EFFECT OF SUPPLEMENTATION AND PARASITIC INFECTION ON PRODUCTIVITY OF THAI NATIVE AND CROSS-BRED FEMALE WEANER GOATS
I. GROWTH, PARASITE INFESTATION AND BLOOD CONSTITUENTS

W. Pralomkarn[1], S. Kochapakdee, S. Choldumrongkul and S. Saithanoo

Small Ruminant Research and Development Centre, Faculty of Natural Resources
Prince of Songkla University, Hat Yai, Songkhla, 90110 Thailand

Summary

This paper presents the effects of supplementary feeding and internal parasites on the growth rates of female weaner goats raised under improved management. A completely randomised 3 × 3 × 2 factorial design was used. Factors were genotype (Thai native; TN, 75% TN × 25% Anglo-Nubian; AN and 50% TN × 50% AN), feeding (grazing only, low (1.0% BW/d) and high (1.5% BW/d) supplementation) and parasite control (undrenched and drenched). It was shown that native goats had significantly ($p < 0.05$) higher growth rates than did the cross-bred goats from 12-24 weeks of the trial. The growth rate of goats grazing improved pasture depended on the amount of concentrate offered as a supplement. There was no significant difference in growth rates between undrenched and drenched goats. There was no interaction effect on growth rates between the treatments. Drenched goats had significantly ($p < 0.01$) lower egg counts per gram of gastro-intestinal nematode than did undrenched goats. There was no significant difference between the treatments for blood constituents (total protein, haemoglobin, packed cell volume, eosinophils, lymphocytes, monocytes and basophils).

(Key Words: Thai Goat, Anglo-Nubian Cross-Bred, Feeding, Supplementation, Drenching)

Introduction

Post-weaning growth rates of Australian cashmere kids grazing improved pastures in Queensland, Australia, were poor, especially in the autumn period, despite adequate quantity and quality of pasture (Ash and Norton, 1984). At the Prince of Songkla University (PSU) in southern Thailand, a program of research is being undertaken to evaluate the impact of various management strategies tegies on productivity. There is little definitive information on the potential of Thai goats to respond to improved management, especially on pasture. Kochapakdee et al. (1994) found that female goats grazing newly established pastures had significantly higher growth rates when supplemented with 0.75% BW/d of a concentrate diet than did goats with no supplement or those supplemented with 0.25% BW/d. There is no information available on the level of supplementary feeding required, or parasite levels in weaner female goats maintained at pasture under low stocking rates. Kochapakdee et al. (1993) found that the cross-bred raised under poor nutrition and/or under high stocking rate in the village would require a 4-6 week drenching to suppress parasite burden. Nevertheless, it is suggested that drenching alone would not result in increased weight gain unless the nutritional status is also improved. This information is essential if recommendations are to be developed for village production. The response of different genotypes to supplementary feeding and to parasites is also of interest. Additionally, environment affects production of goats and so our experiment was conducted during both wet (October-December) and dry (January-March) periods.

The aims of this study were to determine the growth rates, to study haematology, and to monitor the health, of female weaner goats given different levels of supplementary feeding, and different degrees of parasite control while grazing pastures.

Materials and Methods

Location and climate

The study was conducted at the Small Ruminant Research and Development Centre Research Farm, Hat Yai, Thailand. The region has a tropical

[1]Address reprint requests to Dr. W. Pralomkarn, Small Ruminant Research and Development Centre, Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songkhla, 90110 Thailand.

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humid climate with a mean annual rainfall of 2,094 mm. The dry period extends from January to April, and there is a marked incidence of rainfall in May-June and October-November. Temperatures vary from 20 to 35℃, with relative humidity of 68-88% (Milton et al., 1987).

The soils are classified as low humic gleys (pH 5.1) and are deficient in nitrogen, phosphorus, potassium, calcium and sulphur.

Animals and their management

The kids were born in the campus of Prince of Songkla University from mid March to late April 1992. Kids were weaned at 12 weeks of age and were drenched to control internal parasites (Panacur, 125 mg fenbendazol/kg BW, Hoechst Veterinary GmbH, Germany) and (Mansonil-M, 100 mg niclosamide monohydrate/kg BW, Bayer, Australia Ltd.) as they were weaned into separate pens for males and females. A few days later, kids were given vaccinations against foot and mouth disease (Type A, O & Asia 1) and haemorrhagic septicaemia. Female weaners were rotationally grazed in paddocks and offered a concentrate (15% crude protein) at 1.75% BW/d. Details of the goat management were described by Milton et al. (1991). The kids were taken to Khong Hoi Khong (KHK) Research Station and grazed in a good paddock with the same rate of concentrate supplementation. The kids were drenched to control internal parasites with Panacur and Mansonil-M immediately prior to introduction to the experimental treatments (about 6 months of age). The experimental area consisted of 4 × 1.3 ha paddocks. All goats were grazed on each paddock on a 4 week rotation. Goats were housed overnight in sheds, with access to pasture from 08:00 to 17:00 h daily.

Experiment 1 commenced on September 28 and lasted until December 31, 1992; experiment 2 commenced on January 1 and lasted until March 18, 1993.

Experimental design

Forty-six female weaner goats were allocated on a stratified weight basis in 3 × 3 × 2 factorial design with 2 or 3 kids per treatment. The factors were genotype TN, 75% TN × 25% AN and 50% TN × 50% AN), level of supplementary feeding (none, 1.0% and 1.5% BW/d) and parasite control (undrenched and drenched every 4 weeks with Levasol and Nicrosamide). All goats were weighed every 2 weeks and levels of supplement were adjusted accordingly.

Pasture management

Four paddocks of 1.3 ha each of grass-legume pastures were rotationally grazed (rotation over 6 weeks). These were maintained by biennial applications (May-June and December-January) of (kg/ha): 200 urea, 400 rock phosphate, 100 Ammonium sulphate and 100 Potassium chloride.

Diets and feeding methods

Three supplementary treatments were used, nil (control), 1.0% and 1.5% BW/d) daily. The supplement was composed of corn, palm kernel cake, soybean meal, broken rice, ground oyster shell, salt and dicalcium phosphate. The chemical analysis on a dry matter basis was: 16.25% CP, 4.35% ether extract, 17.40% ADF, 24.35% NDF, 6.78% Ash, 1.08% Ca, 0.43% P and 3,667 GE kcal/kg.

Measurements and sampling methods

All goats were weighed every two weeks. Every 4 weeks, two goats from each treatment were bled from the jugular vein (about 7 ml) for haematological analysis and leucocyte counts. The blood was collected in glass bottles containing EDTA (di-sodium salt of ethylene diamine tetra-acetic acid and in plain tubes. The packed cell volume (PCV) of each sample was measured by the capillary microhaematocrit method. The concentration of haemoglobin and white blood cell were measured using Automatic Cell Counter (Baker 8000, U.S. Summit, U.S.A.). The differential leucocyte counts were made on Wright's stained smears of fresh blood by standard procedures. The total serum protein concentration and the concentration of albumins were determined by the Auto-analyzer (Hitachi-704, Boehringer Mannheim Ltd., Germany).

Faecal samples were collected from the rectum of each animal and stored at 4℃ until examination. The Universal Flotation Technique (Whitlock, 1948) was used for quantitative analysis of helminth eggs. Faecal samples (2 g) were thoroughly mixed in 30 ml of saturated sugar solution. This suspension was sieved through a strainer and during steady stirring, a suspension (0.3 ml) was removed and placed into two McMaster counting chamber. The number of oocysts or helminth egg counts within the etched area of these two counting chambers were multiplied by 25 to yield oocysts or eggs per gram (EPG) of faeces. The eggs of the different parasite species were classified by reference to illustrations in Sloss (1970).

Pasture sampling were carried out before and after grazing in each paddock. Quadrat measuring (0.16 square meter) was used to randomly sample 0.01% of each paddock. The area within the quadrat was cut using clippers. The harvested materials were oven dried at 70℃ for 48 h to determine dry matter (DM). Dry samples were sorted to determine DM yields of the different pasture species present. The N content of the major pasture components was also determined (AOAC, 1960).

Statistical analysis

Animal production data from the experiment were analysed as 3 × 3 × 2 (genotype, supplementary feeding and parasite) factorial using the computer program SAS (1987). Growth rate and faecal egg counts after transformation $\{\log_{10}(n + 1)\}$ of goats among the various treatments were compared using analysis of variance (Steel and Torrie, 1960).

Results and Discussion

Pasture available and composition and amount of the concentrate intake

Table 1 shows least squares mean of green DM yield, pasture composition and kg green DM/goat as at before and after grazing. The major species of pasture were *Brachiaria mutica, Centrocema pubescens* and *Panicum maximum* cv. Hamil, which represented about 69% of the pasture. Kochapakdee et al. (1993) reported that after 6-8 months of establishment, these pastures established well and produced 5,132 kg/ha DM. *B. mutica* and *C. pubescens* seem to be suitable in this environment. However, in this experiment, DM yield before grazing was 12,293 kg/ha. Newly established pasture, *P. maximum* cv. Hamil represented only 7% of pasture compared with 13.1% in this study. This indicates that under present management system, these pastures produce more yields and increase the proportion of *P. maximum* cv. Hamil in the later stage.

TABLE 1. LEAST SQUARES MEAN OF GREEN DRY MATTER (DM) YIELDS (kg / ha) WITH STANDARD ERRORS, PASTURE COMPOSITION AND kg GREEN DM / GOAT BEFORE AND AFTER GRAZING

Species	Before grazing			After grazing			Total yield removed (kg/ha)
	DM yield	(%)	Leaf: stem	DM yield	(%)	Leaf: stem	
P. maximum cv. Hamil	1,765±249	13.1	6.87	1,464±241	11.3	2.57	301
B. mutica	4,037±271	32.6	0.85	3,647±271	29.2	0.48	390
C. pubescens	2,692±168	22.9		2,665±195	18.8		27
Weeds	1,999±146	16.7		2,330±205	19.3		+331
Other	602±120	4.7		94± 21	4.1		508
Dead	1,198± 69	10.0		2,026±156	17.3		+828
Total	12,293±313			12,226±311			67
kg green DM/goat	241			222			

Analysis of variance shows that there were no significant ($p > 0.05$) differences between overall mean of *P. maximum* cv. Hamil or *B. mutica* yields at either the beginning or the end of grazing. However, *C. pubescens* at the beginning of grazing had significantly ($p < 0.05$) higher yields than at the end of grazing. There were no significant differences in total yields measured before and after grazing.

Total yield removed was not associated with the proportion of forage in the pasture (table 1). This result is not in agreement with Kochapakdee et al. (1993). The total yield removed was less than that reported by Kochapakdee et al. (1993). This may be due to a low stocking rate in this study (46 v. 75 goat/ha). Leaf-stem ratios of *B. mutica* and *P. maximum* cv. Hamil significantly ($p < 0.01$) declined (0.85 to 0.48 and 6.87 to 2.57, respectively) during the grazing period. At this stocking rate (46 goat/ha), edible forage yield of 9,049 kg/ha (241 kg green DM/goat) seems to be sufficient for 4 weeks grazing. Table 2 shows crude protein with standard error of major pasture components before grazing. Leaf of *P. maximum* cv. Hamil and *B. mutica* had a higher CP content than did stem. CP content of forage in this study (8.2 and 18.8% for *B. mutica* and *C. pubescens*, respectively) was high when compared with those reported by Kochapakdee et al. (1993), 7.6 and 11.2%, respectively. Although fertilizers were applied, soil nutrient loss may have occurred by leaching during a big flood during November-December, 1990. CP content of *B. mutica* (8.2%) and of *P. maximum* cv. Hamil (7.6%) in this study was low compared with tropical grass (10.6%) reported by Minson (1990). However, CP content of *C. pubescens* was high (18.8%) compared with that of tropical legume (16.7%); Milson, 1990. In Thailand, CP values for *B. mutica* varied from 10.2% in urea-fertilized soil (Tinnakorn, 1988) to 4.7 in low fertility soils (Manidool et al., 1984).

In addition to edible forage, two groups of goat were also offered a concentrated dietary supplement (1.0% and 1.5% BW/d). Actual concentrate intake for low and high supplementation was 121 and 208 g/d, respectively.

TABLE 2. CRUDE PROTEIN WITH STANDARD ERROR (% DM) OF PASTURE COMPONENTS BEFORE GRAZING

Pasture species	Crude protein
B. mutica	
Leaf	9.00 ± 0.73
Stem	3.75 ± 0.15
P. maximum cv. Hamil	
Leaf	8.16 ± 1.14
Stem	4.05 ± 0.44
C. pubescens	18.81 ± 1.13
P. phaseoloides	14.71 ± 0.66

Growth rate

Table 3 shows mean squares from an analysis of variance in growth rates of animals given different treatments. Table 4 shows means with standard error of the main effects of genotype, feeding and parasites for growth rates of goats from 0-12, 12-24 and 0-24 weeks of the experimental period. From 0-12 and 0-24 weeks, there was no significant difference in growth rates between genotypes. However, from 12-24 weeks TN goats had significantly ($p < 0.05$) higher growth rates (4.6 $g/kg^{.75}/d$) when compared with 75% TN × 25% AN (3.9) and 50% TN × 50% AN (3.5) goats. TN female goats seem to adapt better in the hot season (from 12-24 weeks of the experimental period) than did cross-bred goats. In this management of weaner goats up to 9 months of age, there was no significant difference between the genotypes for growth rate ($g/kg^{.75}/d$). On the contrary, when growth rates were expressed in terms of g/d, they gained 103 and 80 g/d for male and female, respectively, while cross-bred goats showed superior to native ones (Pralomkarn et al. unpublished data).

Nutrition played an important role in growth rate of goats. From 0-12 and 0-24 weeks, goats fed with high supplementation had significantly ($p < 0.05$) higher growth rates than did those with low supplementation or grazing only. However, from 12-24 weeks, goats which were only grazed had significantly ($p < 0.01$) lower growth rates (2.8 $g/kg^{.75}/d$) than those fed low (3.9) and high (5.4) supplementation. Goats fed with low supplementation had significantly lower growth rates than those fed high supplementation. Results of this study suggest that growth rates of goats grazing improved pasture depend on the amount of concentrate supplementation. This is possibly because of increased dietary protein supply through supplementary feeding. Kochapakdee et al. (1993) found that older (1-2 years of age) female goats grazing newly established pasture gained only 1.3 ± 0.29 $g/kg^{.75}/d$ whilst goats supplemented with 0.25 and 0.75% BW/d gained 1.7 ± 0.29 and 3.2 ± 0.29 $g/kg^{.75}/d$, respectively.

In terms of economics, concentrate costs (4.5 baht/kg) for each goat during 5 months periods were 85 and 146 baht (18.9 and 32.4 kg) for low and high supplementary feeding groups, respectively. Concentrate costs per 1 kg gain were 17.1 and 21.2 baht for low and high supplementation, respectively. If the live-goat price is 35-40 baht/kg, supplementation is recommended.

There was no significant difference in growth rates between control and drenched animals for all experimental periods. Although the kids were

TABLE 3. MEAN SQUARES FROM ANALYSIS OF VARIANCE FOR GROWTH RATE

Source	df	Growth rate		
		0-12 week	12-24 week	0-24 week
Genotype (G)	2	1.299	4.487*	2.574
Feeding (F)	2	11.702*	25.181**	17.184**
Parasite (P)	1	0.165	4.535	1.576
G × F	4	4.790	1.572	1.234
G × P	2	2.983	1.315	1.682
F × P	2	2.380	1.730	2.119
G × F × P	4	0.287	0.694	0.077
Error	28	2.577	1.105	1.032

* ($p < 0.05$), ** ($p < 0.01$).

TABLE 4. MEAN WITH STANDARD ERROR OF THE MAIN EFFECTS FOR GENOTYPE, FEEDING AND PARASITE ON GROWTH RATE OF GOATS

	Growth rate ($g/kg^{.75}/d$)		
	0-12 week	12-24 week	0-24 week
Genotype			
Thai native (TN)	4.5±0.41	4.6±0.27[a]	4.5±0.26
75% TN × 25% Anglo-Nubian (AN)	4.1±0.44	3.9±0.29[b]	4.0±0.28
50% TN × 50% AN	3.9±0.41	3.5±0.27[b]	3.7±0.26
Feeding			
Grazing only	3.5±0.42[a]	2.8±0.28[a]	3.1±0.27[a]
Low supplementation	3.8±0.42[a]	3.9±0.28[b]	3.8±0.27[a]
High supplementation	5.1±0.41[b]	5.4±0.27[c]	5.2±0.26[b]
Parasite			
Drenched	4.2±0.34	4.3±0.22	4.2±0.22
Undrenched (control)	4.1±0.34	3.7±0.22	3.9±0.22

[a,b,c] Means within main effects within columns with different superscripts differ significantly.

raised in the wet season in the first period of the trial (October-December), drenching had no effect on growth rate. This may be due to rotation of the paddocks (rotation over 6 weeks). Rahman and Collins (1990) found that, over a period of 42 days, goats dosed with 20,000 sheep-derived strain larvae of *Haemonchus contortus* lost more weight than those dosed with 10,000 larvae. Furthermore, a relationship between levels of worm infestation and rainfall was found (Rahman, 1991; Kochapakdee et al., 1993). Kochapakdee et al. (1993) studied cross-bred goats under village environments in southern Thailand and recommended that 4-6 week drenching would be necessary to suppress the parasite burden. Nevertheless, it was suggested that drenching alone would not result in increased weight gain unless the nutritional level has also been improved.

In this study, there was no interaction effect on growth rates between the treatments. This may be due to an adequate of nutrients from the pasture. This result is in agreement with (Pralomkarn, 1990; Pralomkarn et al., unpublished data). It would be suggested that the investigation interaction between these characteristics should be conducted under lower nutritional conditions such as in the village.

Parasite infestation

There was no significant difference between genotypes or between levels of feeding for EPG of gastro-intestinal nematodes. Drenched goats had significantly ($p < 0.01$) lower EPG on 13/11/92, 10/12/92, 5/2/93 and 5/3/93 than did undrenched goats (table 5). However, there was no significant difference between drenched and undrenched goats for EPG after drenching for 2 weeks. Table 6 shows mean monthly temperature, relative humidity and rainfall during the experimental period.

TABLE 5. MEAN OF EGG COUNTS PER GRAM OF GASTRO-INTESTINAL NEMATODE FOR DRENCHED AND UNDRENCHED GOATS

Date	Drenched	Undrenched
30/9/92	0	0
16/10/92	74	91
30/10/92*	261	206
13/11/92	43[a]	266[b]
26/11/92*	197	430
10/12/92	163[a]	600[b]
24/12/92*	360	379
8/1/93	210	497
21/1/93*	848	632
5/2/93	90[a]	695[b]
19/2/93*	337	424
5/3/93	55[a]	379[b]
18/3/93	389	361

* Drenching time.
[a,b] Mean within rows with different superscripts differ significantly ($p < 0.01$).

TABLE 6. MEAN MONTHLY CLIMATIC DATA RECORDED DURING THE EXPERIMENT

Month	Year	Temperature (℃)	Relative humidity (%)	Rainfall (mm)
August	1992	27.3	77.8	73.7
September	1992	–	–	74.3
October	1992	26.3	83.8	145.8
November	1992	25.6	85.5	270.0
December	1992	25.5	85.8	135.5
January	1993	26.1	80.4	205.0
February	1993	25.9	76.5	0.0
March	1993	–	–	1,095.0
April	1993	–	–	74.0

Stomach round worms are the most common parasite found in village goats in southern Thailand, with an average EPG in young goats (< 1 year old) of 1,523 (Kochapakdee et al., 1991). In Kambing Katjang goats grazing grass pasture in Malaysia, Daud-Ahmad et al. (1991) reported that EPG levels of this worm were 800-2,000. Pralomkarn et al. (1994) reported that average EPG of stomach round worms in undrenched experimental goats in a village in southern Thailand had a range of 1,110-2,710 and recommended that goats in the village should be drenched every 4-6 weeks in the rainy season and 8-10 weeks in the dry season under non-rotational pasture conditions. Baldock (1984) has suggested that an EPG level of 500- 2,000 may predict severe infestation in goats if these eggs are from *Haemonchus* spp. Baxendell (1987) stated that severe haemonchosis in goats occurred when EPG exceeded 2,000. Rhaman et al. (1991) indicated that 5,000 larvae of *Haemonchus contorus* caused death in goats. In this study, the average EPG of gastro-intestinal nematode of drenched or undrenched goats was low (< 848). This result may be due to grazing under rotational conditions. Therefore, there was no significant difference in growth rates between drenched and undrenched goats (table 3). It is suggested that rotation could be a means of controlling parasite infestation.

There is little information on the interaction between goat genotypes and susceptibility to disease and parasite infestation. Griffin and Allonby (1979) found that indigenous East African and Galla goats in Kenya were tolerant to *Trypanosoma congolense* while Saanen goats suffered badly and had a high mortality rate. Cross-bred (Galla × Sannen) kids were intermediate in their susceptibility to these parasites.

Blood constituents

There was no significant difference in the effects of treatments on haematological values (table 7) or leucocyte counts (table 8). Expected total protein and some haematological values for normal (adults) of goats were 6-8 g% of total protein, 9-14 g/dl of haemoglobin and 25-38% of PCV (Field Officers' Manual, 1982). It would seem that these values lie within the normal range. Rahman and Collins (1990) found that goats dosed with 10,000 and 20,000 sheep-derived strain larvae of *Haemonchus contorus* had significantly reduced PCV. However, there was no significant difference between infected groups. Infected goats showed anaemia after about 2 weeks after infection, as well as reduced levels of total serum proteins and albumins. All goats (6) died in 14-36 weeks after infection with 1,587-4,361 worm burden. Rahman and Collins (1990) showed that goats infected with 5,000 *Haemonchus contorus* larvae showed significant reductions in PCV, total red cells and Hb concentrations when compared with uninfected animals.

TABLE 7. MEAN OF HAEMATOLOGICAL VALUES WITH STANDARD ERRORS OF GOATS AT DIFFERENT GENOTYPES, LEVELS OF SUPPLEMENTATION AND DRENCHING REGIMES

	Total protein (g %)	Haemoglobin (g/dl)	Packed cell volume (%)
Genotype			
Thai native (TN)	6.67±0.055	9.82±0.113	32.40±0.468
75% TN × 25% Anglo-Nubian (AN)	6.50±0.058	9.70±0.128	32.28±0.371
50% TN × 50% AN	6.50±0.050	9.75±0.156	32.13±0.468
Feeding			
Grazing only	6.45±0.048	9.90±0.140	32.74±0.446
Low supplementation	6.72±0.053	9.69±0.132	32.22±0.432
High supplementation	6.51±0.063	9.70±0.124	31.86±0.405
Parasite			
Drenched	6.58±0.055	9.78±0.117	32.45±0.358
Undrenched	6.54±0.053	9.73±0.132	32.08±0.418

TABLE 8. MEAN VALUES OF LEUCOCYTE COUNTS WITH STANDARD ERRORS OF GOATS AT DIFFERENT GENOTYPES, LEVELS OF SUPPLEMENTARY FEEDING AND DRENCHING REGIMES (%)

	Eosinophils	Lymphocytes	Monocytes	Basophils
Genotype				
Thai native (TN)	2.47±0.280	55.57±1.383	1.78±0.258	1.02±0.103
75% TN × 25% Anglo-Nubian (AN)	2.23±0.274	60.11±1.618	1.16±0.106	0.51±0.050
50% TN × 50% AN	3.16±0.405	52.84±1.098	1.67±0.211	0.72±0.117
Feeding				
Grazing only	2.72±0.263	54.14±1.408	1.68±0.169	0.82±0.099
Low supplementation	2.38±0.346	57.65±1.472	1.58±0.136	0.72±0.110
High supplementation	2.72±0.327	56.72±1.421	1.35±0.216	0.77±0.106
Parasite				
Drenched	2.45±0.221	55.23±1.154	1.57±0.113	0.76±0.086
Undrenched	2.78±0.327	56.80±1.498	1.55±0.197	0.68±0.077

Conclusions

Thai native goats had significantly higher growth rates than did cross-bred goats in the second period of the trial. There was no significant difference in growth rates between drenched and undrenched goats. This may be due to a low average EPG of gastro-intestinal nematode. Therefore, there was no significant difference in the effects on blood protein or blood constituents between the treatments (genotype, feeding and parasitic infection). Growth rates of goats grazing improved pasture depended on the amount of concentrate supplementation. There was no interaction effect on growth rates between the treatments.

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