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Effect of restricted time at pasture and indoor supplementation on ingestive behaviour, dry matter intake and weight gain of growing lambs

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ABSTRACT

Herbage intake and production performance of animals are likely to vary between different levels of time grazing pasture because of related changes in foraging behaviour. The effect of restricting pasture access on ingesting behaviour and performance of growing lambs is poorly understood. Thirty-two castrated male Ujumuqin lambs were randomly assigned to the following four treatments: (i) 2-h access to pasture (2H), (ii) 4-h access to pasture (4H), (iii) 8-h access to pasture (8H), and (iv) 12-h access to pasture (12H; control). The lambs began to access pasture at 6:00 h and were removed at 8:00 h, 10:00 h, 14:00 h and 18:00 h for 2H, 4H, 8H and 12H treatments, respectively. All lambs off the pasture were housed and separately fed supplements of concentrate and grass hay. The results showed that ingestive behaviour of lambs was significantly affected by restricting access to pasture. When time at pasture reduced from 12 to 2 h, the proportion of time grazing pasture increased ($P < 0.001$), as did the pasture intake rate ($P < 0.001$), but the proportion of time resting and standing and walking distance decreased ($P < 0.001$). Significant linear relationship was found between supplement and pasture intakes. On average, total feed intake and metabolisable energy intake were unaffected by restricting pasture access, but in July weight gain of lambs clearly increased with less time at pasture. Grazing lambs with supplementation have a good ability to adapt to the restricted grazing schedules through varying their ingestive behaviour. Overall, the results indicate shorter grazing times and higher supplementation in July, with longer grazing times and lower supplementation through August and September is the most efficient to maintain higher lamb growth rates.

1. Introduction

Grassland-based livestock production in China has been practised for millennia, yet continuous overgrazing has substantially reduced the productivity of the grassland systems. In this traditional system based entirely on grazing or with minor amounts of feed supplement in winter–spring, the grazing season always lasts more than 10 months of the year (except 40–60 days of closed-grazing in early spring) and access to pasture often lasts the whole day during the full grazing season. To alleviate the overgrazing of grasslands and realise optimum performance of animals, the strategy of minimizing time on

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pasture in combination with indoor supplementation has been demonstrated in pastoral management systems (Xu et al., 2011; Chen et al., 2013). Studies have found that optimum growth can be obtained with appropriate combination of concentrate and forage in the lamb's diet (Mahajan et al., 1976); restricting the daily grazing of lambs to 4–8 h with 250 g concentrate had a higher weight gain than those grazed for 12-h that were not fed supplement (Xu et al., 2011); and restricting access time to pasture decreased a greater proportion of time spent grazing and the walking distance of Tan sheep (Chen et al., 2013). As a response to restricted access to pasture, animals increase their rate of pasture intake to maintain desired dry matter intake (DMI) and thus the amount of nutrients and energy (Forbes and Mayes, 2002). Low available energy supply will consequently result in a negative energy balance reducing animal production. Conversely, high energy density of feed with high level of concentrate supplementation decreased DMI of animals (Gruber et al., 2014).

The restriction of time for grazing might strongly limit the foraging behaviour of animals, particularly if animals are unable to increase their intake rate (Pérez-Ramírez et al., 2009). In the study of Kristensen et al. (2007), dairy cows offered access of 4 h per day reduced daily milk production and live weight compared with 9 h of access to pasture, in spite of a high rate of supplementation. The lower production seems a direct effect of a lower herbage DMI at pasture. However, the effects of restricting time at pasture combining with indoor supplementation on daily ingesting behaviour, pasture intake and performance of growing lambs is poorly understood.

The objective of the present study was to investigate (i) the changes in behavioural activity of Ujumuqin lambs in response to daily restrictions of time at pasture; (ii) the effects of restricted time to pasture on herbage DMI and weight gain of lambs and, (iii) to identify an optimum feeding strategy that combines time at pasture and supplementation. This information will help to better understand foraging strategies of livestock under restricted time at pasture and further improve grazing management and the productivity of grassland systems.

2. Materials and methods

2.1. Study site

The experiment was conducted over a 99-day period from early July to late September, 2011 in an experimental farm located in eastern Xilinguole (116° 30′E, 44°49′N; alt. 1200 m a.s.l.), Inner Mongolia, China. Here, the climate is semi-arid continental with a mean annual precipitation of 300–360 mm and a yearly average temperature of 2.0 °C. Generally, low temperatures range from −10 to 16 °C with little precipitation from March to May. The central government imposes a policy of closing grasslands to grazing to improve forage growth for a period of 40–60 days in April–May. The main growth period of native vegetation is between June and August when mean temperature is 15–20 °C, and more than 80% of the rainfall occurs. Rainfall is more reliable from late August to September but is less important for plant growth. The non-frost period is 90–120 days from May to September. The natural vegetation grazed in this experiment is dominated by *Stipa krylovi*. Ujumuqin sheep, a local breed for meat and wool, were used. The breed typically produces 2.8–3.6 kg of coarse wool, has a mature live weight of 45–50 kg, produces 1–2 lambs per ewe annually and is highly regarded by local herders for its excellent meat quality.

2.2. Animals and management

Thirty-two castrated male Ujumuqin lambs were randomly assigned to one of four equal treatments with similar body weight (21.86 ± 0.38 kg) and age (120 ± 15 days). The four treatments were: (i) 2-h access to pasture (2H), (ii) 4-h access to pasture (4H), (iii) 8-h access to pasture (8H), and (iv) 12-h access to pasture (12H; control). Three fields of about 10 ha each were divided into four paddocks, giving a total of 12 paddocks of 2.5 each to avoid the interruption of grazing between treatments. Each field was located within a distance of about 100 m of the animal house. All lambs began to access pasture at 6:00 h and were removed at 8:00 h, 10:00 h, 14:00 h and 18:00 h for 2H, 4H, 8H and 12H treatments, respectively. At the end of the time allowed at pasture for each treatment, lambs were separately housed in 32 individual pens and fed supplements of concentrate and grass hay during the rest of the day. The concentrate was separately offered at 18:30 h after grazing within individual fields; and its amount on DM basis was 383 g in the first two months and 425 g in the last month for 2H, 255 g in the first two months and 290 g in the last month for 4H, 215 g in the first two months and 255 g in the last month for 8H, and 110 g in the first two months and 150 g in the last month for 12H treatments, respectively. The grass hay was fed ad libitum from 6:00 h to 21:00 h and was removed from troughs after 21:00 h each day; and it was adjusted daily on the basis of the previous day intake, allowing refusals of 20%. The amounts of hay offered and refused were weighed daily for individual lambs.

Before starting the experiment, the animals were adapted to the experimental conditions over a 12-d period. During this period, the daily intake of concentrate was fixed by the difference between the quantity (g) offered and refused by each lamb and each day. Water and salt blocks were always available for all the sheep throughout the experimental period. All lambs were weighed weekly at 6:00 h prior to grazing.

2.3. Sample preparation

Herbage samples from pasture were collected in the middle of each month from July to September. The herbage was cut and collected manually at 1–4 cm height from 1 m^2 quadrats with thirty-two quadrats per field. The samples were dried in a forced-air oven at 65 °C to a constant mass. Dried samples were ground with a Wiley mill (ZM100, Retsch GmbH, Haan, Germany) and passed through a 1-mm screen for chemical analysis. The chemical composition of each feed and herbage allowance of pasture were given in Table 1.