Bulletin of Animal Science, Supplement Edition, 1998 *ISSN 0126-4400*

NITROGEN BALANCE IN DAIRY GOATS OFFERED NITROGEN SUPPLEMENTS IN ISOCALORIC RATIONS

A.R.S. Asih[1], B.A. Young[2], S. Baxendell[3] and K.G. Wiryawan[1]

ABSTRACT

Four late lactating Saanen goats were assigned into a Latin Square design experiment to evaluate the effectiveness of nitrogen (N) supplements in a high energy ration. The daily rations were 50 % barley hay and 50 % concentrate, based on the amount consumed during preliminary observations. The concentrate was barley meal (BM), or BM supplemented with either soybean meal (BSBM), cottonseed meal (BCSM) or urea (BU) to provide about 2.7% N and 3 Mcal ME kg^{-1} DM. The unsupplement BM contained 1.7 % N. The goats were milked once daily and yield and milk nitrogen determined. Total fecal and urine collection was made during the last seven days of each six weeks treatment period. Addition of different N sources to the ration did not increase milk yield or protein content. The N balance in the goats were not significantly different but those receiving the N supplements had higher excretion of N in urine than the BM control. The study indicates that goats producing 1.3 to 1.5 liter of milk per day offered a concentrate containing 1.7 % N in a high energy diet can maintain similar milk protein and nitrogen balance as those offered 2.2 % N. The excess of N intake of the supplemented diets was excreted in the urine.

Key words: Nitrogen balance, Dairy goats, Nitrogen sources, Milk yield, Milk protein.

INTRODUCTION

The world goat population is growing especially in developing countries and their economic importance is becoming more visible (Park *et al.*, 1989). However, specific practical nutritional information on goats is rare due to lack of research (Haenlein, 1980; Sengar, 1980; NRC, 1981; Sauvant *et al.*, 1991a; Sauvant *et al.*, 1991b) and currently, information on sheep nutritional requirements is used for goats (Singh and Mudgal, 1983; Louca *et al.*, 1982; Hadjipanayiotou *et al.*, 1991a; and Brun-Bellut *et al.*, 1991). The use of sheep nutritional requirement as a reference of feeding for goats may not be justifiable because of different physical, behavioral and feeding activities (Mowlem, 1988; Narjisse, 1991; Morand-Fehr *et al.*, 1991; NRC, 1981; Gaili *et al.*, 1972). The use of different nitrogen sources as protein supplement for milk production in goats is controversial (Lu *et al.*, 1990; Fernandez *et al.*, 1988; Broderick *et al.*, 1993; Sahlu *et al.*, 1993; Hadjipanayiotou and Koumas, 1991 and Hadjipanayiotou, 1992). Possibly because of differences in the density of energy used in experimental rations and the proportion of nitrogen source tested in the various studies.

The aim of the present study was to determine the effectiveness of different nitrogen supplements (barley meal plus soybean meal, cotton seed meal or urea) in high isocaloric diet on total nutrient intakes, milk-feed efficiency, milk production and nitrogen balance in late lactating dairy goats.

[1] Faculty of Animal Husbandry, University of Mataram, Mataram 83125, Indonesia
[2] School of Veterinary Science and Animal Production, The University of Queensland Gatton, QLD, 4345. Australia. E-mail: ar@warigal.uqg.uq.oz.au
[3] Queensland Department of Primary Industries, PO Box 102, Toowoomba, QLD, 4350. Australia

MATERIALS AND METHODS

Diets

Four isocaloric (3 Mcal ME/kg DM) concentrate mixtures were formulated for milking goats. Three with nitrogen supplement and a control containing barley meal only (BM). The nitrogen (N) supplemented concentrates were barley meal plus soybean meal (BSBM), barley meal plus cottonseed meal (BCSM) and barley meal plus urea (BU). Except for BM (1.7 % N), all diets were isonitrogenous (2.7 % N) and almost isoproportion in terms of N contribution from barley meal (57 to 59%) and the added N source (41 to 43%). The concentrates were adjusted with added canola oil to achieve near equal metabolizable energy content. The daily rations offered were 50 % hay and 50 % concentrate, and total amount based on amount consumed during preliminary observations. The rations were offered in equal amounts and fed twice daily at 09:00 am and 17:00 pm. A mineral block designed for goats (Go-Block, manufactured by Olsson Industries Pty Ltd. Brisbane, Australia) and fresh water were available *ad-libitum*.

Animals

Four late lactating Saanen goats with average initial body weight of 71.7 ± 4.9 kg were penned in individual cages. The goats were allowed an adjustment period of 2 weeks, during which time they were all fed the same diet of barley hay and concentrate containing an equal amount of BSBM, CSBM and BU mixture. The purpose of the adaptation period was to stabilize goats` body condition and to accustom them to eating the concentrate in the experimental situation. In addition, all goats were treated at the start of the study with Ivermectin to minimize intestinal parasites.

Design and experimental procedure

A Latin Square design (4x4), was used for the trial which consisted of four periods of 6 weeks duration. The first 5 weeks were allowed for the goats to adjust to the test diet and to have 6 hours weekly exercise in a small yard. The N balance data was collected during the sixth week.

Measurements

The goats were machine-milked once a day at 8:00 and milk samples were taken for N analysis. Body weights were measured weekly immediately after milking and before the 9:00 feed. Daily intakes of both hay and concentrate were determined by subtracting any refusals from the amount offered. The refusals of hay and concentrate were separated for later analysis. Dry matter (DM) and N intake of both hay and concentrate were calculated from analysis of daily feed offered and refusals.

Sampling methods

The feed and refusal for each animal was sampled daily for chemical analysis. N balance measurement (feed intake minus fecal, urine and milk out put) were made during the last 7 days of each period. Total daily fecal output of each animal was measured and a 20 % sub-sample collected every day, directly dried in a forced draught oven at 59 °C and then ground to 1 mm particle size prior to the chemical analysis. Daily urine was collected into a plastic container containing glacial acetic acid (50 ml) to retain nitrogen in the urine. A 10 percent sub-sample from each animal was frozen and stored at −16 °C proceeding chemical analysis.

Chemical and statistical analyses

The content of DM, ash and organic matter (OM) of feeds, feed refusals, milk, fecal and urine samples were determined according to standard procedures (AOAC, 1984). The nitrogen contents were analyzed using an automatic FP-200 nitrogen analyzer (LECO Corporation, Michigan, USA) based on the combustion method (Sweeney, 1989).

The data obtained was analyzed by using General Linear Model (GLM) procedure of SAS® (SAS Institute, Inc. 1990). When dietary treatment effects were significant ($P<.05$), mean separation was by least significant difference.

Table 1. Nutrient intakes, milk yield and body weight changes of goats fed different concentrate treatments

	Treatments				SEM*
	BM	BSBM	BCSM	BU	
DMI (g day^{-1})	1862.0	1811.5	1952	1662.7	114.72
OMI (g day^{-1})	1728.1	1669.0	1799.5	1542.9	109.77
Milk production (g day^{-1})	1466	1420.6	1541.1	1311.0	120.11
Efficiency (milk/DMI)	0.78	0.81	0.80	0.79	0.04
N content of milk (%)	0.50	0.53	0.53	0.52	0.009
BW (kg)	71.6	72.7	72.2	70.3	0.0001

*SEM = standard error of the means

RESULTS AND DISCUSSION

There was no significant difference in intakes of dry matter and organic matter across the treatments (Table 1). While average daily body weight gains (9; 109; 14 and 64 g/day for BM; BSBM; BCSM and BU, respectively) differed amongst the treatments, the substantial individual animal variation meant treatment differences were not significantly different.

Milk yield, N content of milk and feed efficiency (milk/DMI) amongst treatments was also not significantly different. Our results are in agreement with those reported by Brun-bellut *et al.* (1990) who found that increasing level of N content of diets from 1.9 to 2.4 % per DM and offered to milking Alpine goats did not significantly increase milk yield, N content of milk and feed efficiency because of non significant difference in digestible OM, net energy intakes and energy balance between treatment groups. The utilization of dietary nitrogen might be more influenced by the availability of digestible energy in the diets. Badamana *et al.* (1990) were also unsuccessful in increasing N content of Saanen goats' milk by increasing N of concentrates from 1.9 to 2.96 % (1.6 to 1.98 % N in total diet), but milk yield and hay intake were increased. The goats used by Badamana *et al.* (1990) were in early lactation (3 weeks after kidding) compared to the present study where late lactation (after 5-6 months after kidding) does was used. Badamana and Sutton (1992) found that further increase in hay intake and milk yield was not achieved by increasing the level of N concentrate up to 4.1% (2.72 % N in total diet). They concluded that the optimum N

Table 2. Nitrogen utilization (g/1000g DMI) of goat fed different concentrates

	Treatments*				SEM**
	BM	BSBM	BCSM	BU	
N intake	17.6 [a]	22.2 [b]	22.53 [b]	22.5 [b]	0.45
Milk N	3.9	4.2	4.3	4.0	0.21
Fecal N	7.1 [a]	7.4 [a]	8.3 [b]	6.6 [c]	0.12
Urinary N	4.6 [a]	8.9 [b]	8.1 [b]	9.9 [b]	0.52
Total N output	15.6 [a]	20.4 [b]	20.7 [b]	20.5 [b]	0.52
N balance (g / day)	2.1	1.8	1.8	2.1	0.15

*Means within the same row with different superscripts are different (P<.05).
**SEM = standard error of the means

Table 3. The actual nitrogen utilization (g/day) of goat fed different concentrates

	Treatments*				SEM**
	BM	BSBM	BCSM	BU	
N intake	32.8 [a]	40.3 [ab]	43.8 [b]	37.5 [a]	2.91
Milk N	7.27	7.35	8.03	6.75	0.49
Fecal N	13.2 [a]	13.3 [a]	16.3 [b]	10.8 [a]	0.82
Urinary N	8.7 [a]	16.0 [b]	15.6 [b]	16 [b]	1.70
Tot. N output	29.1 [a]	36.6 [ab]	39.9 [b]	34.2 [a]	2.76
N balance	3.7	3.7	3.9	3.3	0.15

*Means within the same row with different superscripts are different (P<.05).
**SEM = standard error of the means

content of concentrate for dairy goats was 2.9 % or 2.24 % N per/DM total diets.

Although the treatment concentrates of this present study were formulated isonitrogenous (2.7 % N and 1.7% for the control), the N content of total intake of goats fed BM; BSBM; BCSM and BU diets was only 1.55; 2.22; 2.32; 2.27 % in DM respectively. This discrepancy might due to the relatively low N content of the hay (1.84 % N) and slightly change in proportion of hay and concentrate ratio from 50:50 offered to be 47:53; 51:49; 46:54; 46:54 for BM; BSBM; BCSM and BU diets respectively. It seems that the goats changed the proportion of hay and concentrate to adjust their nutrient needs to maintain milk production. It also can be seen from adjustment of N out put through the feces and urine (Table 2 and Table 3).

The 2.24 % dietary N content in total intake for BSBM; BCSM and BU treatments in the present experiment were in agreement with the optimum level of N as suggested by Badamana and Sutton (1992). However, these treatments resulted in similar milk N, milk yield and body weight changes compared to the BM control diet, which only had 1.7 % N of concentrate or 1.55 % N in total diet. There was a tendency for the goat to excrete more N via urine, when higher N diets were offered. Brun-Bellut *et al.* (1990) and Osuagwuh and Akisoyinu (1990) also found that with increasing N in the diets, the fecal N and urinary N increased. Similarly, Badamana *et al.* (1990) claimed that with increasing N intake, fecal N changed slightly but urinary N increased markedly. These may be indication that goat offered low N diets may have higher efficiency of urea recycling. Further direct studies in different ration need to be developed to establish the utilization of recycled urea, particularly in the goats.

Dietary energy plays an important role in optimizing utilization of recycled urea. Kennedy and Milligan (1980) after reviewing previous works concluded that addition of readily available fermented energy source in the diet increased the utilization of recycled urea in the rumen. Engelhardt *et al.* (1978) cited Hinderer's findings (unpublished data) that feeding a high energy, low protein diet to goats could stimulate a maximum urea degradation of 36 g N/ day which represented 96 % of endogenous urea production. The recycling value decreased sharply, when the energy diet content reduced, despite similar urea production rate.

In term of utilization of N sources by milking dairy goats, our finding are in contradiction to those of Lu *et al.* (1990) who evaluated the utilization of soybean and hydrolyzed feather meals for milking Alpine goats. By offering isonitrogenous and isocaloric diets (16 % CP and 2.4 Mcal ME/kg) to their goats, Lu and coworkers found that milk protein content increased (P<.05) with soybean meal supplementation. Several workers (Loiseau, 1993; Vassal *et al.*, 1994) have found that level of milk protein in goat differed among breeds, even though they were given similar diets. The above observation of Lu *et al.* (1990) may be a breed specific response and needs further investigation.

It is worth noting that goats offered the addition of urea in concentrate (BU) reduced (P<.05) their fecal N output compared to the goats without receiving addition of N, when expressed on a unit intake basis (Table 2), but not on an absolute basis (Table 3). The urinary N excretion of the BU treatment was significantly higher than the BM treatment, but still comparable amongst the N source treatments (BSBM and BCSM). However, total milk N and N balance across treatments were not significantly different. This study suggested that urea can maintain similar level of milk yield and milk protein and also milk efficiency in goats compared to soybean and cottonseed meals provided that the level of readily available energy of diet is similar.

CONCLUSION

The study indicates that milking goats produced 1.3 to 1.5 liters of milk per day offered a concentrate containing 1.7 % N in high energy diet can maintain similar milk protein and nitrogen balance as those offered 2.2 % N. Excess N intake was excreted in the urine. The results suggest that urea can maintain similar level of milk yield, milk protein and milk efficiency in goats similar to soybean and cottonseed meals provided there is sufficient readily availability of dietary energy.

ACKNOWLEDGMENT

Mr. Andy Goodwin is thanked for his assistance in handling the goats and Ms. Kaye Vockenson is thanked for her technical assistance in nitrogen analysis.

REFERENCES

AOAC. 1984. *Methods of Analysis.* 14th Ed. Association of Official Analytical Chemists. Washington, DC 20044.

Broderick, G. A., W. M. Craig and D. B. Ricker. 1993. Urea versus true protein as supplement for lactating dairy cows fed grain plus mixtures of alfalfa and corn silage. *J. Dairy Sci.*, 76: 2266.

Badamana, M. S., J. D. Sutton, J. D. Oldham and A. Mowlem. 1990. Effect of amount of protein in the concentrate, on hay intake and rate of passage, diet digestibility and milk production in British Saanen goats. *Anim. Prod.*, 51:333.

Badamana, M. S. and J. D. Sutton. 1992. Hay intake, milk production and rumen fermentation in British Saanen goats given concentrates varying widely in protein concentrate. *Anim. Prod.*, 54: 395.

Brun-Bellut, J., G. Blanchart and B. Virgon. 1990. Effects of rumen-degradable-protein concentration in diets on digestion, nitrogen utilization and milk yield by dairy goats. *Small Rumin. Res.*, 3: 575.

Brun-Bellut, J., J. E. Lindberg and M. Hadjipanayiotou. 1991. Protein nutrition and requirements of adult dairy goats. In: P. Morand-Fehr (Editor), Goat Nutrition, *EAAP Publication.* No. 46, pp. 82-93. Pudoc, Wageningen, Netherlands.

Engelhardt, W. V., S. Hinderer and E. Wipper. 1980. Factors affecting the endogenous urea-N secretion and utilization in the gastrointestinal tract. In: D. F. Osbourn, D. E. Beever and D. J. (Editors), *Ruminant digestion and feed evaluation.* A.R.C. London.

Fernandez, J., T. Sahlu, C.D. Lu and M. J. Potchoiba. 1988. Physiological and lactational response of dairy goats to urea supplement. *J. Dairy Sci. Suppl.*, 71: 162.

Gaili, E. S. E., U. S. Ghanem, and A. M. S. Mukhtar. 1972. A comparative study of some carcass characteristics of Sudan desert sheep and goats. *Anim. Prod.*, 14: 351.

Hadjipanayiotou, M., J. Brun-Bellut and J. A. Lindberg. 1991a. Protein nutrition and requirements of growing goats. In: P. Morand-Fehr (Ed.) Goat Nutrition, *EAAP Publication.* No. 46, pp. 94-103. Pudoc, Wageningen, Netherlands.

Hadjipanayiotou, M. and A. Koumas. 1991. Effect of protein source and on performance of lactating Damascus goats. *Small Rumin. Res.*, 5:319.

Hadjipanayiotou, M. 1992. Effect of protein source and formaldehyde treatment on lactation of Chios and Damascus goats. *Small Rumin. Res.*, 3:185.

Haenlein G. F. W. 1980. Nutrient requirements of dairy goats, Past and Present. Intren. *Goat and Sheep Res.* 1: 79.

Kennedy, P. M. and L. P. Milligan. 1980. The degradation and utilization of endogenous urea in the gastrointestinal tract of ruminants: a review. *Can. J. Anim. Sci.*, 60:205.

Louca, A., T. Antoniou and M. Hatzipanayiotou. 1982. Compara-tive digestibility of feedstuffs by various ruminants, specifically goats. In : On Goat Production and Disease. pp. 122 - 132. *Inter. Conf., Jan.*, 10 - 15, Arizona (USA).

Lu, C. D., M. J. Potchoiba, T. Sahlu and J. .M. Fernandez. 1990. Performance of dairy goats fed isonitrogenous diets containing soybean meal or hydrolyzed feather meal during early lactation. *Small Rumin. Res.*, 3:425.

Loiseau, M. 1993. A Hundred goat, milk and milk protein content. *Chevre*, 194: 22.

Morand-Fehr, P., E. Owen and S. Giger-Reverdin. 1991. Feeding Behaviour of Goats at The Trough. In: P. Morand-Fehr (Editor), Goat Nutrition, *EAAP Publication* No. 46, pp. 3-12. Pudoc, Wageningen, Netherlands.

Mowlem, A. 1988. *Goat Farming*. Farming Press Books, United Kingdom.

Narjisse, H. 1991. Feeding Behaviour of Goats on Rangelands. In: P. Morand-Fehr (Ed.) Goat Nutrition, *EAAP Publication*. No. 46, pp. 13-24. Pudoc, Wageningen, Netherlands.

NRC. 1981. *Nutrient Requirement of Goats: Angora, Dairy, and Meat Goats in Temperate and Tropical Countries.* National academy Press, Washington D. C. (USA).

Osuagwuh, A. I. A. and A. O. Akinsoyinu. 1990: Efficiency of nitrogen utilization by pregnant West African dwarf goats fed various levels of crude protein in the diet. *Small Rumin. Res.*, 3:363.

Park, Y.W., G. A. Reynolds and T. L. Stanton. 1989. Comparison of Dry Matter Intake and digestibility of Sun-Cured Pigion Pea, Alfalfa and Coastal Bermuda grass by Growing Dairy Goats. *Small Rumin. Res.*, 2:11.

Sahlu, T., J. M. Fernandez, Z.H. Jia, A. O. Akinsoyinu, S. P. Hart and T. H. Tehe. 1993. Effects of source and amount of protein on milk production in dairy goats. *J. Dairy Sci.*, 76:2701.

SAS Institute Inc., 1990. *SAS STAT User's Guide, version 6*, 4th ed. SAS Institute Inc., Cary, NC. USA, Vol. 2, pp. 891-996.

Sauvant, D., Y. Chilliard and P. Morand-fehr. 1991a. Etiological aspects of nutritional and metabolic disorders of goats. In: P. Morand-Fehr (Ed.) Goat nutrition, *EAAP Publication* No. 46, Pudoc, pp. 124 - 142. Pudoc, Wageningen, Netherlands.

Sauvant, D., P. Morand-fehr and S. Giger-Reverdin. 1991b. Dry matter intake of adult goats. In: P. Morand-Fehr (Ed.) Goat nutrition, *EAAP Publication* No. 46, pp. 25-36. Pudoc, Wageningen, Netherlands.

Sengar, O. P. S. 1980. Indian research on protein and energy requirements of goats . *J. Dairy Sci.*, 63:1655.

Singh, N. and V. D. Mudgal. 1983. Effect of level of protein intake on milk secretion and feed conversion efficiency in goats. Indian *J. Anim. Sci.*, 53:524.

Sweeney R. A. 1989. Generic combustion method for determination of crude protein in feeds: Collaborative study. *J. Assoc. Off. Anal. Chem.*, 72(5):770.

Vassal, L., A. Delacroix-Buchet and J. Bouillon. 1994. Effect of AA, EE

ISSN 0126-4400

and FF genetic variants of alphas1-casein from goat milk on cheese yield an sensory properties of traditional cheeses: preliminary observations. *Lait.*, 74:89-103.