3-METHYLHISTIDINE AND MUSCLE PROTEIN TURNOVER IN RUMINANTS

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Introduction

Skeletal muscle is the largest tissue in animal bodies. The major protein deposition during growth of farm animals is the increase in muscle protein and the protein deposition. A decrease in the tissues is determined by the relative contribution of protein synthesis and breakdown. Therefore, it is important to measure the degradation and synthetic rates of muscle protein under various physiological conditions. Nonetheless, this has been poorly characterized in farm animals. The urinary excretion of 3-methylhistidine (3MH) has been accepted as a valid index for estimating *in vivo* muscle protein breakdown in rats and some farm animals as well as human (Young and Munro, 1978). The present paper shows the development of this method in goats and applications to dairy and beef cattle.

Materials and Methods

Goat study

To determine whether the excretion rate of 3MH is a valid index for measuring muscle protein degradation in goats, the urinary recovery of radioactivity was estimated for ten consecutive days after an intravenous injection of [$^{14}CH_3$] 3MH (Nishizawa et al., 1989). 3MH pool-sizes in skeletal muscle and other tissues or organs of goat were measured to validate an assumption that most 3MH amounts of goat body occurs in skeletal muscle according to Nishizawa et al. (1979).

Dairy cow study

Urine and blood were collected from 7 Hosteins weighing about 608 kg for 3 months before and after parturition and the role of muscle protein breakdown in lactation was estimated from their 3MH concentrations.

Beef cattle study

The catabolic and synthetic rates of muscle protein in Holstein steers and Japanese black steers during growth were compared.

Calculation of degradation and synthetic rates

The degradation and synthetic rates of muscle protein were calculated from the 3MH content in skeletal muscle and urinary excretion rate (Funabiki et al., 1976; Nishizawa et al., 1979). 3MH was quantified by an amino acid analyzer or HPLC after separation of 3MH from other amino acids with Dowex column (Nishizawa et al., 1978).

Results and Discussion

Goat study

Recovery of the radioactivity in urine was mostly 100% after a dose of radioactive 3MH. Distribution of the radio-activity by ion-exchange chromatography showed that 82.4% of the total radioactivity in urine found was 3MH and about 20% was two other components (Nishizawa et al., 1989), one of which is likely to be N-acetyl-3MH. Also it was suggested that the transport of 3MH to the rumen may be avoided *in vivo*. More than 93.2% of the 3MH amount within the goat's body was found in skeletal muscle. These results suggested a usefulness for the urinary excretion of 3MH as an index of muscle protein degradation in goats.

The degradation and synthesis rates of muscle protein in kids of body weight of 5.1 kg were tentatively estimated to be 2.8 and 4.3%/d, respectively. The degradation rate of muscle protein of the adult goats weighing 35.1 to 38 kg was 1.61%/d.

Dairy cow study

Mean milk production of each animal during

a period of lactation was 7,733 kg. Mean plasma 3MH concentration on day 40 before parturition rose from 0.889 μmol/100 ml on day 80 before parturition to 1.23 μmol/100 ml. Then, 3MH concentration continuously decreased and reached a low level of 0.531 μmol on day 80 after calving. This suggests that the breakdown of muscle protein begins to rise before parturition to provide amino acids for milk production and the demand for gluconeogenesis. The ratio (μmol/mg creatinine) of 3MH concentration to creatinine of urine was 0.073 on day 80 before calving while the value on day 50 after calving increased up to 0.103 μmol/mg, suggesting the supply of amino acids from skeletal and uterus muscles synthesize milk protein by the protein degradation after parturition.

Beef cattle study

The degradation and synthetic rates of muscle protein in Holstein of a mean body weight of 395 kg were 1.53 and 1.82%/d, respectively, while those of Japanese black steers were 1.49 and 1.68%/d.

The present study suggested that goats will be useful as experimental models for researching the turnover rates of muscle protein in beef and dairy cattle by applying this method. Also more detailed characteristics of muscle protein metabolism in dairy and beef cattle will be provided by this technique.

The authors thank Dr. F. Terada of National Institute of Animal Industry for his help in conducting the animal experiment.

(**Key Words**: Ruminants, Muscle, Protein Turnover)

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