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Differences in mean retention time of sheep and goats under controlled feeding practices

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ABSTRACT

The objective of this study was to compare the mean retention time (MRT): (a) between sheep and goats when they fed in groups with the same diet, the same amount of food and forage to concentrate (F/C) ratio and (b) between group and individual feeding in each animal specie (the same diet, the same amount of food and F/C ratio). Twelve, 3–4 years old, Friesian crossed dairy ewes and twelve, 3–5 years old, Alpine crossed dairy goats were used for the experiment. The animals were fed with a diet, consisted of alfalfa hay, wheat straw and concentrate, in two treatments. In Treatment A the animals fed on a group basis as it is traditionally used in practise, while in Treatment B the diet was offered individually toin each animal, in order to have fully comparable feeding level among animals and between treatments. Each Treatment (A and B) lasted 3 weeks. The results of this study have shown that: sheep had significantly longer rumen retention time (RRT) (30.03 vs. 14.43) and mean retention time (MRT) (40.80 vs. 27.81), and shorter transit time (TT) (8.86 vs. 11.49) than goats, while the caecum retention time (CRT) did not differ between the two species in Treatment A (group feeding). The comparison between group (Treatment A) and individual feeding (Treatment B) in goats or in sheep has shown that there were no significant differences as RRT, CRT, TT and MRT concerns. In conclusion, animal species (sheep vs. goat) was the main factor which affected the MRT, RRT and TT when the animals were fed in groups with the same diet, amount of food and F/C ratio, while the feeding technique (group vs. individual) had no effect on those parameters in both animal species.

1. Introduction

Differences in mean retention time (MRT) and rumen retention time (RRT) of feed undigested residues may affect animal productivity by modifying the number and diversity of rumen microorganisms (Hoover et al., 1982; Meng et al., 1999; Schadt et al., 1999), the composition and maintenance energy requirements of the microbes, and thus the energetic efficiency of microbial growth. Further effects associated with RRT include a possible reduction in methane production (Matsuyama et al., 2000) and increased long chain fatty acids synthesis in the rumen, which may consequently affect the energetic efficiency of the ruminant. It is concluded that despite strong evidence of genetic diversity in gut function, the central role of MRT and RRT in digestive metabolism has not been fully appreciated, nor have their contribution to productivity differences among livestock of similar or divergent genotypes been adequately investigated (Hegarty, 2004).

According to feeding characteristics, ruminant species are often classified into concentrate selectors, grazers or roughage eaters, and an intermediate type called mixed feeders. Among the domestic ruminants, sheep are considered as typical grazers and goats as typical intermediate feeders (Hofmann, 1985). In order to raise the two animal species scientifically, the differences between them in

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Table 1
The chemical composition (g/kg DM) of the alfalfa hay, wheat straw and concentrate (mean ± SEM) and the calculated composition of the diet consumed[a] by Freisian crossed ewes and Alpine crossed goats.

Feeds	Alfalfa hay ($n=6$)	Wheat straw ($n=6$)	Concentrates ($n=6$)	Nutrients (g/day/head)
Dry matter (DM), g/kg	912 ± 4.1	871 ± 2.7	881 ± 4.2	2530
Crude protein (CP)	140 ± 3.4	26 ± 1.1	165 ± 2.8	392
Ether extract (EE)	8.7 ± 0.9	14 ± 0.6	15.2 ± 2.0	35
Neutral detergent fibre (NDF)	458 ± 4.0	718 ± 3.8	285 ± 5.2	1153
Acid detergent fibre (ADF)	362 ± 2.2	512 ± 2.6	234 ± 4.5	905

[a] The diet consumed consisted of 1.16 kg alfalfa hay, 0.33 kg wheat straw and 1.33 kg concentrate in both feeding treatments.

digestion need to be evaluated. However, direct comparisons between the species (sheep/goats) fed with exactly the same amount of food, to our knowledge, do not exist. Therefore, it is difficult to draw clear conclusions, especially with respect to the influence of diet selectivity on food intake and digestibility. It has been shown that diet digestibility decreases with increased feed intake and reduced digestibility has mainly been attributed to increased MRT.

Many factors affect MRT of undigested feed residues into the gastrointestinal tract such as feeding level (Warner, 1981), forage to concentrate (F/C) ratio of the diet (Colucci et al., 1990), particle specific gravity (Ramanzin et al., 1993), particle size (Hadjigeorgiou et al., 2003), dietary characteristics and physiological condition of the animal (Stern et al., 2006) and animal species (Colucci et al., 1990). The effects of each of the above factors have been examined separately in each animal species with different diets according to their nutritive requirements. Due to the fact that sheep and goats can be fed, in many cases, with more or less comparable diets, the objective of this study was to compare the MRT: (a) between sheep and goats when they were fed in groups with the same diet, the same amount of food and F/C ratio and (b) between group and individual feeding in each animal specie (the same diet, the same amount of food and F/C ratio).

2. Materials and methods

2.1. Animals and feeding

The experiment was conducted according to guidelines of the Agricultural University of Athens for the care and treatment of experimental farm animals in order to avoid any unnecessary discomfort to the animals. Twelve, 3–4 years old Friesian crossed dairy ewes, 59 ± 2.3 kg average body weight (BW) of good body condition score (3.0 ± 0.12) and twelve, 3–5 years old Alpine crossed dairy goats, 55 ± 2.1 kg BW of good body condition score (2.4 ± 0.17), were used for the experiment, which followed a 2 (animal species (AS)) × 2 (feeding management (FM)). Lambing and kidding started in December and in February respectively, and lasted 2 weeks. The animals were fed with a diet consisted of (kg/head) alfalfa hay (1.16), wheat straw (0.33) and a concentrate (1.33) in two treatments. Its F/C ratio was 53/47 on an as-fed basis. In both treatments the intake of DM was 119 and 125 g/kg $W^{0.75}$ in the ewes and goats, respectively. In Treatment A the animals were fed on a group basis, while in Treatment B the diet was offered individually to each animal. The concentrate diet (g/kg) consisted of: maize grain, 360; barley grain, 360; soybean meal, 160; wheat middlings, 110; calcium phosphate, 15; common salt, 3; mineral and vitamins premix, 2. The mineral and vitamin premix contained (per kg as mixed): 150 g Ca, 100 g P, 100 g Na, 100 mg Co, 300 mg I, 5000 mg Fe, 10,000 mg Mn, 20,000 mg Zn, 100,000 mg Se, 5,000,000 IU retinol, 500,000 IU cholecalciferol and 15,000 mg α-tocopherol. The chemical composition of the alfalfa hay, wheat straw and concentrate and the calculated composition of the diet fed in both feeding treatments is shown in Table 1.

Because the sheep and the goats had different requirements (mainly due to their different milk yield, BW), Treatments (A and B) were not applied to the animals at the same days in milk (DIM), but when the animals had about the same energy and protein requirements. Each Treatment (A and B) lasted 3 weeks. On the morning of the 17th day of each feeding treatment, a single dose of C_{36}-alkane, as marker was administered to each of the animals before distributing the daily diet. Cotton swabs were used as carrier matrix of 0.5 g C_{36}-alkane each, and each animal was dosed with 1.0 g C_{36}-alkane with an appropriate balling gun. Individual faecal collection was carried out at the following intervals after dosing: 0, 4, 6, 8, 10, 12, 14, 16, 18, 24, 30, 36, 48, 60, 72, 96, 120, 144 and 168 h. After collection, the faecal lot was sampled about 100 g were stored individually at −20 °C until analysis. Water was offered *ad libitum* to animals throughout the experimental period.

2.2. Treatment A

During Treatment A the diet was fed on a group basis as it is traditionally used in practise. This regimen was decided in order to have comparable food intake (the same average food intake) by both animal species. For this purpose Treatment A was applied to sheep from DIM = 105 to DIM = 126, and to goats, from DIM = 63 to DIM = 84, in order to satisfy their nutrient requirements, assumed to be similar at these stages of lactation The composition of the diet in Treatment A was calculated according to sheep and goats maintenance and lactation requirements (Zervas et al., 2004), taking into account their average BW, milk yield and milk fat content. The forages and the concentrate were offered to animals twice a day in two equal parts, at 0800 and 1600 h. No refusals were left from the offered diet.

2.3. Treatment B

This treatment was chosen to avoid individual feed intake variation and selectivity, which is usually observed