PERFORMANCE OF THE GOAT FED GRASS, SHRUB AND TREE FODDERS DURING THE DRY SEASON IN BALI, INDONESIA

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Summary

An experiment was carried out for 12 weeks to study the feeding behaviour, growth and carcass characteristics of cross-bred goats. Nine bucks with an average live weight of 18.02 ± 0.9 kg were allocated in a completely randomized block design arrangement, consisting of three feeding regimes and three blocks. The feeding regimes consisted of 100% natural grass (Treatment A), 100% gliricidia leaf (Treatment B) and 100% ficus leaf (Treatment C). Frequency of turning-over and sniffing the feed and duration and frequency of ruminating, defaecating, and urinating of goats in treatment B were longer, while duration of masticating and jaw movement of chewing one bolus was shorter than those of goats in treatments C and A ($p < 0.05$). Furthermore, goats in treatment B gained more live weight, consumed more feed, consumed less water and was more efficient in utilizing the feed than goats in treatments C or A ($p < 0.05$). The dressing percentage, carcass length and carcass fat of goats in treatment B were higher and their bone percentages were lower than those in treatments C and A ($p < 0.05$). There is an indication that feeding gliricidia and ficus leaves during the dry season could not only increase the body weight and improve carcass quality of the goat but also save water for household needs.

(**Key Words** : Goat, Gliricidia Leaf, Ficus Leaf, Feeding Behaviour, Growth, Carcass Characteristics)

Introduction

In smallholder dryland farming areas of Indonesia, food crops and plantation crops are the main source of production. Livestock, particularly cattle, which are always integrated in the farming system, are considered as a side-line production. However, the Indonesian Government has given special priority for goat production to be developed in the Eastern part of Indonesia as goats are considered as quicker yielding, have a lower capital investment and lower capital risk than cattle. Furthermore, goat manure has been shown to be a better organic fertilizer than cattle manure because its pelleted form can release nutrients slowly for the food and plantation crops (Nitis et al., 1991).

It has been demonstrated that the botanical composition of the forage fed to goats during the wet season consists of 35% grass and 65% shrub and tree fodders, while during dry season it consists of 6% grass and 94% shrub and tree fodders (Nitis et al., 1980). It is not uncommon, however, that the forage fed to goats consists of shrub or tree fodder only, particularly during the late dry season. It has been shown that goats fed grass supplemented with shrub and tree fodders ate more forage (Sukanten et al., 1992), gained more live weight (Devendra, 1990) and had higher dressing percentage (Saadullah, 1990) than those fed grass only.

The objective of this experiment was to study the effect of either grass, shrub legume or tree fodders diet on the feeding behaviour, growth and carcass characteristics of cross-bred male goats during the dry season in Bali, Indonesia.

Materials and Methods

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Location

The On-station experiment was carried out in a dryland farming area of southern Bali, in the semi-arid climatic zone. This area receives an average annual rainfall of 1,681 mm with 96 rainy days distributed during the four months wet season (December to March) and eight months dry season (April to November). The mean daily temperatures in the shed where the experiment was conducted varied from 23 to 26℃ while relative humidities varied from 69 to 81%.

Goats

Nineteen cross-bred bucks (75% Kacang and 25% Etawah breeds) were bought from a traditional goat farm at Tangkas, and transported by truck to the experimental site. They were accustomed to the conditions in the shed for 14 days. They were then treated with antibiotic, sprayed with insecticide, administered orally with anthelmentic, injected with SE vaccine and scabies drug, before being selected for the feeding trial.

Stalls

The stalls were housed under the shed, which was made from bamboo with a tin roof. The stalls consisted of individual cages and feed troughs with a raised bed 65-cm above the floor level. The floor of the stall consisted of slatted bamboo rails at 0.5 to 1-cm spacing, so that the excreta could fall through to the hardened 15-cm raised soil surface. The size of each cage was 60-cm width × 100-cm length × 100-cm height and partitioned by bamboo rails horizontal to the floor at 10 to 12-cm spacing on both sides and the back of the cage. The feed trough (60-cm length × 50-cm width × 50-cm height) was directly attached to the wide side of the cage, partitioned by bamboo rail perpendiculars to the floor at 12-cm spacing, so that the goat's head could pass through. The other three sides were covered tightly with bamboo pieces so that no feed could spill out.

Feedstuffs

The forage fed to the goats consisted of natural grass, leaf rachis (leaf blade and petiole) of gliricidia (*Gliricidia sepium*) and ficus (*Ficus sub-cordata*). The gliricidia and ficus leaves were still fresh, while the grass was already dry (dry grass from the field). The botanical composition of the natural grass consisted of 76.1% *Eriochloa*, 17.8% *Panicum*, 3.1% *Cynodon*, 2.4% *Leersia* and 0.6% other general. Water requirements of the goats were supplied using rain water.

Design

The completely randomized block design arrangement consisted of three feeding regimes (treatments), three blocks (replicates) and one goat for each treatment. The feeding regime consisted of 100% natural grass (Treatment A), 100% gliricidia leaves (Treatment B) and 100% ficus leaves (Treatment C). The 19 male goats were arranged in the ranking order of live weight. The extreme heavy (3 goats) and light (7 goats) were discarded, leaving the nine goats within a very close live weight range (18.00 to 18.03 kg) between the treatments.

Feeding

The grass, gliricidia and ficus leaves were cut in the afternoon and fed *ad libitum* the next day as a sole diet. The forage was offered in the morning and the refuse was collected in the next morning. Drinking water was offered at 14:00 every day for 15 minutes.

Feeding behaviour

The behaviour study was carried out for 10 hours (07:00 to 17:00) for nine days. The observations were frequency of turning-over and sniffing the feeds, duration and frequency of eating the feeds, duration and frequency of ruminating, number and duration of bolus mastication, jaw movement in masticating one bolus, duration and frequency of defaecating, duration and frequency of urinating and duration and frequency of resting. Each observation was repeated three times and then pooled so that the average represented one replication.

Two mobile observation ladders (88-cm length × 35-cm width × 150-cm height) made from bamboo were used to observe the feeding behaviour of the goats. Each observation ladder could accommodate two persons. With the 150-cm height, it was possible to see the feed trough and cage floor clearly. The stall was sprayed with an insecticide before being used for the experiment.

Growth performance

Each goat was weighed every week without prior fasting. Feed consumption was calculated by subtracting the amount of feed offered with the amount of feed refused. Water consumption was calculated in the same way. A sub-sample of feed offered and refused was taken for dry matter (DM) determination each day.

Carcass characteristics

At the end of the experiment, all the goats were slaughtered according to Moslem custom. They were partitioned for body composition (head, hide, tail, legs, internal organ and digestive tract) and for carcass appraisal (foreshank, brisket, shoulder, breast, rack, leg and short

loin) according to the method described by Levie (1970).

Duration of the experiment

The experiment was carried out during the dry season. The one week preliminary period was followed by a 12 week experimental period. During the preliminary period, all the goats were fed a mixture of equal proportion of grass, gliricidia and ficus leaves.

Statistical analysis

Data were analyzed with analysis of variance and the significance of differences between treatment means ($^{+}p < 0.10$; $^{*}p < 0.05$) was assessed by the Duncan's multiple range test (Steel and Torrie, 1960).

Results

Feeding behaviour

Even though goats in treatment B turned the feed over and sniffed the fodder more frequently ($p < 0.05$) the time spent in eating the fodder was less ($p < 0.10$) than in treatments C and A (table 1). This lesser time spent in eating was compensated for by more frequent eating ($p < 0.10$) to meet daily intake requirements. Because of more fodder being consumed, goats in treatment B ruminated more frequently, and spent more time ruminating, defaecating, urinating and masticating the bolus ($p < 0.05$) than goats in treatments C and A. However, goats in treatment B spent less time in masticating and less frequently chewed one bolus ($p < 0.05$) than the other goats. Goats in treatment B rested more frequently ($p < 0.10$), while the duration of resting was shorter ($p < 0.05$) than goats in treatment C and A.

TABLE 1. FEEDING BEHAVIOUR OF GOATS FED GRASS, SHRUB AND TREE FODDERS DURING THE DRY SEASON

Feeding behaviour parameters (10 hours observation)	Diets			SEM[2]
	Natural grass (A)	Gliricidia leaves (B)	Ficus leaves (C)	
Frequency of turning over the feed (times)	100.56^{c}	218.44^{a}	186.8^{b*} [1]	16.88
Frequency of sniffing the feed (times)	44.89^{c}	104.33^{a}	97.78^{b*}	8.83
Duration of eating (hours)	5.35^{a}	4.19^{b}	4.12^{b+}	0.40
Frequency of eating (times)	5.00^{b}	7.44^{a}	5.89^{ab+}	0.84
Duration of ruminating (hours)	1.40^{b}	2.79^{a}	2.34^{ab*}	0.40
Frequency of ruminating (times)	3.22^{b}	7.00^{a}	4.44^{b*}	0.77
Number of bolus masticated	75.33^{c}	227.56^{a}	154.00^{b*}	29.96
Duration of masticating a bolus (seconds)	60.62^{a}	39.62^{c}	49.74^{b*}	2.13
Frequency of jaw movement per bolus mastication (times)	86.03^{a}	76.05^{b}	88.04^{a*}	2.65
Duration of once defaecating (seconds)	82.77^{c}	122.33^{a}	90.11^{b*}	6.16
Frequency of defaecating (times)	38.00^{c}	57.33^{a}	44.33^{b*}	3.06
Duration of urinating (seconds)	48.33^{b}	85.21^{a}	15.44^{c*}	7.53
Frequency of urinating (times)	10.00^{b}	30.00^{a}	8.67^{b*}	2.42
Duration of resting (hours)	1.97^{a}	1.43^{b}	1.34^{b*}	0.16
Frequency of resting (times)	69.00^{a}	72.34^{a}	59.00^{b+}	4.10

[1] Values in the same row with a different superscript letter are significantly different from each other at $^{+}p < 0.10$; $^{*}p < 0.05$.
[2] SEM = Standard error of the treatment means.

Growth performance

Goats in treatment B grew faster and gained more live weight than animals in treatment C, while goats in treatment A lost live weight ($p < 0.05$) (table 2). Furthermore, goats in treatment B consumed more feed and were more efficient ($p < 0.05$) in utilizing the feed than goats in treatments C and A. Water consumption of goats in treatment B was similar to goats in treatment C ($p > 0.05$) but lower ($p < 0.05$) than goats in treatment A.

Carcass characteristics

The heavier overall weight of goats in treatment B than goats in treatment A was due to their body components being heavier (table 3), differences in weight of some internal organs (table 4), and some carcass components (table 6). The digestive tract composition was similar in all treatments ($p > 0.05$) (table 5). Differences in body composition were due to heavier hides ($p < 0.05$); in the case of internal organs it was due to heavier tongue ($p < 0.05$), liver, kidney and internal fat ($p <$

TABLE 2. PERFORMANCE OF GOATS FED GRASS, SHRUB AND TREE FODDERS DURING THE DRY SEASON

Performance parameters	Diets			SEM[2]
	Natural grass (A)	Gliricidia leaves (B)	Ficus leaves (C)	
Initial live weight (kg)	18.03[a]	18.00[a]	18.03[a]	0.24
Final live weight (kg)	17.30[c]	24.73[a]	21.47[b*+][1]	0.49
Daily gain (g)	−8.69	80.12	40.95	−
Feed consumption (g DM/day)	577.98[b]	792.98[a]	722.98[a*]	4.49
Water consumption (ml/day)	314.05[a]	170.95[b]	155.00[b*]	5.17
Feed/gain ratio	−	9.90	17.66	−

[1] Values in the same row with a different superscript letter are significantly different from each other at $^{*}p < 0.05$.
[2] SEM = Standard error of the treatment means.

TABLE 3. BODY COMPOSITION OF GOATS FED GRASS, SHRUB AND TREE FODDERS DURING THE DRY SEASON

Body composition parameters	Diets			SEM[2]
	Natural grass (A)	Gliricidia leaves (B)	Ficus leaves (C)	
	····· g/100g live weight ·····			
Head	6.60[a]	6.43[a]	6.78[a]	0.21
Hide	5.75[b]	7.22[a]	6.83[a*+][1]	0.24
Tail	0.14[a]	0.18[a]	0.16[a]	0.02
Forelegs	0.89[a]	0.91[a]	0.91[a]	0.06
Hindlegs	0.86[a]	0.82[a]	0.87[a]	0.05
Internal organ	5.73[b]	7.26[a]	6.71[a+]	0.41
Digestive tract	6.73[a]	7.48[a]	6.50[b+]	0.43

[1] Values in the same row with a different superscript letter are significantly different from each other at $^{+}p < 0.10$; $^{*}p < 0.05$.
[2] SEM = Standard error of the treatment means.

0.10); while in the carcass composition it was due to heavier foreshanks, shoulders and racks ($p < 0.10$). In terms of carcass quality, goats in treatment B had a heavier dressing percentage and longer carcass ($p < 0.05$), more meat ($p < 0.10$) and fat ($p < 0.05$), but less

TABLE 4. INTERNAL ORGAN WEIGHTS OF GOATS FED GRASS, SHRUB AND TREE FODDERS DURING THE DRY SEASON

Internal organ parameters	Diets			SEM[2]
	Natural grass (A)	Gliricidia leaves (B)	Ficus leaves (C)	
	····· g/100g live weight ·····			
Tongue	0.58[a]	0.45[b]	0.48[b*+][1]	0.03
Trachea	0.16[a]	0.16[a]	0.16[a]	0.01
Heart	0.37[a]	0.42[a]	0.41[a]	0.04
Lung	0.72[a]	0.66[a]	0.73[a]	0.07
Liver	1.46[b]	1.99[a]	1.84[ab+]	0.22
Kidney	0.37[a]	0.33[b]	0.36[a+]	0.01
Spleen	0.12[a]	0.12[a]	0.11[a]	0.02
Internal fat	1.95[b]	3.13[a]	2.60[a+]	0.29

[1] Values in the same row with a different superscript letter are significantly different from each other at $^{+}p < 0.10$; $^{*}p < 0.05$.
[2] SEM = Standard error of the treatment means.

TABLE 5. DIGESTIVE TRACT COMPOSITION OF GOATS FED GRASS, SHRUB AND TREE FODDERS DURING THE DRY SEASON

Digestive tract parameters	Diets			SEM[2]
	Natural grass (A)	Gliricidia leaves (B)	Ficus leaves (C)	
	····· g/100g live weight ·····			
Oesophagus	0.22[a]	0.19[a]	0.15[a]	0.07
Rumen	1.99[a]	2.44[a]	2.20[a]	0.24
Reticulum	0.45[a]	0.39[ab]	0.33[b+]	0.03
Omasum	0.52[a]	0.43[a]	0.50[a]	0.05
Abomasum	0.44[a]	0.50[a]	0.48[a]	0.07
Small intestine	1.57[a]	1.78[a]	1.64[a]	0.10
Large intestine	1.54[a]	1.75[a]	1.60[a]	0.16
	Length of intestine (cm)			
Small intestine	1,666.00[a]	1,902.00[a]	1,757.00[a]	135.00
Large intestine	469.00[a]	480.00[a]	394.00[b+]	20.00

[1] Values in the same row with a different superscript letter are significantly different from each other at $^{+}p < 0.10$.
[2] SEM = Standard error of the treatment means.

bone ($p < 0.05$) than goats in treatments A and C (table 7).

TABLE 6. CARCASS COMPONENTS OF GOATS FED GRASS, SHRUB AND TREE FODDERS DURING THE DRY SEASON

Carcass component parameters	Diets			SEM[2]
	Natural grass (A)	Gliricidia leaves (B)	Ficus leaves (C)	
	..... g/100g live weight			
Foreshank	8.79[a]	7.33[b]	8.32[ab+1]	0.28
Brisket	2.70[a]	3.23[a]	3.20[a]	0.38
Shoulder	32.62[b]	34.20[a]	32.53[b+]	0.69
Breast	4.85[a]	4.88[a]	4.20[a]	0.42
Rack	8.64[a]	7.97[b]	8.14[b+]	0.20
Leg	33.55[a]	33.25[a]	34.42[a]	0.76
Short loin	8.85[a]	9.16[a]	9.19[a]	0.45

[1] Values in the same row with a different superscript letter are significantly different from each other at $^{+}p < 0.10$.
[2] SEM = Standard error of the treatment means.

TABLE 7. CARCASS QUALITY OF GOATS FED GRASS, SHRUB AND TREE FODDERS DURING THE DRY SEASON

Carcass quality parameters	Diets			SEM[2]
	Natural grass (A)	Gliricidia leaves (B)	Ficus leaves (C)	
Dressing percentage (%)	34.29[c]	44.54[a]	39.29[b*1]	0.41
Carcass length (cm)	56.00[b]	61.80[a]	58.70[ab*]	0.88
Loineye muscle area (cm^2)	11.00[a]	11.67[a]	11.67[a]	1.61
	..... g/100g live weight			
Meat	63.61[b]	68.18[a]	65.55[b+]	1.19
Fat	0.94[b]	4.95[a]	3.93[a*]	1.44
Bone	35.45[a]	26.87[b]	30.52[ab*]	1.28

[1] Values in the same row with a different superscript letter are significantly different from each other at $^{+}p < 0.10$; $^{*}p < 0.05$.
[2] SEM = Standard error of the treatment means.

Discussion

Due to the astringent odour of the gliricidia leaves, some cattle may not eat much of such leaf material. The astringent odour can be minimized by wilting, by harvesting the leaves in the evening and feeding to livestock the next day (Nitis et al., 1989) or by feeding gliricidia as a supplement to accustom the livestock to such feed (Sukanten et al., 1992). Furthermore, calves born from cows used to eating gliricidia leaves find no difficulty in eating such leaves (Nitis loc. cit). The turning-over and sniffing the gliricidia in the present experiment was probably due to goats selecting the older leaves in preference to the younger leaves, since the astringent odour is stronger in the young leaves and becomes less pungent as the leaves become older (Nitis loc. cit). Higher consumption of older gliricidia leaves than the younger gliricidia leaves has been reported by Nitis et al. (1993).

Van Eys et al. (1986) indicated that feed consumption becomes lower when a ruminant feed contains higher crude fiber (CF). According to Nitis et al. (1985) the natural grass and ficus leaf contain more CF and less crude protein (CP) than gliricidia leaf, whereas ficus leaf contains more CP and CF than natural grass. The present experiment also showed that natural grass and ficus leaf were consumed less than the gliricidia leaf. Furthermore, the longer time spent in chewing the bolus from the natural grass and from the ficus leaves than that from the gliricidia leaves was presumably due to the process of breaking of the CF to acceptable particle size for rumen digestion (Richards et al., 1994). Fariani et al. (1994) showed that boluses of animals consuming ammoniated rice straw were masticated longer than boluses of animals eating rice straw supplemented with soybean and barley because of differences in CF content of the feeds. Similar trends were also reported by Tokita et al. (1994) for reed canary grass treated with pyroligneous acid which contained more neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) than the untreated reed canary grass.

Generally, livestock will eat to their stomach capacity to satisfy their nutrient needs. However, bulkiness of the feed due to high fiber content can cause stomach distention, which in turn reduces feed consumption, as was the case for the goats fed natural grass in the present experiment. Natural grass contains low level of total digestible nutrient (TDN) (23.56%) and CP (9.75%) (Nitis et al., 1985). In this study such low feed quality led to low feed intakes and loss in live weight of goats consuming natural grass. On the other hand, gliricidia (which contains 24.75% CP and 56.15% TDN) and ficus leaves (which contains 10.88% CP and 32.05% TDN) were of higher quality and such nutrient concentrations permitted modest live weight gains. Furthermore, CP was presumably more limiting than CF, since the goats fed ficus leaves which contained more CP and less CF gained in live weight, while goats fed natural grass which

contained less CP and more CF lost in live weight. The higher live weight gain of the goats fed gliricidia leaves was not only due to its higher feed consumption, but also due to its higher efficiency in feed utilization through better rate of passage of digesta in the gastro-intestinal tract (Aitchison et al., 1986). The higher digestibility of gliricidia leaves compared with natural grass (Nitis et al., 1985) resulted in more nutrients being available for collagen and fat formation for the internal organs and for bone, meat and fat formations of the carcass as shown in the present experiment. A similar trend was observed for the goats fed sesbania leaves compared with those fed grass only (Saadullah, 1990).

Lower water consumption by goats fed gliricidia and ficus leaves compared with those fed natural grass has important implications for the water economy of smallholder farmers in dryland farming areas, since water is limited in these areas, particularly during the dry season. According to Kearl (1982) the goat has an amazing ability to withstand water deprivation, particularly during browsing. Furthermore, shortage of forage during the dry season can be overcome by adopting the three strata forage system. In this system strategic cutting of the grass and ground legume (first stratum) is carried out mainly during the wet season, shrub legumes (second stratum) are harvested mainly during the early dry season, while fodder trees (third stratum) are harvested during the late dry season (Nitis et al., 1989).

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