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RESEARCH ARTICLE

Growth performance and rumen microorganism differ between segregated weaning lambs and grazing lambs

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Abstract

Two feeding patterns of the segregated weaning or grazing in the pasture are carried out worldwide in animal production. To investigate the difference of growth performance and rumen microorganism population related to methane metabolism in the two feeding patterns, three groups of lambs (70 in total) were used: Weaning at 21 days old and being subjected to high-concentration diets (3WK group with 20 lambs), weaning at 35 days old and being subjected to high-concentration diets (5WK group with 20 lambs), or grazing at pasture with the nursing mother (Grazing group with 30 lambs). The growth performance, pH value of rumen content, and the rumen microbes were investigated during weaning period and fattening period with approximately 3 months. Our results showed that lambs in 3WK and 5WK groups demonstrated a better growth performance than the lambs in Grazing group, but no significant difference was observed in the pH value between the three groups (P>0.05). The total rumen bacterial population of the Grazing lambs was significantly lower than that of 3WK lambs (P<0.05) and 5WK lambs (P<0.05); however, the population of methanogens was 4.2- and 2.7-fold lower in the 3WK (P<0.05) and 5WK (P<0.05) lambs compared with Grazing lambs, respectively; protozoa were also 3.5- and 3.4-fold lower in the 3WK (P<0.05) and 5WK (P<0.05) lambs, respectively. The results revealed that segregated weaning lambs may have better growth performance, and reduce methane-producing microbes.

Keywords: weaning, grazing, growth performance, microorganism, methane emission

1. Introduction

Ruminants and humans have shared a long history. Much of our meat and virtually all of our milk are produced by domestic ruminants (Russell and Rychlik 2001). However, in recent years, due to the climate changes observed worldwide, greenhouse gas emissions, particularly, methane from ruminants, which accounts for 9–18% of anthropogenic emissions, have gained increased attention. In addition, methane production represents a loss of between 2 and 12% of the gross energy intake (Johnson and Johnson 1995), which may also result in energy waste. Thus, a variety of nutritional management strategies to reduce methane production in ruminants have been studied by changing the feeding patterns, altering the diet components or adding additives (Abecia *et al.* 2011). Martin *et al.* (2010) demonstrated that methane emissions may decrease by reducing the transfer of hydrogen from protozoa to methanogens when animals were fed high-starch diets. The increasing

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level of grain in diet had also been shown to reduce the proportion of dietary energy converting to methane, which was mainly due to changes in the fermented substrate from fibre to starch (Blaxter and Clapperton 1965). Currently, two feeding patterns of the segregated weaning or grazing with nursing mother in the pasture are performed worldwide in sheep production, but the differences in microorganism associated with potential methane emission in two patterns are not yet fully understood. Thus, the objective of this study was to investigate the changes of protozoa populations, and methanogen populations with quantitative real-time PCR (qPCR) technology in weaning and grazing lambs.

2. Results

2.1. Feed intake, growth performance and pH value of rumen fluid

In current experiment, three groups of lambs (70 in total) were used: Weaning at 21 days old and being subjected to high-concentration diets (3WK group with 20 lambs), weaning at 35 days old and being subjected to high-concentration diets (5WK group with 20 lambs), or grazing at pasture with the nursing mother (Grazing group with 30 lambs). The average intake of the milk replacer was 219 and 260 g d^{-1} for the 3WK and 5WK groups, respectively. The grass meal intake slightly changed during the experiments, and the average intake was 65 and 80 g d^{-1} for the 3WK and 5WK groups, respectively. However, the concentrate supplement intake increased during the experiments (Fig. 1), and the intake of the 5WK group was higher compared to that of 3WK group.

The initial body weight (BW) of 3WK, 5WK and Grazing groups were (5.96±0.24), (10.47±0.94), and (11.52±0.54) kg, respectively, and the BW of the Grazing group was higher compared to those of the 3WK group (P<0.05) and 5WK group (P>0.05). At the end of our experiment, the BW of the 3WK, 5WK and Grazing group lambs reached (27.25±1.11), (35.94±1.05), and (26.19±1.08) kg, respectively, and Grazing group was lower compared to 3WK group (P>0.05) and 5WK group (P<0.05) (Fig. 2).

The pH values of the rumen fluid of the 3WK, 5WK, and Grazing groups were (6.36±0.04), (25±0.02), and (6.32±0.12), respectively, and no significant difference was observed between the three groups (P>0.05, Fig. 3).

2.2. Quantification of ruminal microorganisms

After DNA extraction, the ruminal microorganisms of the three groups were monitored, and the qPCR results were summarized in Fig. 4. The results revealed that the total bacterial population in the grazing lambs was 7.87×10^{10} copies mL^{-1} of rumen fluid, which was significantly lower than those in the 3WK lambs (1.25×10^{11}, P<0.05) and 5WK lambs (1.42×10^{11}, P<0.05). However, an opposite trend was observed for methanogen and protozoa population between 3WK, 5WK and Grazing groups. The methanogen population of 3WK and 5WK groups were 1.11×10^{8} and 1.69×10^{8} copies mL^{-1}, respectively, which were 4.2 and 2.7 times lower than that of Grazing group (4.62×10^{8}, P<0.05). Protozoa were considered to have a symbiotic relationship with methanogens, and the quantity observed was also 3.5- and 3.4-fold lower in the 3WK lambs (P<0.05) and 5WK (P<0.05) lambs, respectively.

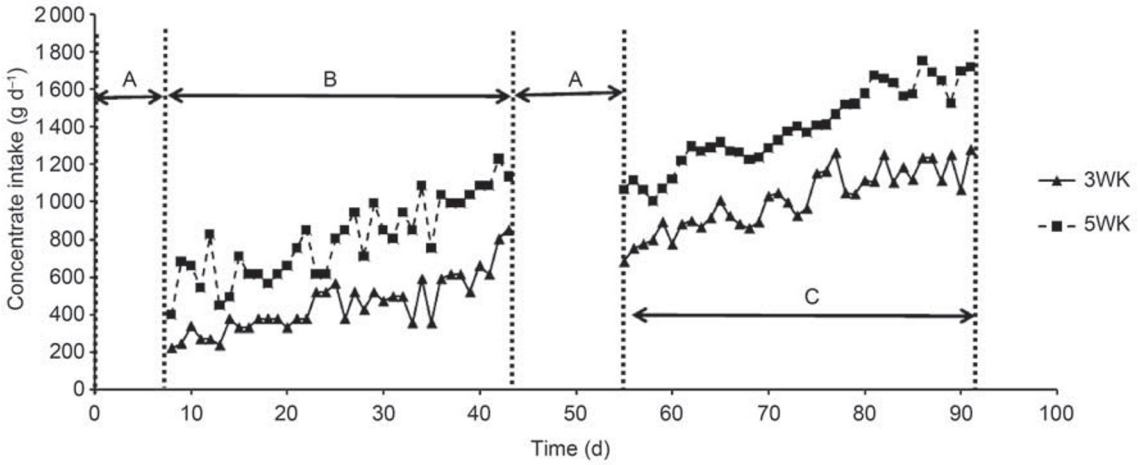

Fig. 1 Concentrate intake of the 3WK and 5WK groups were shown, respectively. The beginning of the experiment was defined as day 0, and stage A represents the period of food shifting. Stage B is the weaning period with milk replacer, grass meal, and concentrate I, and stage C is the fattening period with grass meal and concentrate II. Concentrates I and II are shown in Table 1.