Summary of Doctoral Thesis

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UGAS Specialty: Bioproduction science
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Title	**Studies on the Effects of Dietary Urea and Negative Energy Balance on Metabolisms of Glucose and Urea in Sheep**

General introduction

For economical reason, urea could be substituted for rumen degradable protein in ruminant diet because ammonia from urea can be utilized by rumen microbes to form microbial protein. Rumen ammonia, blood ammonia and blood urea concentrations were elevated when urea was hydrolyzed by rumen microbes. High blood ammonia concentration was negative relation with hepatic gluconeogensis. Moreover, negative energy balance (NEB) situation in ruminant production cycle, early lactation period in dairy cow or late gestation in ewe, was associated with depressed gluconeogenesis and also decreased capacity of ureagenesis. Therefore, urea usage during NEB may be argued as it compromises the hepatic gluconeogenesis and ureagenesis under practical feeding condition. It was hypothesized that the urea usage during NEB condition in practical feeding would be more depress rate of gluconeogenesis and ureagenesis.

Experiment 1

The first experiment, the objective was to determine effects of isonitrogenous replacing soybean meal by urea and NEB on nitrogen balance, ruminal fermentations, plasma glucose and urea kinetics in sheep. A crossover design with two different types of isonitrogenous source, either soybean meal or replaced with urea, was assigned to six sheep. High energy diet following with low energy diet treatment was nested in each isonitrogenous source for NEB induction. Plasma glucose and urea turnover rates were determined by the primed continuous infusion. NEB

induction was modest damage with indication by increased (P<0.01) of serum non-esterified fatty acid (NEFA) concentration, while triglyceride and β-hydroxybutyric acid (BHBA) concentrations did not change. Nitrogen retention was lower (P<0.01) in low energy. Rumen pH and ammonia concentration were higher with urea replacement (P=0.04) and low energy (P<0.01). Almost all rumen volatile fatty acid (VFA) concentrations and plasma free amino acid concentrations were lower (P<0.01 and P<0.05) in low energy. Plasma glucose and ammonia concentrations were not influenced by urea replacement and low energy. The glucose turnover rate was lower (P<0.01) in low energy. However, plasma urea concentration and turnover rate were higher (P<0.01) in low energy while had no (P>0.05) effects of urea replacement. These findings suggest that NEB has strong influence on both of glucose and urea kinetics without urea replacement effect and interaction of urea x energy.

The result from first experiment does not accord with hypothesis that the isonitrogenous replacement of soybean meal by urea could effect on plasma glucose turnover rate. The reason may be caused by lower plasma ammonia concentration when compared with other studies that successfully decrease the glucose production. For achieved the hypothesis, urea treatment was increased in second experiment. Moreover, a contrary result from first experiment was showed that plasma urea turnover rate was higher during NEB induction. The primary possible might be due to lack of severe NEB induction and lack of high lipid accumulation in liver cells to impair liver functions. Therefore, NEB induction in second experiment was intended to lower than first experiment.

Experiment 2

The second experiment, the objective was to clarify effects of high urea supplementation and negative energy level on nitrogen balance, ruminal fermentations, microbial protein supply, plasma glucose and urea kinetics in sheep. The experiment was carried out by using 6 x 5 incomplete Latin square designs. The six dietary treatments composed of two levels of urea (low and high) and three levels of energy (low, middle and high) were randomly introduced to six sheep. Plasma glucose and urea turnover rates were determined by using as same as previous method. NEB induction was mild damage with indicate by increase (P<0.01) of serum NEFA concentration according with lower energy levels, while serum BHBA concentration kept in normal range in sheep. Serum total protein, albumin and globulin concentrations did not change. Nitrogen retention was higher (P=0.01) in high energy than lower energy treatment and was also higher (P<0.01) in high urea level than low urea level. The interaction effect of urea x energy with different responding of dietary treatments in rumen pH was identified (P=0.02). Rumen ammonia concentration was higher (P<0.01) in low energy than high energy treatment and was higher (P<0.01) in high urea level than low urea level as well. Total rumen VFA, acetate and propionate concentrations were higher (P<0.01) according with energy levels. Almost of free amino acid concentrations were lower (P<0.05) in high urea level than low urea level treatment and were also lower (P<0.05) during low energy, except arginine concentration was higher (P<0.01). Plasma glucose concentration was not influenced by any dietary treatments. Plasma ammonia and urea concentrations were higher (P<0.01) in high urea level than low urea level while plasma urea concentration was lower (P<0.01) in high energy than lower energy levels. Total microbial nitrogen supply increased (P<0.01) related with increasing of energy levels. The

plasma glucose turnover rate was positive related (P=0.03) according with energy levels, but the plasma urea turnover rate was negative related (P<0.01) with energy levels and was higher (P<0.01) with high urea level treatment. These findings conclude that NEB crucially influences on both glucose and urea kinetics independently without interactions of urea x energy. Urea level supplementation was positive related with ureagenesis.

Finally, the results of this study not accorded with the hypothesis. The major reason is insufficient NEB due to physiological status of the experimental animals. Even NEB was induced by feeding half or one-third of maintenance energy level, the animals can recover in energy homeostasis. However, the natural NEB by increase energy demands, lactating in dairy or high fetal growth rate in ewe, may influence on glucose and urea metabolisms following in this hypothesis.

General conclusion

Soybean meal replaces with urea or high level of urea supplementation in the ration did not affect on glucose turnover rate. However, low energy treatment seriously decreases glucose turnover while increases urea turnover rate independently without interaction effects of urea and energy. The implication of this study raveled that urea replacement or low urea level supplementation was suggested in dietary ration due to limited effects on glucose and urea metabolisms. Unfortunately, NEB is the major inescapable situation with influences on both glucose and urea metabolisms in sheep. Further investigations need to find on the compromising ways between glucose and urea metabolisms during NEB.