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Metabolic changes, ovarian function and growth related gene expression in goats given stair-step feeding during estrous cycle

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ABSTRACT

The study was conducted to determine effects of the stair-step feeding during estrous cycle on metabolic changes, ovarian function, and growth related gene expression. Mature goats (n = 48) that exhibited at least two normal, consecutive estrous cycles were randomly assigned to either the control or stair step fed group. In the control group, goats were fed at 100% of nutrient requirement (at a rate to maintain normal growth of 46–50 g/day) throughout two consecutive estrous cycles. The goats in the stair-step group were fed 70 and 130% of the control for first estrous and second estrous cycles, respectively. Blood and ovaries samples were collected throughout the 6-week experiment to examine concentration of blood metabolites, progesterone (P4) and ovarian cells proliferation. Serum glucose, insulin concentrations and number of visible follicles were greater ($P < 0.05$) in stair-step fed goats than in control goats. Serum P4 concentrations were not different ($P > 0.05$) throughout the experiment. Percentages of good oocyte quality obtained from all sizes of follicle were better ($P < 0.05$) in the stair-step fed goats than that of the control goats. Rates of cell proliferation in granulosa and thecal layers across all follicular size, as determined by labeling index, were greater ($P < 0.05$) in stair-step fed goats than in control goats. The mRNA levels of BCL-2 gene in granulosa and thecal layers in all follicular size were similar between groups, except for granulosa layer of follicle size 1–3 mm, expression of BCL-2 gene in the stair-step fed goats was greater than ($P < 0.05$) that of the control group. These data demonstrate the stair-step feeding management affects metabolic, ovarian functions, and expression of BCL-2 gene in goats.

1. Introduction

Compensatory growth, induced by feed restriction and realimentation (or stair-step feeding), is defined as a physiological process by which an organism expedites its growth after a period of restricted development (Hornick et al., 2000). Energy restriction has a profound influence on the biology and health of animals including the retardation of aging and the reduction of cancer incidence and other late-life diseases (Hursting et al., 2003). Realimentation after energy restriction induces compensatory growth, which is characterized by an accelerated anabolism, a reduced maintenance requirement, an activated endocrine status, and an altered tissue composition (Ashworth and Millward, 1986). Compensatory growth enhances the efficiency of general body development and induces hyperplasia and hypertrophy of tissues and organs, including the mammary gland (Park, 2005).

The compensatory growth and stair-step feeding regimens have been applied to livestock species, such as beef (Hays et al., 1995), dairy heifer (Ford and Park, 2001), dairy cow (Choi et al., 1998), pigs (Wiecek et al., 2011), sheep (Yang et al., 2014), and goat (Joemat et al., 2004). Multistep nutrition regimens have also been applied during pubertal and gestational periods in heifers (Choi et al., 1997) and dairy cows (Choi et al., 1998) indicating that compensatory growth during late gestation increases mammary cell proliferation and decreases mammary cell regression throughout the consecutive lactation cycles. However, the multistep feedings are extremely complicated and labor intensive. Therefore, we proposed the sim-

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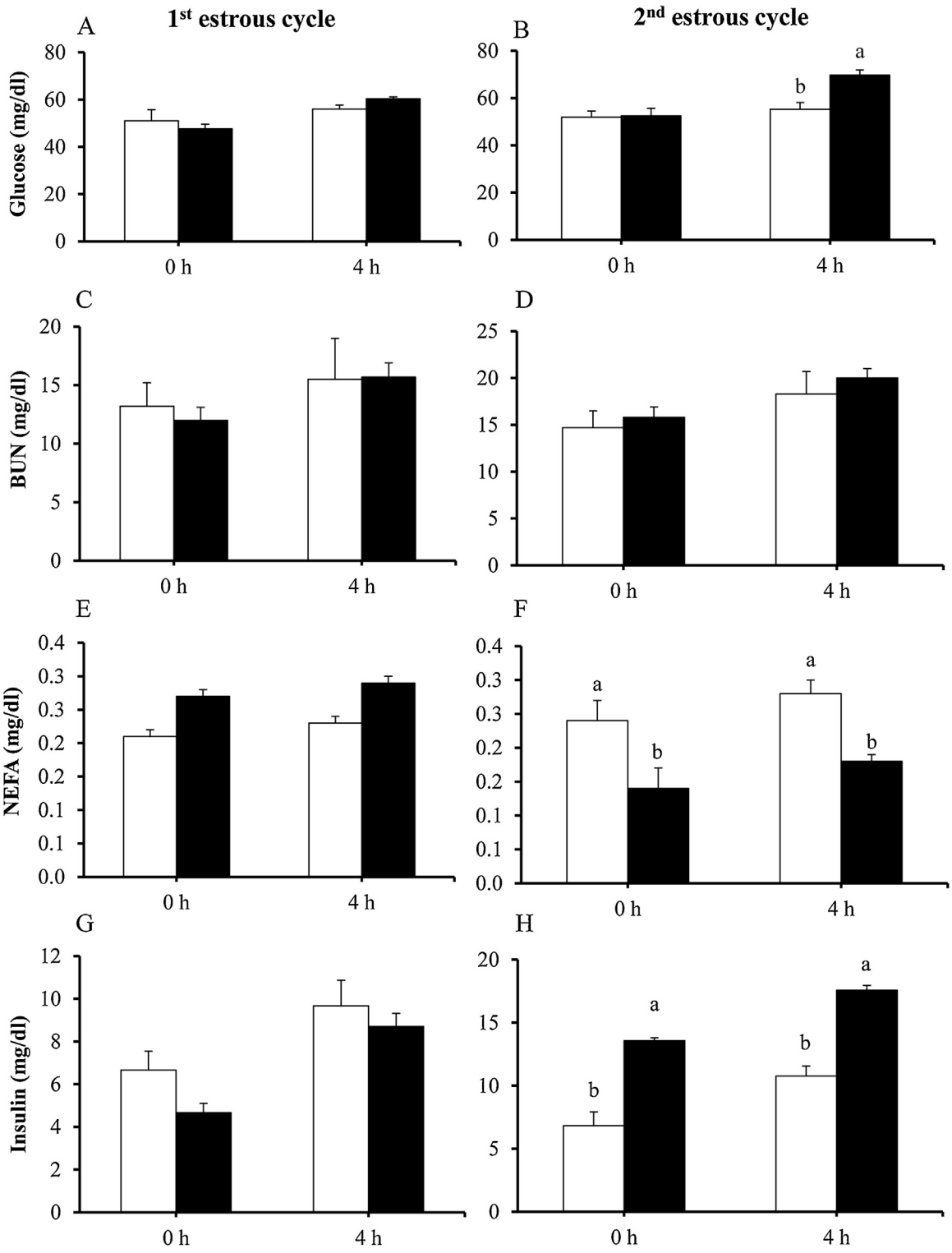

Fig. 1. Effect of stair-step feeding during the 1st and 2nd estrous cycle on serum glucose (A and B), BUN (C and D), NEFA (E and F), and insulin (G and H) concentrations from the control and stair-step fed goats at 0 (prior feeding) and 4 h (post feeding) (a and b differ at $P < 0.05$).

plified stair-step feeding during the estrous cycle. Stair-step feeding evaluated during the pubertal period has positive effect in murine (Kim et al., 1998) and swine (Wiecek et al., 2011). However, the compensatory growth in caprine has not been evaluated. Therefore, the aim of this study was to examine metabolic changes, ovarian function, and growth related gene expression during the estrous cycle in goat fed different regimes.

2. Materials and methods

2.1. Animal and diets

All experimental procedures were managed according to the guidelines approved by the Animal Ethics Committee of Khon Kaen University. Forty eight native non pregnant goats were used with