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Blood hormonal and metabolite levels in grazing yak steers undergoing compensatory growth

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ABSTRACT

Yaks (*Bos grunniens*) are adapted to a harsh alpine environment above the altitude of 3000 m, and show strong compensatory growth ability. The objective of this study was to investigate the plasma hormonal status and metabolite levels of growing yak steers when either offered supplements (SP) or not supplemented (NS) during the annual season of severest pasture shortage in late April and early May. The experiment was conducted between 23 April (day 0) and 8 July 2013 (day 76). Twelve 3-year-old yak steers were allocated to one of two treatments, either to receive supplements for 25 days or to remain unsupplemented. The supplement, which was composed of ground maize (75%) and local rapeseed meal (25%), was offered at maintenance level of energy and protein to the group of yaks receiving supplements from 23 April to 18 May (day 25) at evening. All the yaks were released to pasture during the daytime. Rectal temperature was measured fortnightly using an electro thermometer. Heart rate was recorded over four 4-day periods using modified heart rate monitors. Live weights (LW) were weighed weekly in the morning. Afterward, blood samples were drawn before release to the pasture to measure blood glucose (GLU), blood urea nitrogen (BUN), nonesterified fatty acids (NEFA), β-hydroxybutyrate (BHBA), growth hormone (GH), cortisol, the thyroid hormones (triiodothyronine [T_3] and thyroxine [T_4]), insulin and insulin-like growth factor 1 (IGF-1). The supplemented yaks showed a higher growth rate and compensation ability compared with the unsupplemented yaks. The overall mean heart rates of the unsupplemented yaks were higher than those of the supplemented yaks, and were higher in both treatments in July than in June. There were significant treatment effects on the concentrations of IGF-1, insulin, NEFA and BUN. Whilst supplementation reduced the concentration of IGF-1, it increased the blood concentration of insulin. The differences of blood NEFA between treatments during feed restriction period disappeared in forage growing period. BUN concentrations of SP were significantly lower than NS from day 8 to day 28. Thereafter, BUN concentrations of yaks on the two treatments

Abbreviations: HR, heart rate; DM, dry matter; OM, organic matter; ADF, neutral detergent fiber; NDF, neutral detergent fiber; LW, live weight; CP, crude protein; GLU, blood glucose; BUN, blood urea nitrogen; NEFA, nonesterified fatty acids; BHBA, β-hydroxybutyrate; GH, growth hormone; T_3, triiodothyronine; T_4, thyroxine; IGF-1, insulin-like growth factor 1.

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were similar. The results indicate that supplementary feeding to alleviate nutritional stress in yaks during the period of lowest herbage availability is critical for improving their ability to replace body tissue mobilized over the previous winter months.

1. Introduction

Yak (*Bos grunniens*) have evolved within a high-altitude alpine grassland environment for thousands of years. On the Qinghai-Tibetan plateau they graze extensively all year round, so the seasonal changes in pasture conditions have considerable impact on yak productivity. Yak undergo a period of feed restriction in winter and spring (from October to May), and a period of realimentation during the summer and autumn (from June to September). Unless weather conditions are sufficiently severe to restrict access to pasture during the winter and spring, in most years, normal management practice is not to provide any supplementary feeding. A previous study showed that yak have potential to exhibit compensatory growth enabling them to recover body condition after a long period of feed restriction during the previous winter and spring (Ding et al., 2007). The potential for compensatory growth in animal production has long been recognized (Wilson and Osbourn, 1960). Many explanations have been postulated for the mechanism of compensatory growth, such as reduced maintenance requirement, reduced liver size and energy expenditure (Carstens et al., 1991; Ryan et al., 1993). The proportion of subcutaneous fat increases in the realimentation period because the energetic efficiency use of fat for maintenance and gain is more efficient than protein (Old and Garrett, 1987; Yambayamba et al., 1996a; Ding et al., 2014). Several studies have shown the correlation of ruminants' compensatory growth and endocrine status (Hayden et al., 1993; Yambayamba et al., 1996b; Choi et al., 1997; Ford and Park, 2001). No studies have been conducted to examine yak compensatory growth. The hypothesis of this study is that yaks have substantial ability to exhibit compensatory growth following severe feed restriction. The objective of this experiment was to investigate plasma hormonal status during yak compensatory growth, and to understand the hormonal signals mediating nutrition and metabolism of yak under feed restriction and realimentation.

2. Materials and methods

2.1. Animals and feeding

This experiment was conducted at Wushaoling Alpine Grassland Research Station of Lanzhou University, Gansu Province, China, from 23 April (day 0) to 8 July (day76) in 2013. Twelve 3-year-old yak steers (average initial live weight = 153 ± 11 kg) were used in this study. Steers were allocated to two treatments ($n = 6$/treatment), both being allowed access to extensive grazing, but either without or with a supplementary feed provided from day 0 to day 25 (treatments NS and SP, respectively). The supplement was composed of ground maize (75%) and rapeseed meal (25%) (Table 1) providing an estimated ME concentration of 12.4 MJ/kg DM. Based on the published metabolizable energy maintenance requirement (ME_m) for yaks of 458 kJ/kg $LW^{0.75}$ day (Ding et al., 2014), the weight of supplements offered to each yak was calculated according to the individual yak bodyweight. Supplements were provided to SP yaks in individual bags at evening after the yaks returned from pasture. There were no orts of supplement observed. Supplementation was stopped on day 25. Throughout the experiment, all the experimental yaks were grazing on the pasture 24 h. At the beginning of this experiment, the grass was still dormant, but new green material had begun to emerge by the middle of May, and was growing well by June. The above-ground biomass of the pastures was measured within three periods (April 26 to May 1, May 26 to May 28, July 1 to July 2) measured by cutting the vegetation to ground level within twenty 50 cm × 50 cm quadrats, weighing each sample and drying a sub-sample to determine the DM content. Additional sub-samples were retained for determination of crude protein (CP, AOAC, 1990; method 981.10), organic matter (OM, AOAC, 1990; method 923.03), acid detergent fiber (ADF, Van Soest et al., 1991) and neutral detergent fiber (NDF, Van Soest et al., 1991) contents.

Table 1
Mean (±SE) herbage mass and nutrient content of the herbage and supplement components.

	Herbage mass, DM g/m^2	CP, g/kg DM	OM, g/kg DM	NDF, g/kg DM	ADF, g/kg DM
Herbage					
April 26 –May 1	29 ± 17.5^b	126 ± 8.9^b	886 ± 28.8^{ab}	613 ± 24.2^a	243 ± 22.3
May 26 – May 28	82 ± 11.1^a	153 ± 5.6^a	876 ± 18.2^b	516 ± 15.3^b	196 ± 14.1
July 1 – July 2	92 ± 9.4^a	165 ± 4.7^a	942 ± 15.4^a	508 ± 13.0^b	212 ± 11.9
Ground maize	–	84 ± 1.2	983 ± 1.4	109 ± 0.7	46 ± 1.4
Rapeseed meal	–	328 ± 1.4	903 ± 1.5	267 ± 12.8	186 ± 17.1

Means of herbage components within columns having different superscripts differ significantly at $P < 0.05$.