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True digestibility of calcium from sources used in finishing lamb diets

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Abstract

The isotope dilution technique was used to evaluate calcium true digestibility and calcium balance in finishing lambs fed different calcium sources. The experiment was carried out at the Animal Nutrition Laboratory of the Centre for Nuclear Energy in Agriculture, University of São Paulo (CENA/USP). Twenty Santa Inês non-castrated male lambs, aged 7–8 months were used. Treatments consisted of a basal diet (corn, soybean meal, hydrolysed sugarcane bagasse, urea, monoammonium phosphate (MAP) and mineral mixture) supplemented with five calcium sources: citrus pulp (diet CTP), Lucerne hay (diet LUC), limestone (diet LIM), oyster shell meal (diet OSM) and dicalcium phosphate (diet DCP). After 21 days for diet adaptation, the lambs were allocated into metabolic cages and each animal was injected intravenously with 7.7 MBq of ^{45}Ca, as calcium chloride in aqueous solution. Blood samples were collected at 5 min, 1, 2, 4, 6, 24, 48, 72, 96, 120 and 144 h after injection. Faeces and urine samples were collected at each 24 h after injection for 7 days. The radioactivity of plasma, faeces and urine samples were determined by a liquid scintillation method. Comparison of the means (Duncan test) and regression analysis were carried out, and for statistical analysis the experiment was considered a randomised design with five treatments and four replicates. Animals fed either diet CTP (98%) or diet LUC (100%) had higher calcium faecal output than those fed diet LIM (58%). The percentage of endogenous loss varied from 11 to 20%, and was not influenced by either dry matter or calcium intakes. Calcium absorption and true digestibility was highest for diet LIM. Calcium retention for animals fed diet LIM was higher than those fed either or diets CTP and LUC. Calcium availability and metabolism was affected by dry matter and calcium intake and by the chemical form of calcium in the diet. It is recommended that citrus pulp and Lucerne hay should not be used as the sole calcium source in a diet for finishing lamb.

Keywords: Isotopic dilution; Lucerne hay; Citrus pulp; Ruminants

1. Introduction

Minerals are essentials components in ruminant diets, Ca being the most demanded element due to its structural function (Underwood and Suttle, 1999). Ca is also required for the functioning of several intra- and extracellular processes including muscle contraction, nerve transmission, blood clotting, and for regulation of many hormones (Andriguetto et al., 1993). Low Ca intake can lead to a decrease in animal performance, taetania and skeleton anomalies, as such rickets in young animals and osteomalacia in adults.

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Table 1
Proximal analysis[a] of feeds (g/kg DM) given to sheep fed different sources of Ca

Ingredients	DM[b]	MM	P	Ca	ADF	NDF	CP
Soybean meal	872.0	78.8	7.30	2.8	12.2	19.1	51.2
Corn grains	875.9	17.8	2.50	0.3	4.6	47.7	9.0
Lucerne hay	828.9	72.8	3.90	11.5	29.5	40.9	23.1
Sugarcane bagasse	735.0	62.5	0.50	0.9	54.4	58.9	2.0
Citrus pulp	916.8	52.8	1.20	15.5	28.9	23.8	7.5
Oyster shell meal	990.0	975.0	0.50	411.0	–	–	–
Dicalcium phosphate	981.6	910.7	188.5	270.0	–	–	–
Limestone	999.2	994.4	0.10	386.0	–	–	–
MAP[c]	981.8	525.0	250.0	4.5	–	–	–
Mineral mixture[d]	992.2	913.0	0.50	1.3	–	–	–

[a] DM, dry matter; MM, mineral matter; ADF, acid-detergent fibre; NDF, neutral-detergent fibre; CP, crude protein.
[b] DM represented in g/kg of original matter.
[c] Monoammonium phosphate.
[d] Ca (0.03%), Mg (1.0%), S (7%), Na (14.5%), Cl (21.86%), Cu (300 ppm), Mn (1100 ppm), Zn (4600 ppm), Fe (500 ppm), I (80 ppm), Co (40 ppm) and Se (15 ppm).

For adequate nutrition, in addition to the Ca present in the feed, it is necessary to know its true digestibility for each species and animal category, to meet the nutritional demands relating to age and genetics potential for weight gain (Silva, 1995). The lack of knowledge about Ca availability present in ingredients lead to miscalculation of dietetic Ca impairing animal performance.

Some feeds have high level of Ca and are frequently used as Ca source in ruminant diets. However, the Ca availability for absorption by animal body is not always known. Factors such as genetics, physiologic stage and animal growth rate or chemical form and structural associations in plant can determine Ca absorption efficiency (Nicodemo and Laura, 2001).

Conventional digestibility trials are the most common form for assessing plant capacity to supply nutrients for animals and to obtain mineral apparent absorption (Playne, 1976). Among the techniques used to determine true absorption, isotopic dilution is one method to determine faecal and urine endogenous losses (Comar et al., 1953; Vitti, 1989).

The principles of using the radiotracer method were shown initially by Kleiber et al. (1951), based on isotopic dilution using radiophosphorus ^{32}P in dairy cows. Despite being a methodology used by few researches in Brazil (Vitti, 1989; Salviano, 1996; Salviano and Vitti, 1998; Dorigan, 2000), the world literature considers isotopic dilution a trusted technique for mineral metabolism studies in animals.

The aim of this work was to determine the true digestibility of Ca from sources used in diets for lambs and to study the kinetics of this element using isotopic dilution technique and ^{45}Ca as radiotracer.

2. Materials and methods

The experiment was carried out at Animal Nutrition Laboratory installations located in the Centre for Nuclear Energy for Agriculture, University of São Paulo (CENA/USP), Piracicaba, São Paulo, Brazil.

Twenty Brazilian breed male sheep, aged 8 months, averaging 31.6 kg were fed diets composed based on NRC (1985) recommendations for growing lambs, considering dry matter intake equal to 4.3% of animal live weight. The basal diet containing hydrolyzed sugarcane bagasse (HSB), corn (ground grains), soybean meal, urea, monoammonium phosphate (MAP) and mineral mixture was supplemented with different sources of Ca: citrus pulp (diet CTP), Lucerne hay (diet LUC), limestone (diet LIM), oyster shell meal (diet OSM) and dicalcium phosphate (diet DCP).

The chemical characterization of ingredients is shown in Table 1 and diet composition can be seen in Table 2.

The analysis of dry matter (DM), mineral matter (MM) crude protein (CP) and acid-detergent fibre (ADF) were done according to Association of Official Analytical Chemists (1995) (ID number 9830.15, 942.05, 954.01, 973.18, respectively). Neutral-detergent fibre (NDF) was analyzed according to Mertens (2002). Phosphorus content present in faeces, feeds and urine were determined by colorimetry (Sarruge and Haag, 1974) and Ca present in feeds by spectrometry of atomic absorption (Zagatto et al., 1979).

Sheep were housed indoors in stalls (four per stall) and received the experimental diets for 21 days (adaptation period), twice a day, at 8 a.m. and 5 p.m. After this period, they were transferred to individual metabolism cages, designed for isotope studies and handling of fae-