

Feeding Time and Botanical Composition of Diets Selected by Indigenous Goats on Native Pastures in Malaysia

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ABSTRAK

Masa makan, tabiat pemakanan dan komposisi botanikal diet yang dipilih oleh Kambing Kacang di padang rumput yang berbeza di Selangor, Malaysia Barat ditentukan melalui pengawasan terus. Di antara bulan Nov-Dis 1992, empat kelompok kambing dipilih mengikut kawasan mereka meragut (sawah yang terbiar, di tepi-tepi jalan, tempat pembuangan sampah dan dusun) dan diawasi. Bergantung kepada kelompok, kedudukan kawasan ragut dan kemudahan mendapat makanan, kambing-kambing bergerak sejauh 0.6 hingga 5.6km sehari. Masa yang dihabiskan untuk makan adalah antara 79.2 hingga 152.7 minit. Kualiti diet yang paling tinggi diperolehi dengan memilih bahagian pokok yang paling muda dahulu. Dari segi masa yang dihabiskan untuk setiap spesis, spesis utama yang dipilih ialah *Mimosa pudica*, diikuti dengan *Ottochloa nodosa*, *Asystasia intrusa*, *Mikania cordata*, *Paspalum conjugatum*, *Axonopus compressus* dan *Ischaemum timorense*. Komposisi tumbuhan di empat kawasan ragut dinilai dengan menggunakan plot-plot wakilan. Tumbuh-tumbuhan memenuhi 100% kawasan yang disampel kecuali dikawasan pembuangan sampah (51%). Daripada rekod pemilihan makanan dan kesediaan tumbuhan, keutamaan indeks dikira untuk tiap-tiap kelompok dan spesis tumbuhan. Tumbuhan herba adalah yang paling digemari dan *Mimosa pudica* menjadi pilihan utama diantara tumbuhan kekacang. Berdasarkan kepada masa meragut, kambing-kambing ternyata tidak dapat menampung keperluan bahan kering mereka. Strategi tambahan berdasarkan pemilihan diet dan sumber makanan yang ada harus dibuat untuk meningkatkan produktiviti mereka.

ABSTRACT

The feeding time, grazing behaviour and botanical composition of diets selected by the indigenous Kambing Kacang on different native pastures of Selangor State, West Malaysia, were determined by direct observation during Nov - Dec 1993. Four herds were selected according to their grazing area (abandoned ricefield, roadside verges, waste ground and orchard) and monitored. Grazing animals travelled from 0.6 to 5.6 km daily. Depending on the locality of the grazing area and the forage available, time spent feeding ranged from 79.2 to 152.7 min. The herds were observed to first select the most juvenile plant parts which provided the highest quality of diet. In terms of time spent on each species, the main species selected in descending order of importance were: *Mimosa pudica*, *Ottochloa nodosa*, *Asystasia intrusa*, *Mikania cordata*, *Paspalum conjugatum*, *Axonopus compressus* and *Ischaemum timorense*. The vegetation composition of the four grazing areas was assessed by means of representative plots. Vegetation covered 100% of the total sample area except on the waste ground (51%). From records of feed selection and vegetation available, preference indices were calculated for groups and

individual plant species. Herbs appeared to be very palatable, with Mimosa pudica among legumes by far the most palatable. Judging by the feeding time, it would appear that the goats could not adequately meet their dry matter demands. Supplementation strategies based on diet selectivity and available resources may have to be developed to increase their productivity.

INTRODUCTION

In Peninsular Malaysia the majority of ruminants rely on natural vegetation. Presently there are about 288,500 goats including the indigenous Kambing Kacang mostly reared by smallholder farmers. Despite some increase in productivity, goat and sheep production cannot keep up with the increasing local demand for mutton. Production efficiency of goats under extensive and semi-extensive management systems could be improved with better knowledge of their grazing behaviour.

The quantity of forage ingested by range grazing animals is controlled by animal and plant factors, their interaction, and management strategies. Important factors are duration of grazing, rate of biting, bite size, herbage availability and quality, and ease of prehension and removal of herbage from the plant. To what extent goats exploit available resources is important since the production and yield of these animals depend on their voluntary intake of digestible dry matter (Humphreys 1991). Different methods have been used to measure feed intake. Most common techniques include the use of markers, fistulated animals, faecal index techniques and the direct observation technique (Malechek and Provenza 1983; Meuret *et al.* 1985). The last mentioned technique has the following advantages: it can be used on heterogeneous pastures; measurements are easy and fast; and it does not require laboratory analyses. The botanical composition of the diet can be studied through direct observation by measuring the time spent feeding on each species. This indicates the proportion of species in bites and time, but not in DM.

The purpose of the present study was to assess the feeding time, grazing behaviour and dietary preferences of the indigenous Kambing Kacang on various types of native pastures.

MATERIALS AND METHODS

Site of Investigation

Four representative smallholdings were selected according to the vegetation types in the grazing area. These farms were located in Berang (3)

and Ulu Langat (1), Selangor State. Different vegetation types occurred: (i) The abandoned ricefield consisted mainly of grasses, cyperus and legumes. This grazing area was very rich in plant species. (ii) The roadside under study consisted mainly of grasses and shrubs, the former being mown frequently. (iii) The waste ground was an old tin mining area characterised by a large variety of vegetation types: vast scarcely covered sandplains, grassland, brushwood, pondside vegetation, etc. and (iv) The grazing area in Ulu Langat was a traditional Malay orchard, consisting mainly of *Musa cv.*, *Artocarpus heterophyllus*, *Artocarpus integer*, *Nephelium lappaceum* and *Durio zibethinus*. The vegetation was homogeneous and disturbed. Relatively smaller groups of plants but dominating communities were found under such multi-strata canopies. Herbaceous weeds such as the shade-tolerant invasive *Asystasia intrusa* was one of the typical examples of native forage under orchard.

Selangor State, Malaysia, is located in the humid tropics in the agro-ecological zone with a 1-month or no prominent dry season (Nieuwolt *et al.* 1982). The mean temperature during the observation period was 27° C with a mean daily sunshine duration of 5 h. During November and December 273 mm and 348 mm of rain were recorded respectively.

Animals

Herds under study comprised between 30 and 50 goats and were kept under semi-extensive management. The goats were of the local Kambing Kacang type and crossbreds. In each farm, five animals were selected for growth and grazing observation monitoring, and identified by ear tags. Young goats, 4 - 6 months old, were chosen to prevent interference of reproductive status with growth, and to avoid loss of information if the animals were sold or slaughtered during the period of observations. The goats had an average initial weight of 8.2 kg. They were weighed fortnightly over a period of 141 days to assess the growth rate. To minimise the effect of gastro-intestinal parasitism on their health status, body condition, and grazing behaviour, all ani-

mals were given systematic anthelmintic treatments (1 ml Supaverm/kg BW) two weeks before the beginning of the experiment and three months later.

Attention had to be paid to the observations made at the roadside, because the young goats tended to stay close to the shed and did not graze together with the adult ones.

In accordance with the management practice goats were allowed to graze in the late afternoon for about 2 - 4 h. Grazing without supervision was most common. In all herds kitchen salt was provided in the shed. Cut-and-carry was provided especially for kids and sick animals, after the herd had been taken to the grazing area. This consisted mainly of *Mikania cordata*, *Panicum amplexicaule*, *Nephrolepis biserrata* and *Manihot esculenta* leaves (abandoned ricefield), and of *Elaeis guineensis* leaves (waste ground). The herd grazing under orchard was irregularly supplemented with old banana peelings (*Musa cv.*) at irregular intervals.

Experimental Procedures

The study was carried out from November 1993 to April 1994. Sites where the farmers frequently take their goats were selected. A preliminary study of the pasture was carried out by inventorying the plant species. For easy identification, a reference collection of herbarium specimens was made before the experiment started.

After the observation period (Nov-Dec 1993) vegetation was assessed at the four grazing areas. Each grazing area was studied by dividing it into different vegetation types and measuring their respective proportions within the grazing area. Each vegetation type was analysed by means of representative plots (Knapp 1984). Vegetation composition was assessed by recording the cover using the decimal scale of Londo (1984). Vegetation at the waste ground characterised by sandy soils, was changing fast during the drier month (Jan 1994) following the observation period. Therefore, information on plant availability had to be gathered as fast as possible and the approach of Tansley (1939) was used in combination with the Londo-scale. At the other grazing areas changes due to the short drier period were not noticed.

TABLE 1
Cover of group of plants at different native pastures (%)

Vegetation	Abandoned ricefield	Roadside	Waste ground	Orchard
Grasses	76.7	91.4	16.3	20.6
Legumes	15.3	3.1	8.3	8.6
Herbs	10.9	6.2	9.8	46.3
Others	26.4	66.9	16.7	28.9

Feed preference studies were carried out using the direct observation technique. The same herd was observed for five consecutive days. Because herds split into different sub-flocks, it was not possible to observe all the animals. Hence one goat was marked and followed throughout its grazing journey across the rangeland. Successively, every other day, another animal was observed. Two observers recorded the grazing time (i.e. the total time spent in the range) and distance travelled (Lu 1988; Ricardi and Shimada 1992) by means of a pedometer. The plants and the time (rounded to 5 s) spent feeding on a particular plant species were recorded for each animal during its grazing journey. Total observation time was 54 h for the four herds. The information was tabulated and the plant species were divided into four groups: grasses, legumes, herbs and others. Data were subjected to analyses of variance using procedures of SAS (1987).

Even in entirely mixed pastures this method could be used because goats tend to take discernible individual bites and rarely go from one plant species to another within a few seconds. The closer the observers could get to the animal the better, enabling the animals to become accustomed to the observers (Meuret *et al.* 1985; Guerin 1988), which was achieved by the observer following the same animal throughout the day. During the experiment, animals could be observed from 1 to 2 m distance without influencing their grazing behaviour. The botanical composition of the diets needs to be related to available plant species in the pasture. From the records of feed selection and plant availability, preference indices were calculated for plant species and plant groups. The preference factor (PF) or index was calculated as:

$$PF = \frac{\text{plant consumed}}{\text{plant available}}$$

where plant consumed is the feeding time on respective vegetation expressed as a percentage of the total feeding time; and plant availability is the percentage cover of plant material not exceeding a height of 2 m (Becker and Lohrmann 1992). On the basis of preference indices plant species and groups were ranked in palatability classes (Table 2).

TABLE 2
Palatability based on the preference index

Palatability	Preference Index
Highly palatable	> 5.00
Very palatable	1.51 - 5.00
Palatable	0.51 - 1.50
Not palatable	0.00 - 0.50

RESULTS AND DISCUSSION

The average daily weight gain (ADWG) was calculated for each herd (Table 3). Animals grazing on the waste ground gained least weight (20.2 g/day) and those grazing on the abandoned ricefield the most (31.6 g/day). However, no statistical differences were found. Experiments with feeding Kambing Kacang goats under optimal conditions show an ADWG of 60 g/day for animals of the same age (4 - 6 months) weighed over the same period of time (M. P. Davis 1994, *Personal communication*).

The grazing time was different for the four herds (Table 4) depending on the management. Herds were brought to the grazing area in the late afternoon (14.30 h) or after heavy rains, even later. They were always brought back to the shed before darkness. The longer the period the goats were allowed to graze, the greater distance they travelled. Energy expended during grazing can account for a significant part of the total energy requirements of the goat. Huston (1978) suggested that goats travel greater distances than other ruminant species.

TABLE 3
Average daily weight gain (ADWG) and standard error (SE) of 4 - 6 months old animals weighed over a period of 141 days

Vegetation	Abandoned ricefield	Roadside	Waste ground	Orchard	Average
ADWG	31.5	27.3	20.2	24.6	25.6
SE	5.8	7.7	5.4	4.9	3.2

TABLE 4
Average and standard error of distance travelled (km per day), time grazing i.e. time spent in the range (min per day), feeding time on plants (min per day) and as percentage of the grazing time

Vegetation	Abandoned ricefield	Roadside	Waste ground	Orchard
Distance (km)	2.8 ± 0.3b	0.6 ± 0.1c	5.6 ± 0.6a	1.6 ± 0.3c
Grazing time (min)	190.0 ± 6.5b	105.0 ± 5.0c	245.0 ± 16.7a	115.0 ± 8.7c
Feeding time (min)	152.7 ± 3.8a	79.2 ± 3.4c	119.8 ± 7.5b	92.0 ± 7.3c
Feeding time (%)	80.4	75.4	48.9	80.0

Values within rows with similar superscripts are not statistically different ($P < 0.05$).

Judging by the time spent on feeding, it would appear that the goats could not adequately meet their dry matter demands, which partially explains their rather low productivity. In all the pastures, except on the waste ground (48.9%), the goats spent 75.4 - 80.4% of their time feeding to ensure a sufficient forage intake. On waste ground vegetation was less abundant and the goats had to walk longer distances. This resulted in a relatively shorter feeding time. Animals were seldom seen to rest on the ground during the grazing period. Only in heavy rain did they seek shelter under trees or shrubs.

Vegetation covered 100% of the total sample area except on the waste ground (51%). In the other cases the sum total of the cover of groups of plants exceeded 100%, which reflects the overlapping of the pasture (Table 1)

Different plant groups were selected according to the pasture vegetation (Table 5). This emphasizes the mixed nature of the feeding habits of goats.

The herd grazing under orchard had a significantly larger proportion of grazing time on dicotyledonous weeds (of higher nutrient content)

than on grasses (of lower nutrient value) compared to the herd grazing along the roadside. However, no significant difference in growth between the herds was observed. Probably the overall low grazing time, which was less than half to two-thirds of normal grazing hours, imposed daily on the animals, was a critical constraint on their performance.

Dicotyledonous weeds were preferred to grasses in all cases except along the roadside, where palatability of plants in general was low (Table 6). On the waste ground, grasses had a very low preference index. Most of the grasses grew along well-established tracks. Here treading as well as excreta are important contributory factors to unpalatability. The general low palatability of the group 'others' is due to the occurrence of non-palatable species, comprising mainly *Eupatorium odoratum*, *Melastoma malabathricum* and *Lantana aculeata*. At the orchard, legumes had a low preference index. Seemingly glabrous leaves of other species were preferred to the hairy leaves of *Pueraria phaseoloides* and *Calopogonium mucunoides*.

TABLE 5
Average and standard error of time feeding on groups of plants at four different native pastures (min per day)

Vegetation	Abandoned ricefield	Roadside	Waste ground	Orchard
Grasses	69.5 ± 2.6 ^a	67.1 ± 2.5 ^a	2.0 ± 0.4 ^c	12.1 ± 2.3 ^b
Legumes	31.9 ± 2.2 ^b	0.0 ± 0.0 ^c	83.9 ± 6.6 ^a	3.0 ± 0.3 ^c
Herbs	40.5 ± 1.8 ^a	1.5 ± 0.4 ^c	32.6 ± 3.0 ^b	44.8 ± 3.0 ^a
Others	10.8 ± 1.5 ^b	10.6 ± 1.7 ^b	1.3 ± 0.2 ^c	32.1 ± 3.5 ^a

Values within rows with similar superscripts are not statistically different (P < 0.05).

TABLE 6
Preference index and palatability of plant groups at four different native pastures

Vegetation	Abandoned ricefield	Roadside	Waste ground	Orchard
Grasses	0.59*	0.93*	0.10*	0.55*
Legumes	1.36*	—	8.45***	0.40*
Herbs	2.43**	0.31*	2.78**	1.05*
Others	0.27*	0.20*	0.06*	1.21*

Not palatable, * palatable, ** very palatable, *** highly palatable

Table 7 summarizes cover and relative feeding time on individual species. On the abandoned ricefield, roadside, waste ground and orchard there were 23, 11, 14 and 15 different species respectively grazed by the goats. Although they consumed a large variety of species, in terms of time spent, most of their diet consisted of just 8, 4, 2 and 6 species. These results are consistent with previous findings by Murken and Mukherjee (1988) and Peinado-Lucena *et al.* (1992) who stated that although goats may consume a large

variety of species, most of their diet consists of 3 - 8 main species. *Mimosa pudica*, which contains the toxic agent mimosine (Hickey and King 1988), was highly selected by the goats. Species diversity of the pasture is an important factor as it allows grazing animals to select a greater variety of plant species. A mixed diet is not only better balanced but also prevents the animal's detoxification mechanism encountering a large dose of one single toxin (Moss 1991).

TABLE 7
Cover (C) and relative feeding time (FT) for different plant species

Vegetation	Abandoned ricefield		Roadside		Waste ground		Orchard	
	C (%)	FT (%)	C (%)	FT (%)	C (%)	FT (%)	C (%)	FT (%)
<i>Mimosa pudica</i>	10.4	20.2	—	—	7.1	68.8	—	—
<i>Ottochloa nodosa</i>	2.6	1.6	38.0	34.7	1.2	1.1	13.1	9.3
<i>Asystasia intrusa</i>	0.3	0.2	—	—	—	—	36.6	43.3
<i>Mikania cordata</i>	4.7	13.4	—	—	4.9	21.5	1.9	5.2
<i>Paspalum conjugatum</i>	8.2	12.0	19.0	20.2	—	—	5.8	3.8
<i>Axonopus compressus</i>	8.2	3.5	22.9	24.4	2.2	—	1.9	1.7
<i>Ischaemum timorensis</i>	23.2	16.4	—	—	—	—	—	—
<i>Musa cv.</i>	—	1.3	—	—	—	—	0.9	10.8
<i>Heliconia hybrid</i>	—	—	—	—	—	—	1.3	8.6
<i>Borreria latifolia</i>	—	—	—	—	1.4	4.0	5.7	5.5
<i>Leersia hexandra</i>	1.8	7.3	—	—	—	—	—	—
<i>Ficus spp.</i>	—	0.7	5.7	6.3	—	—	—	—
<i>Imperata cylindrica</i>	5.7	2.5	6.8	2.7	4.8	0.6	—	—
<i>Cyperus spp.</i>	5.2	2.5	—	—	0.9	0.4	4.8	2.5
<i>Commelina nudiflora</i>	1.8	5.2	—	—	—	—	—	—
<i>Ipomoea aquatica</i>	—	3.8	—	—	—	—	—	—
<i>Pueraria phaseoloides</i>	—	—	—	—	—	—	8.1	3.6
<i>Caryota mitis</i>	—	—	1.1	3.5	—	—	—	—
<i>Aneilema nudiflorum</i>	2.0	2.8	—	—	—	—	—	—
<i>Saccharum arundinaceum</i>	—	—	2.0	2.7	—	—	—	—
Fern (undetermined)	—	1.2	—	1.3	—	—	—	—
<i>Merremia umbellata</i>	—	—	—	—	0.6	1.3	2.2	1.0
<i>Panicum amplexicaule</i>	0.9	2.2	—	—	—	—	—	—
<i>Melastoma malabathricum</i>	—	—	3.0	1.0	3.5	0.2	4.2	1.0
<i>Borreria laevicaulis</i>	—	—	1.6	1.9	—	—	—	—
<i>Nephelium lappaceum</i>	—	—	—	—	—	—	0.8	1.8
<i>Stachytarpheta jamaicensis</i>	—	—	2.4	1.3	—	—	—	—
<i>Limnocharis flava</i>	—	1.1	—	—	—	—	—	—
<i>Durio zibethinus</i>	—	—	—	—	—	—	—	1.0
<i>Lygodium circinnatum</i>	—	—	—	—	—	—	0.8	1.0
<i>Centrosema pubescens</i>	—	—	—	—	0.6	0.8	—	—
<i>Cassia tora</i>	—	0.7	—	—	—	—	—	—
<i>Manihot esculentum</i>	—	0.7	—	—	—	—	—	—
<i>Mimosa invisa</i>	—	—	—	—	0.3	0.4	—	—
<i>Lygodium flexuosum</i>	0.1	0.2	—	—	—	0.1	—	—
<i>Melochia corchorifolia</i>	—	—	—	—	—	0.3	—	—
<i>Lantana aculeata</i>	—	—	10.0	—	1.6	0.3	—	—
<i>Sida rhombifolia</i>	—	0.3	—	—	—	—	—	—
<i>Phyllanthus niruri</i>	—	—	—	—	—	0.2	—	—
<i>Urena lobata</i>	0.7	0.2	—	—	0.5	—	—	—

— Not present or only found sporadically

TABLE 8
Preference index and palatability for individual plant species

Vegetation	Abandoned ricefield	Roadside	Waste ground	Orchard
<i>Mimosa pudica</i>	1.95**	—	9.70***	—
<i>Ottlochloa nodosa</i>	0.62*	0.91*	0.90*	0.67*
<i>Asystasia intrusa</i>	0.77*	—	—	1.18*
<i>Mikania cordata</i>	2.87**	—	4.40**	2.74**
<i>Paspalum conjugatum</i>	1.46*	1.06*	—	0.66*
<i>Axonopus compressus</i>	0.43*	1.07*	—	0.88*
<i>Ischaemum timorense</i>	0.71*	—	—	—
<i>Musa cv.</i>	—	—	—	12.1***
<i>Heliconia hybrid</i>	—	—	—	6.83***
<i>Borreria latifolia</i>	—	—	2.90**	0.96*
<i>Leersia hexandra</i>	3.96**	—	—	—
<i>Ficus spp.</i>	—	1.11*	—	—
<i>Imperata cylindrica</i>	0.44*	0.39*	0.13*	—
<i>Cyperus spp.</i>	0.48*	—	0.46*	0.52*
<i>Commelina nudiflora</i>	2.92**	—	—	—
<i>Pueraria phaseoloides</i>	—	—	—	0.44*
<i>Caryota mitis</i>	—	3.27***	—	—
<i>Aneilema nudiflorum</i>	1.41*	—	—	—
<i>Saccharum arundinaceum</i>	—	1.35*	—	—
<i>Merremia umbellata</i>	—	—	2.06**	0.46*
<i>Panicum amplexicaule</i>	2.39**	—	—	—
<i>Melastoma malabathricum</i>	—	0.33*	0.06*	0.24*
<i>Borreria laevicaulis</i>	—	1.17*	—	—
<i>Nephelium lappaceum</i>	—	—	—	2.14**
<i>Stachytarpheta jamaicensis</i>	—	0.54*	—	—
<i>Lygodium circinnatum</i>	—	—	—	1.28*
<i>Centrosema pubescens</i>	—	—	1.31*	—
<i>Mimosa invisa</i>	—	—	1.25*	—
<i>Lygodium flexuosum</i>	2.00**	—	—	—
<i>Lantana aculeata</i>	—	—	0.18*	—
<i>Urena lobata</i>	0.27*	—	—	—

Not present or only found sporadically

* Not palatable, * palatable, ** very palatable, *** highly palatable

The main species selected were *Mimosa pudica*, *Ottlochloa nodosa*, *Asystasia intrusa*, *Mikania cordata*, *Paspalum conjugatum*, *Axonopus compressus* and *Ischaemum timorense*.

Observations showed that the goats first selected the growing points which are the most juvenile and nutritious portion of the plant. Then they searched for the younger leaves, followed by more mature ones. In this way the highest quality diet could be selected from the pasture.

From the recordings of cover and relative feeding time, preference indices were calculated and species were ranked in palatability classes (Table 8). Banana leaves (*Musa cv.*), leaves from the Crab-claw (*Heliconia hybrid*) and leaves from

the legume *Mimosa pudica* were highly palatable. The climber *Mikania cordata*, the herbs *Borreria latifolia* and *Commelina nudiflora*, leaves from the palm *Caryota mitis*, the rambutan tree (*Nephelium lappaceum*), and the fern *Lygodium flexuosum* were very palatable. The swamp grasses *Leersia hexandra* and *Panicum amplexicaule* had a higher palatability than the other grasses. Attention has to be paid in that palatability is also determined by the structure of the vegetation, i.e. accessibility of plant species. The twining herb *Merremia umbellata* was very palatable at the waste ground, where vegetation was less dense, while it was found unpalatable at the orchard, where it was overgrown by other species. A study of the

nutrient content and voluntary intake, which is determined by feeding time, bite frequency and bite size, has been addressed in a related work in progress.

CONCLUSIONS

In all the pastures, except on the waste ground (48.9%), the goats spent 75.4-80.4% of their time feeding to compensate for the short duration of grazing.

Results of this experiment have shown that goats consumed grasses readily only on pastures where their availability was high. Compared to grasses, herbs with a higher nutrient content were generally highly selected. The climbing herb *Mikania cordata* was very palatable. Among the legumes only *Mimosa pudica* was highly palatable. The leguminous cover crops *Pueraria phaseoloides* and *Centrosema pubescens* were less palatable. Banana leaves (*Musa* cv.) and leaves from the rambutan tree (*Nephelium lappaceum*) were highly to very palatable. Some species which were abundant in the pasture were not found in the diet, and the reverse situation occurred with some species of limited availability. The number of unpalatable species is a good indication of the pasture quality. This nature of selectivity in grazing by goats suggests that the number of plant species in pastures should be as high as possible so as to offer to goats different levels of nutrition from herbage.

Preference indices calculated from records of feed selection and availability of vegetation were good indicators for palatability of plant species in general. However, in some cases pasture structure interfered in such a way that accessibility was more important than availability. This suggests that studies of comparative palatability should be evaluated carefully when other vegetation types are assessed.

Poor animal performance indicates that the problem of increasing goat production could best be solved by increasing the grazing time and/or by supplementing the animals' diet especially in areas where goats depend mainly on grasses or where vegetation is less dense. Based on dietary selectivity and available resources, supplementation strategies on dietary needs could be developed to increase productivity.

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