatment for scours. No LG calves experienced scours. Three HG calves were treated for respiratory illness. Low- or NG calves did not show signs of respiratory illness.

**Table 1. Composition of milk replacer[1].**

| Component | Analysis |
|---|---|
| Crude protein | not less than 30% of DM |
| Fat | not less than 20% of DM |
| Lactose | not less than 30% of DM |
| Crude fiber | not more than 0.15% of DM |
| Calcium | not more than 1.25% of DM |
| Phosphorous | not less than 0.70% |
| Retinyl acetate | not less than 20,000 IU/lb |
| 25-hydroxyvitamin $D_3$ | not less than 5,000 IU/lb |
| Tocopheryl acetate | not less than 100 IU/lb |

[1]Manufactured by Land O'Lakes Animal Milk Products Co, Shoreview, MN

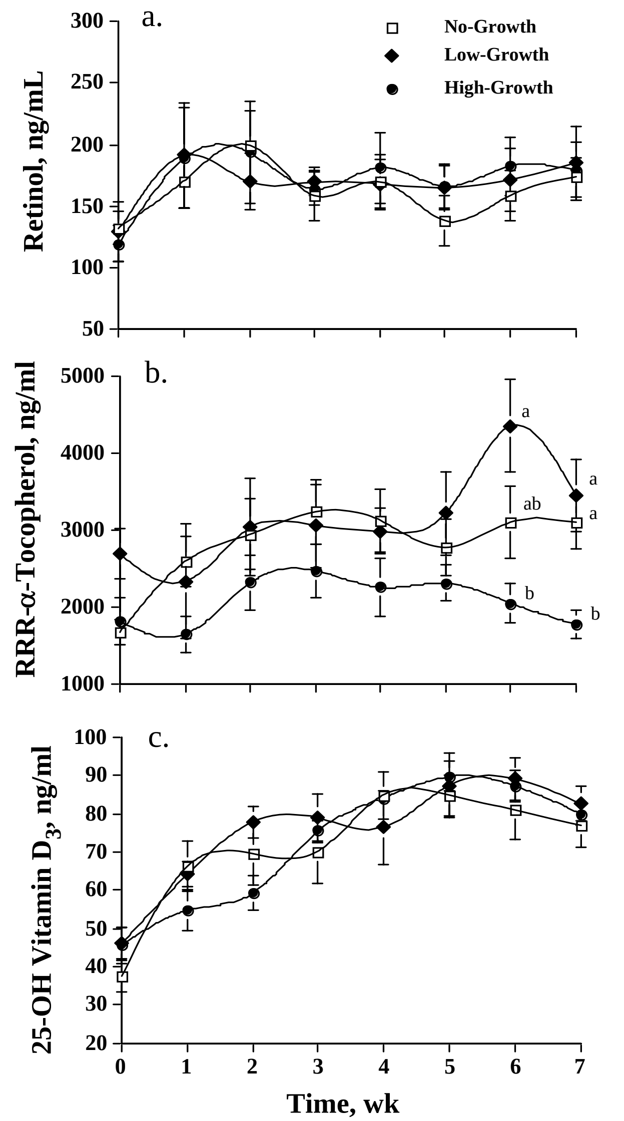
**Figure 1.** Body weights (means ± SEM) of calves fed milk replacer to achieve no-, low-, and high growth rates (n = 8/treatment). Dietary treatments were initiated at wk 0.




Serum vitamin A/D (Fig. 2) and Zn (Fig. 3) concentrations were unaffected by growth rate; however, A and D increased and Zn decreased with time. These age-related changes are representative of those reported for preruminant calves. Vitamins A/D and Zn concentrations were within "normal" ranges for neonatal calves.

Serum vitE and Cu concentrations; however, were affected by growth rate. At wk 6 & 7, vitE levels in HG calves ranged from 47% to 66% of those in NG- and LG calves but were still within the normal range for preruminant calves. These results suggest that feeding to achieve high growth rates in preruminant calves may increase biological demand for vitE and increased supplementation of the diet may be justified.

**Figure 2.** Vitamins A (**panel a**), E (**panel b**), and D (**panel c**) concentrations (means ± SEM) in sera from calves fed to achieve no-, low-, and high growth rates (n = 8/treatment). [a,ab,b] Treatment means at specific time (i.e. wk of study) with different letter superscripts differ, $P < 0.05$




Serum Cu levels in NG and LG calves were lower than those in HG calves from wk 3 to 7 (Fig. 3). Normal Cu range is between 0.7 - 1.0 μg/mL with deficiency occurring at < 0.6 μg/ml. The biological significance of the progressive decline in serum Cu in NG and LG calves to approximately 0.7 μg/ml is unknown. Serum Cu concentrations in the calf normally achieve near-adult values (1.0 μg/mL) by 1 wk of age.

**Figure 3.** Copper (**panel a**) and zinc (**panel b**) concentrations (means ± SEM) in sera from calves fed to achieve no-, low-, and high growth rates (n = 8/treatment).
[a,ab,b] Treatment means at specific time (i.e. wk of study) with different letter superscripts differ, $P < 0.05$