Animal Feed Science and Technology 188 (2014) 28–35

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Ruminant

Performance and immune response of suckling calves fed organic selenium☆

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ARTICLE INFO

Article history:
Received 25 April 2013
Received in revised form
13 November 2013
Accepted 18 November 2013

Keywords:
Mononuclear cells
Mineral
Neutrophils
Nutrition
Immunological system

ABSTRACT

The objective of this research was to explore whether supplementation of Se above the recommended levels or application directly to the abomasum is superior to rumen supplementation in terms of boosting the immune system and promoting the growth of suckling calves. Thirty newborn calves, 18 Jersey breed and 12 crossbred (Holstein × Jersey), during 75 days, were assigned in a randomized block design (sex and breed) with the following treatments C = control (no supplementation and selenium derived only from milk and concentrate); SeA = 0.80 mg of Se/animal per day to the abomasum (milk); and SeR = 0.80 mg of Se/animal per day to the rumen (oral). The blood concentration of Se was higher in the SeR- and SeA-treated animals than in the control animals (P = 0.001) at 30 days of age. The phagocytic activity of macrophages was higher in animals receiving Se supplementation compared to the control and in SeA animals compared to SeR (P = 0.007). No difference in the oxidative activity of neutrophils or hematocrit was observed among treatments regimes when the calves were 30 days old. Dry matter intake (P = 0.059) and HGG (P = 0.059) tended to be higher in SeR-treated animals than in SeA-treated animals at 30 days of age. Feed conversion tended to be more efficient in Se-supplemented animals compared to the control (P = 0.075). There were no significant differences in WG, HG or LG among treatment regimes at 30 days of age. At 75 days of age, Se-supplemented animals tended to present higher concentrations of Se in the blood (P = 0.079) and greater heart girth gain (P = 0.088). Supplementation of suckling calves with 0.80 mg of organic Se increased the serum levels of this trace mineral in the animals and boosted their immune systems at 30 days of age. A superior immune parameter response was observed in calves supplemented with Se to the abomasum. In addition, Se supplementation maintained the performance of animals that had a diagnosis of diarrhea. Selenium supplementation did not act as a growth promoter but did improve immune system function during this phase of compromised health.

Abbreviations: ADFom, acid detergent fiber (exclusive of residual ash); DM, dry matter; DMI, dry matter intake; FCE, feed conversion efficiency; GE, gross energy; HGG, heart girth gain; HG, height gain; LG, length gain; aNDFom, neutral detergent fiber (assayed with heat stable amylase and exclusive of residual ash); Se, selenium; WG, weight gain.

☆ Financial support by FAPESP/Brazil.

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http://dx.doi.org/10.1016/j.anifeedsci.2013.11.008

1. Introduction

The use of nutrition to improve the resistance of animals to infections and to reduce the infection's intensity still needs to be explored (Scaletti et al., 1999). Selenium (Se) plays an important role within this context. Selenium is an essential component of selenocysteine, which is an amino acid found in proteins related to many aspects of cellular biochemistry and immune system activity, and exerts immunomodulatory effects in different species when administered in quantities that exceed dietary requirements (Surai, 2006). Selenium is an essential trace element in ruminant diets and a component of the enzyme glutathione peroxidase. This enzyme converts hydrogen peroxide into water and plays a crucial role in the cellular antioxidant system (NRC, 2005). Reactive oxygen and nitrogen species can cause cell damage in animal tissues in cases where antioxidant enzymes are deficient.

Selenium supplementation of suckling calves is important because newborn calves have functionally immature immune systems. In addition, suckling calves lack antibodies in their bloodstream because maternal immunoglobulins do not cross the placenta in cattle. In nature, this problem is solved through maternal colostrum, which transfers immunoglobulins from the cow to the calf after birth (Goff, 2006). Even if their immune systems have been established, nursing ruminants are more susceptible to disease due to rapid hematological changes.

Certain minerals can affect or be affected by ruminal microorganisms (Knowles et al., 2006). Approximately 0.40 g/g of Se orally administered to cattle is absorbed in the intestine, and this absorption is directly influenced by the route of administration. According to Van Ryssen et al. (1989), the finding that microorganisms are able to change the form of Se in the rumen led to studies that investigated the metabolism of organic and inorganic sources of Se in animal feed. Rumen microorganisms can incorporate Se into selenoamino acids, but the element is more strongly bound to microbial proteins in organic sources of the mineral (Church, 1988). Van Ryssen et al. (1989) observed that selenomethionine was the main compound present in the rumen when organic Se was administered.

The rumen or abomasum can change the degradation, metabolites, and consequent activity in the animal's body of administered trace materials. This fact highlights the importance of studying the administration of minerals to calves through fermentation or acid digestion. According to Nockels (1996), the amount of nutrients needed to boost an animal's immune system is higher than that suggested by the National Research Council. Cow milk contains an average of 0.02 to 0.15 mg of Se/kg dry matter (DM), and the amount recommended by the NRC (2005) as the ration for young calves is 0.30 mg/kg DM. In this study, we investigated a daily intake of 0.80 mg of Se per animal.

The objective of this research was to explore whether supplementation of Se above the recommended levels or application directly to the abomasum is superior to rumen supplementation in terms of boosting the immune system and promoting the growth of suckling calves.

2. Materials and methods

2.1. Animals and study design

The experiment was conducted at APTA Fazenda Experimental, Ribeirão Preto, São Paulo, Brazil using 30 newborn calves including 18 Jersey and 12 crossbred (Holstein × Jersey) animals. A randomized block design (sex and breed) consisting of the following treatments was used: C = control (no supplementation and selenium derived only from milk and concentrate); SeA = 0.80 mg of Se per animal per day to the abomasum (milk); and SeR = 0.80 mg of Se per animal per day to the rumen (oral). The protocol was approved by the Ethics Committee on Animal Experimentation of the Animal Science Institute, São Paulo State Government.

2.2. Diet and feed management

The calves were kept in individual pens bedded with sand, and each pen contained individual milk, water, and concentrate buckets. All calves were bottle fed 4 L of colostrum on the first day of life and were trained to drink from the bucket by the second day. The animals received 4 L of fresh milk per day (2 L at 8 am and 2 L at 3 pm) from day 2 to day 30 followed by 2 L of milk per day (1 L at 8 am and 1 L at 3 pm) from day 31 to day 75. The animals were weaned after this period. The milk provided during the experiment had the following composition: 30.8 g/L of fat, 28.9 g/L of protein, 43.9 g/L of lactose, 82.7 g/L of solid nonfat, 12.47 mg/dL of urea nitrogen, and 0.02 mg of Se/kg DM. Pelleted concentrate was offered *ad libitum* until a consumption of 1.4 kg/animal per day was reached (Table 1).

Selenium supplementation was calculated so that each animal would receive 0.80 mg/day during the experimental period. The amount of mineral intake derived from milk and concentrate was subtracted from this value (0.80 mg). Dry matter intake (DMI) was estimated according to the animal's body weight (NRC, 2001). The selenium dose (0.80 mg/kg/day) was chosen because it corresponds to the expected intake of this mineral when the animal is close to weaning and DMI increases.

Selenium yeast (*Saccharomyces cerevisiae* CNCM I-3060) was weighed on an analytical scale and stored in gelatin capsules for use as the mineral source. For the SeA treatment, the capsules were opened daily and their content was added manually to the milk and offered individually to the animals. For the SeR treatment, the capsules were administered individually to the calves directly through the esophagus using a small esophageal tube 1 h after milk feeding. In SeA- and SeR-treated animals,