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Effects of growth stage and sward structure of *Macroptilium lathyroides* and *M. atropurpureum* on selective grazing and bite size in goats

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Abstract

This study was conducted to investigate the effects of growth stage (26, 49, 63, 78 and 106 days of regrowth) and sward structure of phasey bean (*Macroptilium lathyroides*) and siratro (*M. atropurpureum*) on selective grazing and bite size of oesophageal fistulated goats. The selectively grazed parts of phasey bean and siratro had higher levels of leaf, crude protein, *in vitro* dry matter digestibility (IVDMD) and digestible energy (DE) and lower levels of cell wall components than the residual forage. There was more selection when grazing phasey bean than siratro. As plants matured, leaf percentage of the grazed phasey bean decreased but changes in siratro were small. Goats grazing phasey bean had the largest bite size when grazing the 106 day regrowth, whereas animals grazing siratro had the largest bite size when grazing the 63 day regrowth. Bite size of goats grazing phasey bean and siratro was positively correlated with sward height, stem length and dry matter yield, and a higher correlation was found for phasey bean than for siratro. However, the relation between the leaf percentage in the grazed layer of the sward and bite size was inconsistent between the two legumes.

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Introduction

More than 430 million goats, 94% of the world total, are kept in developing countries in the sub-tropics and tropics (FAO 1985). Increasing the production from goats in those regions depends on improving the utilisation of tropical pastures (Coop 1986). This may be achieved by increasing the use of legumes, which are generally of higher quality and are eaten in larger quantities than grasses (Minson 1990). The level of animal production from pastures is mainly controlled by the intake of forage, and the measurement of the number of grazing bites and bite size has been proposed as a rapid method of estimating herbage intake (Stobbs and Cowper 1972; Stobbs 1973; Minson 1990). Bite size is largely influenced by sward conditions (Hodgson 1982; 1985) and this has been extensively studied with cattle and sheep (Stobbs 1974; Stobbs and Hutton 1974; Hodgson 1982). However, less information is available for grazing goats, and previous studies with goats have been limited to the measurement of bite size and selective grazing on tropical grasses (Nakanishi *et al.* 1985; 1987; 1989). *Macroptilium lathyroides* (phasey bean) and *M. atropurpureum* (siratro) are two important tropical legumes which have a different physical form (Skerman *et al.* 1988) and might be expected to be grazed in different ways.

This study was designed to study the effects of growth stage and sward structure of *Macroptilium lathyroides* and *M. atropurpureum* on selective grazing and bite size of goats.

Materials and methods

Pastures

The pastures were grown at Kyushu University, Japan, (33°37'N, 130°25'E, altitude 11 m) in 1986. Two tropical leguminous forages, phasey bean and siratro, were sown at 20 kg/ha in rows 60 cm apart and fertilised with 500 kg/ha of a mixture of N:P:K(14:14:14). The first growth was cut and discarded at 73 days, a further 500 kg/ha of fertiliser was applied and the regrowth was grazed by goats after growing for 26, 49, 63, 78 and 106 days.

Grazing management

Two Japanese Saanen goats (mean body weight 67.5 kg), fistulated at the oesophagus, grazed each pasture at the different stages of growth. Before grazing, using 3 quadrats of 100 x 60 cm, sward height and stem length were measured and a sample was cut at 5 cm above ground level to determine dry matter yield. Two fenced sections were erected in each pasture at each growth stage. Grazing behaviour was recorded by putting one goat in each enclosure in the morning and collecting the forage selected from the oesophageal fistula to measure the intake during 20 minutes (Nakanishi *et al.* 1985). All the forage left by each goat in the grazed enclosure was cut at 5 cm above ground level. Using a quadrat of 100 x 60 cm per fenced enclosure, a sample from the grazed layer of the sward was also collected by cutting the forage, at the same height as was grazed by the animals, from the ungrazed sward. Thus, for each pasture at each growth stage, there were 2 samples collected from fistulated goats, 2 of the residue left after grazing and 2 which represented the grazed layer of the sward.

Leaf proportion

A binocular microscope (20x) was used to determine the leaf and stem fraction in subsamples of the extrusa. The simulated selected forage was separated into leaf and stem fractions prior to drying.

Chemical analyses

Samples of selectively grazed (extrusa) and uneaten forage were dried at 70°C for 24 h and ground in a mill fitted with a 1 mm aperture screen. The samples were analysed for crude protein (Kjeldahl method), cell wall components (Goering and Van Soest 1970), *in vitro* dry matter digestibility (Minson and McLeod 1972) and energy using an adiabatic bomb calorimeter (Shimadzu CA-4 type).

Bite size

Total bites (TB) during grazing were measured by watching the goats for 20 minutes and pressing a counter every time a bite was observed. Observations had previously shown that the observers with the counters did not disturb the animals. Herbage intake per bite was calculated from the total dry matter (DMI/TB), digestible dry matter (DDMI/TB) and digestible energy (DEI/TB) eaten in the 20 minutes and extruded through the oesophageal fistula.

Statistical analyses

Correlation analysis between bite size and its related variables followed the method described by Snedecor and Cochran (1967).

Results and discussion

Pasture characteristics

Sward height, stem length and dry matter (DM) yield of the phasey bean and siratro grazed by the goats are shown in Table 1. With increasing maturity, the sward height of phasey bean increased, but in siratro, which had a prostrate habit, there was little change in height. Stem length increased with advancing maturity in both pastures. Phasey bean was higher yielding than siratro at all stages of growth. Between 78–106 days regrowth there was a reduction in DM yield of the siratro, possibly due to the death of material in the bottom layer and leaf drop into the layer below cutting height.

Nutritive value

The chemical composition of selected forage and uneaten residue of phasey bean and siratro are shown in Figure 1. Crude protein of the selected forage was about 9 percentage units higher than that of the residue of the phasey bean but in

siratro the difference was only 4 percentage units between the two fractions. The concentration of neutral detergent fibre (NDF) and acid detergent fibre (ADF) in the selected forage were lower than in the residues of both pastures, but the differences between the two fractions of siratro were smaller than those found with phasey bean. The acid detergent lignin (ADL) content of the selected forage was slightly lower than that of the residues of both pastures. Dry matter digestibility *in vitro* and digestible energy were higher in the selected forage than in the residues of both pastures with smaller differences in the siratro than in the phasey bean (Figure 1).

Thus, the goats selected parts of the plant that had a higher nutritive value and left uneaten forage of lower quality. This selection is partly due to the more accessible upper layer of pasture being younger than the less accessible lower layers of the sward. With siratro there was a smaller difference in the fibre fractions between the grazed and ungrazed fractions than phasey bean. This appeared to be related to the creeping, less rigid habit of stems of siratro.

Leaf proportion

The proportion of leaf was higher in the forage selected by the goats than in the material cut by hand from the grazed layer of both pastures (Table 2). This preference of goats for leafy parts of the sward is in agreement with the observations of Alder and Minson (1963) with cattle and Bryant *et al.* (1979) and Malechek and Leinweber (1972) with goats. This is probably due to the smaller quantity of energy required to remove leaf than stem from the plant during grazing (Hendricksen and Minson 1980). The 106 days regrowth of phasey bean had long twining stems and the selected forage contained less than 50% leaf. This may be due to the difficulty of separating leaf from the twining stems. By contrast, there was no reduction in the proportion of leaf selected from the siratro at 106 days regrowth.

With increasing maturity, the forage selected from the phasey bean tended to contain less leaf, probably due to a reduction in leaf proportion in the canopy. However, there were only small changes in the leaf percentage of the forage selectively grazed from the siratro sward (Table 2).

Intake per bite

Bite sizes of goats grazing phasey bean and siratro are shown in Figure 2. The bite size of goats grazing phasey bean generally increased as it matured. The larger bite size at 106 days regrowth is possibly associated with the grazing of twining stems which were easy to separate from the plant. The bite size of goats grazing siratro also increased with maturity up to 63 days regrowth and then decreased slightly. In both pastures the changes in DDM and DE per bite were similar to those found for bite size of dry matter (Figure 2).

Bite size of goats grazing phasey bean was positively correlated with sward height, stem length and dry matter yield, but had a significant negative correlation ($P<0.05$) with leaf percentage of the grazed layer (Table 3). This negative correlation with leaf percentage contrasts with the findings of Hendricksen and Minson (1980) with *Lablab purpureus*. Those authors found that leaf percentage, sward height and dry matter yield were all positively correlated with bite size of grazing cattle. This contrast between goats and cattle in the relation of leaf

Table 1. Sward height, stem length and dry matter yield of phasey bean and siratro.

Regrowth days	Height		Length		DM yield	
	Phasey bean	Siratro	Phasey bean	Siratro	Phasey bean	Siratro
	(cm)		(cm)		(kg/ha)	
26	74	32	79	69	1560	1140
49	112	35	117	77	3350	1920
63	145	34	150	95	4260	2630
78	159	39	168	88	5740	3100
106	153	38	162	107	5710	2690

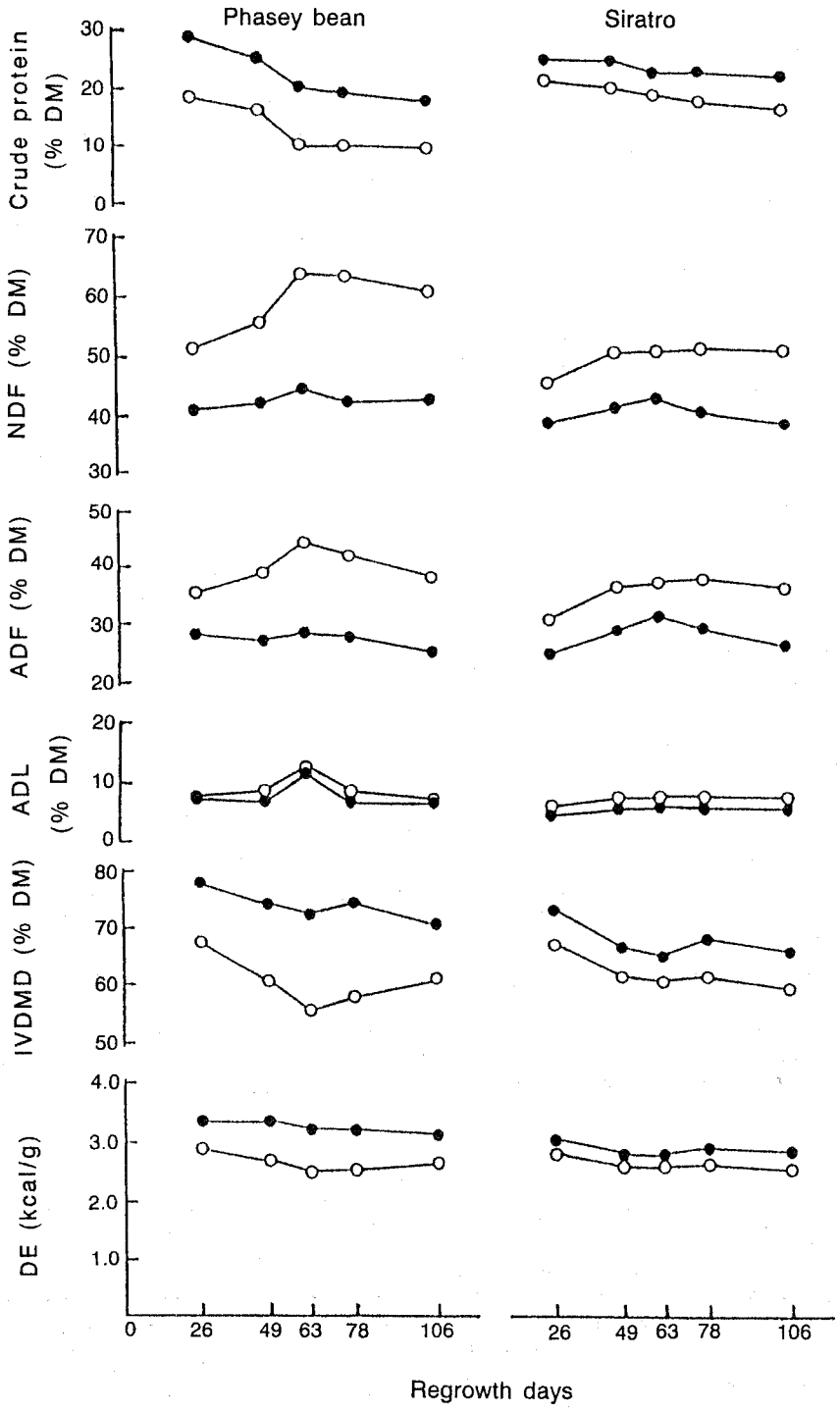

Figure 1. Chemical composition, *in vitro* dry matter digestibility (IVDMD) and digestible energy (DE) of the selected forage (●) and uneaten parts (o) of phasey bean and siratro.

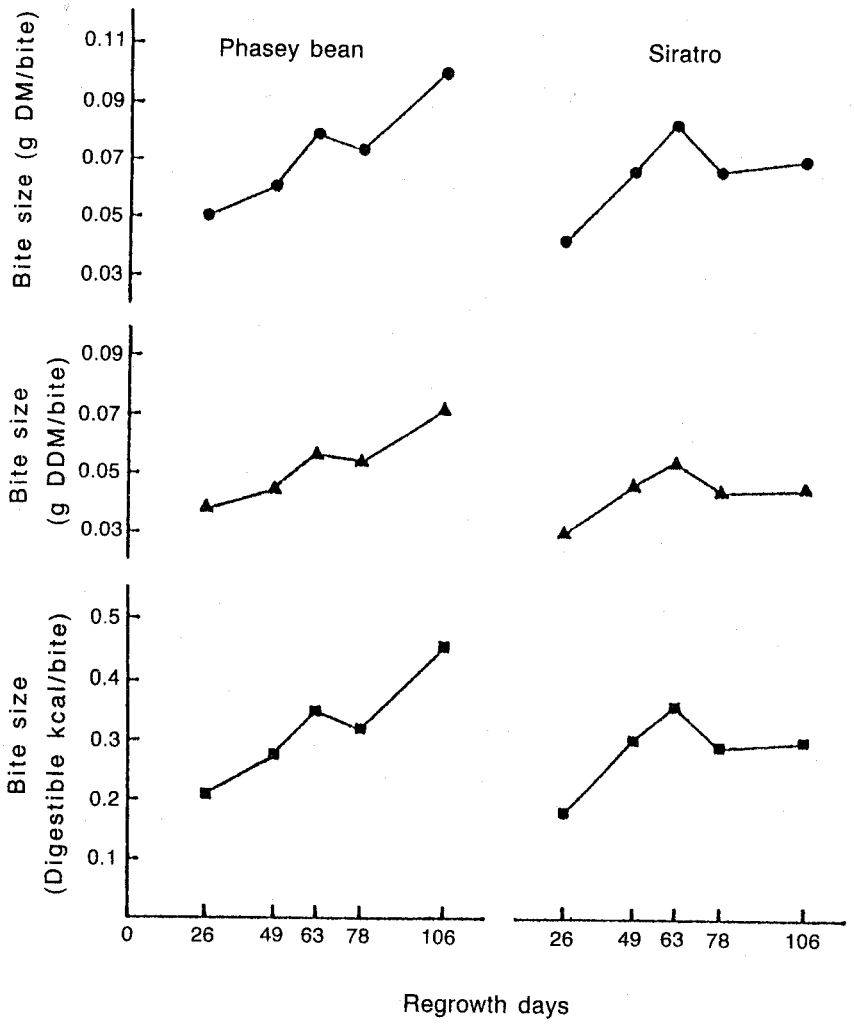

Figure 2. Dry matter intake per bite (●), digestible dry matter intake per bite (▲) and digestible energy intake per bite (■) of goats grazing phasey bean and siratro.

percentage to bite size is probably due to the browsing habit of goats that could graze even the mature plant with less proportion of leaves, whereas cattle prefer leafy plants (Arnold and Dudzinski 1978). When grazing siratro, bite size of goats was positively correlated with sward height, stem length and dry matter yield, although the coefficients were lower than with phasey bean (Table 3). Bite size for siratro had a positive correlation with leaf percentage of the grazed layer that showed only small changes during growth.

Table 3. Correlation coefficients (r) between bite size (DM/bite) and sward characteristics of phasey bean and siratro.

Variable	Correlation coefficient (n = 5)	
	Phasey bean	Siratro
Plant height	0.815+	0.394
Stem length	0.821+	0.727
Dry matter yield	0.838+	0.767
Leaf percentage	−0.911*	0.496

+ $P<0.10$ * $P<0.05$

Table 2. Leaf percentage of the selectively grazed part of the sward (extrusa from oesophageal fistula) and the grazed layer of the sward.

	Extrusa		Grazed layer	
Regrowth days	Phasey bean	Siratro	Phasey bean	Siratro
26	86	74	72	52
49	80	79	59	53
63	75	77	55	57
78	72	76	44	59
106	48	83	35	52

It is concluded that goats grazing *Macroptilium lathyroides* and M. *atropurpureum* selectively graze the leafy parts of the forage and have a bite size that is positively correlated with pasture yield, sward height and stem length, but the relation between the leaf percentage in the grazed layer and bite size was inconsistent between the two legumes.

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