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Effects of main protein, non-forage fibre and forage source on digestibility, N balance and energy value of sheep rations

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Abstract

Two in vivo digestion trials were conducted, by using a latin square 4 × 4 experimental design with castrated rams, to evaluate the effects of main protein source, non-forage fibre source (NFFS) and forage source on nutrient digestibility, N balance and energy value of sheep rations. In each trial, rams were fed at maintenance level four isocaloric-isonitrogenous and isofibrous rations, differing in the main protein and/or NFFS. At the first trial, alfalfa hay was used as a forage source whilst in the second trial, corn silage was used as a forage source. At both the trials, the 1st ration contained soybean meal (SBM) and wheat bran (WB), the 2nd SBM and corn gluten feed (CGF), the 3rd corn gluten meal (CGM) and WB and the 4th CGM and CGF. Data of both the trials were analyzed in common as 2 × 2 × 2 factorial experimental design. Main protein source (SBM versus CGM) did not affect nutrient digestibility, energy value and N balance of diets, except an increase in crude fibre (CF) digestibility of diets containing SBM. Those results suggest that an increase in rumen undegradable protein (RUP) content does not negatively affect digestibility or nutritive value of the diets if adequate fermentable metabolizable energy (FME) is provided. CGF significantly elevated CF, NDF and ADF digestibility in comparison with WB, but NFFS did not affect other nutrients' digestibility or N balance or energy value (ME) of the diets. Rations containing alfalfa hay had higher digestibility of crude protein (CP), organic matter (OM) and gross energy (GE) in comparison with those containing corn silage; the opposite was true for NDF and ADF digestibilities. The combination of CGM and CGF (16% of concentrate mixture each) did not have a negative effect on nutrient digestibility, N balance and energy value of sheep rations when isonitrogenous replaced SBM and WB (22% of concentrate mixture each), respectively. Probably, CGF had positive effect on digestibility of the fibre fraction of the ration regardless of the main protein and forage source used. There were no significant interactions between forage × protein, forage × NFFS and protein × NFFS, for any parameter studied.

Keywords: Sheep; Alfalfa hay; Corn silage; Non-forage fibre; Protein; Digestibility

1. Introduction

Interest on nutritional value of corn gluten meal (CGM) has been elevated latest because it is a feed

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with high concentration in undegradable protein (UP) that could replace animal by-products in diets for the high productive ruminants. CGM is a by-product of wet milling corn, inferior on amino acid profile compared to soybean meal (SBM) but exceeds it on UP content (Stern and Satter, 1982). Cozzi and Polan (1994) reported that CGM can partially (50%) replace SBM in diets of the lactating cows with no dietary differences in DM digestibility. Also, Seymour et al. (1992), on lactating cows, reported that apparent digestibility of crude protein (CP) and organic matter (OM) of the ration was not affected after 40% substitution of SBM by CGM. On the other hand, Titgemeyer et al. (1989) reported higher CP digestibility of steers' rations when CGM was used as a protein source instead of SBM. Data of Van Horn and Powers (1992) indicated that the replacement of SBM by CGM is more effective in rations containing alfalfa hay as a forage instead of corn silage because alfalfa hay may cover small protein deficiencies in the protein source used (Van Horn and Haris, 1993). So, discrepancies in effectiveness of the substitution of protein sources may exist according to the forage used.

Corn gluten feed (CGF) often is included in dairy rations as a source of energy, protein and fibre. CGF is a non-forage fibre source (NFFS) with high concentration in effective NDF (Swain and Armentano, 1994; Allen and Grant, 2000). Bernard et al. (1988) reported greater digestibility of hemicellulose when CGF supplied 40% of the dietary energy for steers in comparison with supplements of SBM, shelled corn, soybean hulls or wheat middlings.

There is too limited data evaluating these by-products in sheep rations (Asplund and Nelson, 1989), and even in the experiments on cows and steers, usually indirect methods are used to estimate digestibility (Titgemeyer et al., 1989; Collins and Pritchard, 1992; Cozzi and Polan, 1994; Calsamiglia et al., 1995; Chan et al., 1997). Moreover, in most cases, the control feed is only partially substituted by the tested feed (Seymour et al., 1992; Cozzi and Polan, 1994; Chan et al., 1997).

Our objectives were to determine the effects of isonitrogenous replacement of SBM with CGM, wheat bran (WB) with CGF and total replacement of SBM and WB with CGM and CGF, regardless of the kind of forage source used on the digestibility of nutrients, N balance and energy value of sheep rations.

2. Materials and methods

2.1. Experimental design and procedure

2.1.1. Trial 1

An in vivo digestibility trial was conducted with four castrated rams, 7–11 months of age and 41–43 kg live body weight, by using four rations in a 4×4 latin square design. The formulation, chemical composition and nutritive value of the diets are presented in Table 1. The four diets were isocaloric, isonitrogenous and isofibrous and were formulated to meet maintenance energy requirements according to the values suggested by Jarrige (1978). Rams were placed into metabolism cages 10 days before the trial began (preliminary period); during this period, rams were fed with ration soybean meal + wheat bran (SW) (control), whilst measuring body weight every 2 days (three times) in order to adjust the quantity of feed needed for the maintenance. Experimental diets were fed in two equal amounts daily at 08:00 and 17:00 at a rate of 0.7 kg DM/day as TMR. Each of the four periods consisted of 14 days adaptation period and 8 days collection period. Any animal at any treatment left no refusals. Water was freely accessible through individual drinkers. Faeces and urine were collected and weighted at approximately 08:00 each day, composted by treatment and ram. Samples were stored at a temperature of 2–3 °C until all the samples for that collection period had been taken. Rations' samples were taken for laboratory analysis by grab sampling as the feed allowances were being weighted.

2.1.2. Trial 2

The same procedure was used with the differences focused in rams' age (13–17 months), live body weight (51–55 kg) and forage source used. The same rams were used in both the trials. Rations were fed at a rate of 0.73 kg DM/day, corresponded to maintenance requirements in energy. The formulation, chemical composition and nutritive value of the diets are shown in Table 2.

2.2. Chemical analysis

Feed and composite faecal samples were ground to pass through a 1 mm screen. DM was determined