The 3rd ISTAP, Faculty of Animal Science, Gadjah Mada University, 2002 *ISBN : 979 – 97243 – 2 - 5*

ENERGY BALANCE AND GLUCOSE METABOLISM OF LACTATING ETAWAH CROSSBRED GOATS FED BY *TEMPE* WASTE

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Abstract

A study involving energy balances and radioisotope-labelling techniques was undertaken to examine the energy metabolism and glucose kinetics on lactating Etawah crossbred goats, using 16 first lactating does (BW 50.0 ± 5 kg). Animals were randomly allotted into four dietary treatment groups that received 50 % King grass plus R_1 : 50% concentrate, R_2 : 25 % concentrate and 25% fresh *tempe* waste, R_3 : 25 % concentrate and 25% fermented *tempe* waste, and R_4 : 25% concentrate and 25% gelatinising of liquid *tempe* waste. The rations offered were containing 16 MJ/kg of GE. Energy balance studies were conducted during a two-week trial for measuring the digestibility and metabolism of energy. Measurement of glucose kinetics using radioisotope technique involved 8 animals that were injected with glucose-2-3H and milk production was collected 2 times a day. The result showed that R_3 was the highest in GE intake compared to the rest of the group. Digestibility energy of R_1 and R_3 was significantly different from R_2 and R_4 ($P< 0.05$). Consistently metabolisable energy of R_1 and R_3 also significant from R_2 and R_4. Glucose metabolism in Etawah crossbred goat receiving R_3 treatment was the best for glucose plasma concentration, glucose pool, distribution space and glucose flux. Milk production in R_3 was 1544 ml/d, significantly different from R_1 (1072 ml/d), R_2 (700 ml/d) and R_4 (570 ml/d). There was a strong supporting that glucose kinetic affected to the milk production.

Key words: Etawah crossbred goat, Glucose kinetic, Lactating goat, *Tempe* waste

Introduction

Tempe is one of favorite foods of Indonesian and made of soybean, which is fermented by fungi. From *tempe* processing there are some waste products, such as solid and liquid waste which can be used for animal feeding. The solid waste product can be used as a fibre source while the liquid waste product can be mixed with gelling agent to make feedstuff. Small ruminant production plays an important

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rule within farming system in the humid tropics of Southeast Asia as an income-generating activity, as a living bank for role in the social life of the village (Wodzicka-Tomaszewska *et al.*, 1993). The factor affecting small ruminant productivity are feeding and breeding management.

Etawah crossbred are indigenous breeds of Indonesia and Malaysia goats, which are small in body size, long ears but well known for milk producer. Glucose is an important nutrient to produce milk. Glucose in ruminants, where absorption from the gut is small, is equally important and its utilization is greater during pregnancy and lactation (Battaglia and Meschia, 1981). Glucose is believed to play a key role in regulating lactation (Mepham, 1993). The latest research showed that glucose metabolism in Etawah crossbred female goat is active, but glucose flux is low compared to temperate ruminant breeds, which may implicate its rule to support production (Astuti *et al.*,2000).

To gain the information about glucose metabolism in Etawah crossbred (long ears), a study involving energy balances and radioisotope-labelling technique was made on 16 first lactating Etawah crossbred fed with *tempe* waste. This research also designed to evaluate the utilization of *tempe* waste to substitute concentrate on the ration.

Material and Methods

Sixteen first lactating female Etawah crossbred goats (10 – 12 months old, long ears and 50 ± 5 kg BW) were observed for up to tree months. Animals were randomly allotted into dietary treatments groups that received 50% King grass plus R_1 : 50% concentrate, R_2 : 25% concentrate and 25% non fermented *tempe* waste, R_3 : 25% concentrate and 25% fermented *tempe* waste, R_4 : 25% concentrate and 25% gelatinising of liquid *tempe* waste. The rations offered were pellets for concentrate and fresh materials for king grass. The energy and protein content of the rations were 16MJ/kg of GE and 14%, respectively. The fermented *tempe* waste was made by fermentation of the solid *tempe* waste using *Aspergillus niger* (0.5%) and dried to make powder, while the gelatinising liquid *tempe* waste was made by using gelling agent (15% maize flour) mixed with liquid *tempe* waste and dried on sun dry to make powder. The nutrient composition of the rations is presented in Table 1.

Table 1. Proximate analysis of the lactating Etawah crossbred rations

Nutrient (%)	R1	R2	R3	R4
Dry matter	91,22	93,74	93,74	94,02
Crude Protein	14,00	14,25	14,10	13,01
Fat	4,83	3,99	3,80	4,70
Crude fibre	20,61	29,94	29,27	20,0
Gross Energy (MJ/kg)	16.44	15,56	16.55	15.43

A two-week energy balance trial composed of 4 days to get the animals accustomed to the faeces bag, followed by 10 days total collection of excreta and unconsumed feed. Adaptation to the experimental feed for the pregnant does started from the 3rd months of pregnancy and continued until 3rd months of lactation. Data on milk yield were obtained twice a day by hand milking followed by injection of oxytocin. Glucose kinetics (pool and flux) were measured by the single injection of glucose-2-^{3}H as described Sastradipradja *et al.*, (1976). The glucose flux was estimated from the exponential decrease in plasma glucose-2-^{3}H specific activity (SA). Glucose pool size was calculated by dividing dose of injected glucose-2-^{3}H by the SA value found from extrapolation of ^{3}H-glucose SA to zero time. Glucose space of distribution was calculated by dividing pool size by plasma glucose concentration, expressed as % BW.

A completely randomised design with one way classification for each group was adopted. The significance of difference between means was compared using Duncan's Multiple Range Test (Steel and Torrie, 1986).

Results and Discussion

The results of the energy balance and glucose kinetics are presented in Table 2 and 3.

Table 2. Energy balance of lactating Etawah crossbred goat fed with *tempe* waste

Parameters	R1	R2	R3	R4
DM intake (g/d)	1053^{q}	982^{q}	1382^{p}	1002^{q}
Energy intake (MJ/d)	17.83^{qr}	14.29^{qr}	21.6^{p}	14.8^{r}
Energy digest. (MJ/d)	16.29^{p}	12.36^{q}	15.93^{p}	11.67^{q}
ME intake (MJ/d)	14.16^{p}	10.28^{q}	13.35^{p}	9.98^{q}
ME/DE	86	83	84	85

$^{p, q, r}$ Means in the same row followed by different letters are significantly different ($P<0.05$)

The values of DM intakes in this research range from 0.98 to 1.38 kg/d. where the highest was done in R_3. Alderman *et al.*, (1995) reported that DM intake for lactating goats (50 kg BW) produced 1 kg of milk was around 1.30 – 1.50 kg/d, while for the ME intake at the same physiological state was around 9.40 – 14.40 MJ/d during 1st to 3rd lactation. The energy intakes in R3 were the highest compared to the others. Palatability was the main factor, which influenced to the intake. Energy digestibility of R_1 and R_3 were higher than R_2 and R_4 ($P<0.05$), while the value of ME intake in this research were around 9 – 14 MJ/d, which were same with Alderman *et al.* (1995) recommendation.

Table 3. Glucose metabolic parameters and milk yield of lactating Etawah crossbred goats

Parameters	R1	R2	R3	R4
Glucose:				
Concentration (mg%)	65^{q}	60^{q}	79^{p}	50^{r}
Flux (mg/min.animal)	22.10^{q}	24.70^{q}	30.20^{p}	21.16^{q}
Pool (g/animal)	9.22^{pq}	9.10^{pq}	13^{p}	8^{q}
Space (% BW)	19^{q}	20^{q}	25^{p}	18^{q}
Milk yield (g/d)	1072^{q}	700^{r}	1544^{p}	567^{r}
Milk protein (g/d)	45.82^{q}	28.27^{r}	67.51^{p}	19.28^{r}
Milk lactose (g/d)	41.81^{q}	20.81^{r}	57.76^{p}	23.24^{r}
Milk fat (g/d)	44.48^{q}	21.98^{r}	58.50^{p}	23.23^{r}

$^{p, q, r}$ Means in the same row followed by different letters are significantly different ($P<0.05$)

The results (Table 3.) showed that plasma glucose concentration were relatively normal for the ruminants, nevertheless glucose flux, pool and space in R_3 were the highest. Astuti *et al.*, (2000) reported that the values of glucose flux were 14 to 29 mg/min.animal following the level feeding, while Kiranadi *et al.*, (2002) reported that glucose flux on Etawah cross bred goat fed with silage were 2.52 to 4.50 mg/kg-$BW^{0.807}$. The values of glucose flux in these treatments were around 21.60 to 30.20 mg/min.animal. This means that those values were higher than both reported before. Pool glucose range from 8 – 13 g/animal, which was higher than, reported before (135 mg/kg) Kiranadi *et al.*, (2002).

The data on space of distribution of glucose for animals receiving enough ME intakes demonstrated that glucose space were the same with the theoretical value of 20 % BW. The Etawah crossbred has higher performance for glucose metabolism. This result was closer to the *tempe*rate goats. For the milk yield and milk quality, R_3 had the highest productivity followed by R_1, R_2, and R_4.

Conclusion

The present investigation with Etawah crossbred goats with long ears revealed that utilization of *tempe* waste could substitute 50 % of concentrate on the ration and fermented *tempe* waste was more palatable than other ration for the animals. This research also showed that glucose kinetics on lactating Etawah crossbred goats affected to the milk production.

Acknowledgement

The authors wish to thank to URGE Project IPB-UGM Collaborative Research Program from the Department of National Education of the Republic of Indonesia, for funding this research.

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