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Review

Digestibility, fermentation and rumen microbiota of crossbred heifers fed diets with different soybean oil availabilities in the rumen

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ABSTRACT

The goal of this study was to evaluate the effects of different soybean oil availabilities on the intake and partial and total digestibility of dry matter (DM) and nutrients, rumen fermentation parameters, efficiency of microbial synthesis, and the rumen microbiota of crossbred beef heifers. Nine crossbred heifers fitted with rumen and duodenal cannulae were evaluated in a triple 3 × 3 Latin square design with three treatments and three periods in three simultaneous repetitions. Heifers approximately 18 months old, with mean initial and final body weights of 316.3 ± 28.8 and 362.6 ± 34.4 kg, respectively, were fed a diet containing 600 g/kg of corn silage and 400 g/kg concentrate with a 58.0 g/kg fat content in the total diet. The sources of lipids included soybean grain, rumen-protected fat, and soybean oil. The statistical analyses were conducted using PROC MIXED from SAS, and the means were compared using Tukey's test (P<0.05). Dietary lipid sources did not affect nutrient intake (P>0.05). Except the apparent digestibility of organic matter (P=0.024), the apparent digestibility of the other nutrients did not differ among the treatment groups. Regarding body nitrogen retention, the soybean grain treatment was more effective than the rumen-protected fat treatment (P=0.045); however, the soybean oil treatment did not differ from the other two treatments. In relation to the efficiency of microbial protein synthesis (g N/kg of organic matter apparently digested in the rumen corrected for microbial organic matter), the soybean oil and soybean grain treatments were more efficient than the rumen-protected fat treatment (P=0.001). Animals fed rumen-protected fat had larger numbers of protozoa (P<0.001) and fungi (P<0.001) than those supplemented with soybean grain and soybean oil. The dietary lipid sources did not affect pH, the molar concentration of propionate and total volatile fatty acids (P>0.05), whereas the concentrations of ammonia nitrogen and acetate were higher in animals fed with rumen-protected fat than in those submitted to the other treatments. The use of different soybean oil availabilities did

Abbreviations: ACE, acetate; ACE:PROP, acetate:propionate ratio; ADFom, acid detergent fiber (expressed exclusive of residual ash); aNDFom, neutral detergent fiber (assayed with a heat stable amylase and expressed exclusive of residual ash); BUT, butyrate; CP, crude protein; DM, dry matter; DMI, dry matter intake; EE, ether extract; GE, gross energy; Lignin (sa), lignin determined by solubilization of cellulose with sulphuric acid; MLN, most likely number; N, nitrogen; NDFi, indigestible neutral detergent fiber; NH_3-N, ammonia N; OM, organic matter; OS, soybean oil; PROP, propionate; RPF, rumen-protected fat; SG, soybean grain; TCHO, total carbohydrates; VFA, volatile fatty acid.

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not affect nutrient intake; however, treatments with soybean oil and soybean grain were more efficient regarding nutrient intake than rumen-protected fat because they reduced the numbers of fungi and protozoa and consequently improved the efficiency of microbial protein synthesis.

Contents

1. Introduction

One of the alternatives that has been studied for manipulation the ruminants diets is the utilization of feeds rich in lipids, which can contribute to the supply the energy levels closer to those required by high producing animals, in addition to promoting a more adequate balance between structural and non-structural carbohydrates of the diet, and even optimizing the utilization of the digestible energy (Hess et al., 2008).

Lipids present in most feed used in animal feeding have higher proportions of unsaturated fatty acids (Van Soest, 1994), which affects the permeability of the microbial membrane; in particular, they inhibit activity of Gram-positive bacteria and protozoa and modify rumen fermentation (Nagaraja et al., 1997).

The effects of lipids on the rumen and total digestion are difficult to predict and are highly variable because they depend on the nature and concentration of lipids in the diet, the types of chemicals and/or physical treatments added to feeds, and the nature and amounts of forages, concentrates, and minerals (especially calcium) in the diet (Jenkins and McGuire, 2006). Due to these complex interactions, the metabolic effects of lipid supplementation in the diet cannot be analyzed as a simply result of increased in the absorption of intact fatty acids (or transformation by the rumen) from the diet (Oliveira et al., 2007b). Thus, when one wants to supply lipids in the diet of ruminants, it is important to evaluate their effects on ingestion and digestion of nutrients so as not to impair the necessary uptake for the desired production (Jenkins and McGuire, 2006).

This study was conducted to evaluate the effects of supplementation with different soybean oil availabilities on the intake and digestibility of nutrients, rumen fermentation, and the rumen microbiota and microbial efficiency of crossbred heifers.

2. Materials and methods

2.1. Animals and experimental feeds

Nine crossbred heifers fitted with rumen and duodenal cannulae were used in the study. The animals were approximately 18 months old and had average initial and final body weights of 316.3 ± 28.8 and 362.6 ± 34.4 kg, respectively. The protocol used in this experiment was in accordance with the Brazilian College of Animal Experimentation (COBEA – *Colégio Brasileiro de Experimentação Animal*) guidelines and was approved by the Ethics, Bioethics, and Animal Welfare Committee (CEBEA – *Comissão de Ética e Bem Estar Animal*) of the FCAV–UNESP–Jaboticabal campus.

The experimental period lasted 66 d, and it was divided into three periods of 22 d; the first 15 d comprised a period of adaptation to the diets in pens, and the subsequent 7 d were used for data collection in metabolism stalls. The experimental diets were formulated to provide a dry matter (DM) intake of 23.0 g/kg of body weight and gain of 1.20 kg/d, which were calculated using RLM/Esalq-USP software (Lanna et al., 1999) in accordance with the CNCPS system developed by Fox et al. (2000).

The three different soybean oil availabilities in the rumen tested (soybean oil, rumen-protected fat (Megalac-E® – Church & Dwight, affiliate Química Geral do Nordeste S/A), and soybean grain) were incorporated into the concentrate mixture, which was composed by corn and soybean meal. Soybean meal was not used in the soybean grain diet; the soybean grain was ground, and it constituted the main protein source.

The diets were isoenergetic and isonitrogenous, had 58 g/kg of ether extract (EE) in the total diet, which consisted by corn silage as forage, and presented a forage:concentrate ratio of 60:40 (Table 1). Animals were fed with corn silage, and the experimental concentrates once a day at 0800 h. Throughout the entire experimental period, the provided quantities were adjusted to allow approximately 100 g/kg surplus in relation to the total consumed the previous day.