THE EFFECT OF POST-INGESTIVE FEED BACK OF NUTRIENTS ON INTAKE OF OVEN-DRIED GLIRICIDIA LEAVES

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ABSTRACT

Two trials were conducted to assess the effect of post-ingestive feed back of nutrients on intake of gliricidia leaves by sheep. In trial 1, six rumen fistulated sheep were used to compare four dietary treatments in a randomised complete block design. Gliricidia leaves were fed *ad lib*. with no other additives (treatment 1) or with 15 mg metoclopramide/kg body weight (treatment 2), or 0.5 % body weight of ground barley grain (treatment 3), or 0.5% body weight of cottonseed meal (treatment 4) administered into the rumen within 30 minutes before feeding the leaf. In trial 2, the same sheep as in trial 1 were used to compare four dietary treatments in a randomised complete block design. Gliricidia leaves were fed *ad lib*. (treatment 1), or with 0.5% body weight of cottonseed meal either administered into the rumen before feeding the leaf (treatment 2), or mixed with the leaf (treatment 3), or fed separately prior to offering the leaf (treatment 4). The results showed that administration of cottonseed meal into the rumen in trial 1 increased significantly daily intake of gliricidia leaves compared to the control treatment, or to administration of metoclopramide into the rumen (285 g vs. 171 g vs. 142 g) dry matter. However, administration of ground barley grain into the rumen did not significantly differ from any other treatment. In addition, none of dietary manipulations in trial 2 increased intake of gliricidia leaves by the sheep.

Keywords: post-ingestive feed back of nutrients, gliricidia leaves, sheep

PENGARUH UMPAN BALIK NUTRIEN TERHADAP KONSUMSI DAUN GAMAL KERING OVEN OLEH TERNAK DOMBA

ABSTRAK

Dua jenis percobaan telah dilaksanakan untuk mempelajari pengaruh umpan balik nutrien terhadap konsumsi daun gamal oleh ternak domba. Percobaan 1 menggunakan empat ekor domba dewasa yang difistula rumennya untuk membandingkan empat macam perlakuan dengan rancangan acak kelompok. Perlakuan tersebut adalah daun gamal diberikan secara berlebihan tanpa tambahan (perlakuan 1), diberikan tambahan 15 mg/kg berat badan metoclopramide (perlakuan 2), atau 0,5% tepung biji kapas dari berat badan (perlakuan 3), atau 0,5% biji barley giling dari berat badan (perlakuan 4), yang ke semuanya dimasukkan ke dalam rumen melalui fistula setengah jam sebelum pemberian daun gamal. Percobaan 2, menggunakan empat ekor domba yang sama seperti pada percobaan 1 untuk membandingkan empat macam perlakuan dengan rancangan acak kelompok seperti pada percobaan 1. Perlakuan tersebut adalah

daun gamal diberikan berlebihan (perlakuan 1), atau dengan tambahan 0,5% tepung biji kapas dari berat badan yang dimasukkan dalam rumen sebelum penyajian daun gamal (perlakuan 2), atau dicampurkan dengan cara diremas dengan daun gamal (perlakuan 3), atau disajikan terpisah sebelum penyajian daun gamal (perlakuan 4).

Hasil percobaan menunjukkan adanya peningkatan konsumsi daun gamal harian secara berarti oleh domba dengan adanya 0,5% tepung biji kapas dari berat badan yang dimasukkan ke dalam rumen dibandingkan dengan perlakuan kontrol atau dengan pemasukan 0,5% metoclopramide ke dalam rumen (285 g vs. 171 g vs. 142 g) bahan kering. Meskipun demikian, semua manipulasi penyajian pakan pada percobaan 2 tidak ada yang menunjukkan pengaruh positif yang berarti terhadap peningkatan konsumsi daun gamal oleh ternak domba.

Kata kunci: umpan balik nutrien, daun gamal, domba

INTRODUCTION.

Gliricidia leaves used in the previous trials (Karda and Spudiati, in press) were not palatable to either sheep or goats. Although addition of molasses increased intake over the whole 6 h intake measurement compared to the control diet, the amount eaten during that period was very low (74 v 43 g, for the molasses and control diet, respectively). Other approaches such as drying, freezing, addition of additives and supplementation with polyethylene glycol administered into the rumen did not influence its intake by sheep. Additionally, sheep showed an aversion within an hour of being offered gliricidia leaves. Provenza (1996) and others have published effects on food preference, by using antiemetic chemicals and post-ingestive feedback, which offer alternative possibilities for manipulating gliricidia intake. Antiemetic drugs such as metoclopramide have been known to attenuate toxin-induced food aversion. For example, Aldrich *et al.* (1993) showed that intake by sheep of tall fescue containing an endophytic fungus *(Acremonium coenophialum)* which produces ergopeptide alkaloids was lower than for endophyte-free fescue.

However, when sheep were given daily doses of metoclopramide (20 mg/kg body weight) through rumen cannulae, the intake of infested fescue was increased by 24%, whereas intake of endophyte-free fescue was not changed. In this case, metoclopramide was suggested to be an effective antiemetic for ergoalkaloids, and that antiemetic drugs increase intake of foods that cause aversive postingestive feedback because they attenuate food aversion (Mitchelson, 1992, cited by Provenza *et al.*, 1994). It is not known whether an aversive response of consuming gliricidia can be attenuated by supplementation with metoclopramide or not.

Preferences for food as a result of postingestive feedback have been demonstrated by Buritt and Provenza (1992). According to these authors, a strong preference for a novel diet can be acquired if it is fed with intra-ruminal nutrient infusion. Similar studies by Ralph *et al.* (1995) have demonstrated that high levels of glucose administered into the rumen significantly conditioned a preference for flavoured straw. It was suggested that the glucose treatment increased microbial mass, and consequently more nutrients were absorbed in the lower gastrointestinal tract. These were thought to provide the positive nutrient feed back required to form a preference.

This experiment was designed to examine methods of increasing gliricidia intake by sheep through creating a favourable postingestive feed back, and the use of an antiemetic drug.

MATERIALS AND METHODS.

Animals and Dietary Treatments.

Trial 1: six rumen-fistulated sheep (34.4 ± 4.6 kg, mean ± SD) were used to compare 4 dietary treatments in a randomised complete blocks design. There were four experimental periods, each of nine days. Two weeks rest was allowed between periods to eliminate any carryover effect. Gliricidia leaf was dried in a forced draught oven at 50 ^{0}C for 48 hours and offered *ad lib.* with no other additive, or with 15 mg metoclopramide/kg body weight, or ground barley grain (0.5 % body weight), or cotton seed meal (0.5 % body weight) administered into the rumen within 30 minutes before feeding the leaf. Trial 2: the same sheep as in trial 1 were used to compare four dietary treatments. There were again four experimental periods, each of nine days with one week rest between periods. Gliricidia leaf was offered alone *ad lib.*, or with 0.5% body weight of cottonseed meal either administered into the rumen before feeding the leaf, or mixed with the leaf, or fed separately prior to offering the leaf.

Feeding Routines and Measurements.

Trial 1: before the commencement of the trial, the animals were familiarised with gliricidia leaf over a 10 day period. Gliricidia leaf was offered at 0900 h on alternate days. On the days when intakes were not measured all sheep were offered Callide Rhodes grass hay at one-third of their voluntary intake. Fresh water and multimineral blocks were also available *ad lib.* throughout the trial. The amount of the test forage consumed during intake measurements was calculated by difference which was measured over 1 h, 4 h and 24 h periods. In trial 2, feeding routines and intake measurements were the same as in trial 1. When

gliricidia was mixed with cottonseed meal, intake was estimated by assuming that the proportions of these two feedstuffs in the refusals were the same as in the offered feed. Rumen fluid samples were taken during the last day of gliricidia intake measurement in each experimental period, 4 h after feeding. Samples were strained through cheesecloth and were preserved with $HgC1_2$, and then stored frozen until analysis for rumen ammonia-N and VFA determination.

Chemical Analysis.

Condensed tannin in gliricidia leaf was determined by a modification of the butanol-HCI technique of Perez-Maldonado (1994). Rumen ammonia-N concentration was determined by steam distillation using MgO and $CaC1_2$ (AOAC 1970). Volatile fatty acid contents of rumen fluid samples were determined by gas chromatography (Hewlett 5890, Packard Series H) fitted with a capillary column AT wax non packed 30 M. The oven temperature was 210 ^{0}C.

Statistical Analysis.

Differences between means were compared by analysis of variance using the general linear model procedure of the Statistical Analysis System (SAS, Institute Inc., 1988). Significant differences between the treatment groups were determined by least significant difference, and were declared at $P<0.05$. One sheep died in the last period of trial 2 and missing values were calculated. Intake data in trial 2 were reported as least square means.

RESULTS

Administration of cottonseed meal into the rumen significantly increased daily intake of gliricidia leaf compared to the control treatment, or to administration of metoclopramide ($P<0.05$). Intake of gliricidia leaves following administration of ground barley grain into the rumen did not significantly differ from any other treatment ($P>0.05$) and is presented in Table 1.

On the other hand, none of the dietary manipulations in trial 2 increased intake of gliricidia leaves. In contrast to trial 1, intra-ruminal administration of cottonseed meal at the same level increased intake of the leaf by only 20 % compared to the control diet, and the difference was not significant. A smaller increase in intake of the leaf of only 10 % compared to the control treatment was observed when the leaf was mixed with the supplement. However, feeding cottonseed meal before gliricidia feeding increased intake of the leaf by 59 % compared to the control diet, and this difference almost approached significance (P=0.052) as presented in Table 2.

Table 1. Intake of gliricidia leaf by sheep when metoclopramide, or ground barley grain, or cottonseed meal was administered into the rumen.

Intake of gliricidia (g DM)					
Measurements	Control	Metoclopramide	Ground barley grain	Cottonseed meal	LSD (P<0.05)
Within 1h	34[a]	34[a]	48[a]	58[a]	28
Within 4h	80[a]	87[a]	100[a]	122[a]	60
Within 6h	171[a]	142[a]	194[ab]	285[b]	110

[ab] within rows, mean values with dissimilar notations are significantly different (P<0.05).

Table 2. Intake of gliricidia leaves by sheep when cottonseed meal was either administered into the rumen, or mixed, or fed separately prior to offering the leaf.

Intake of gliricidia (g DM)				
Measurements	control	administered into the rumen	mixed with the leaf	fed before the leaf
Within 4 h	62[a]	69[a]	83[a]	89[a]
SE	13	12	12	12
Within 24 h	116[a]	139[a]	128[a]	185[a]
SE	24	21	21	21

[aa] within rows, least square means with similar notation are not different (P>0.05). SE = standard error of least square means.

Rumen ammonia-N concentrations of the rumen fluid samples taken at 4 h after feeding increased with intra-ruminal administration of cottonseed meal, or mixing cottonseed meal with the leaf, or feeding cotton seed meal separately prior

to offering the leaf, compared to control diet. Rumen total volatile fatty acid concentrations tended to increase (P<0.08) due to administration of cottonseed meal or feeding cottonseed meal separately, but not when it was mixed with the leaf, compared to the control diet. The molar proportion of propionic acid was increased by administering cottonseed meal into the rumen, or mixing it with the leaf, or feeding it before offering gliricidia, compared to the control diet. However, the proportions of other acids were not changed due to dietary treatments (Table 3).

Table 3. Rumen ammonia-N, volatile fatty acids (VFA) concentrations and its proportions of sheep offered gliricidia leaf *ad lib.* either with administering cottonseed meal into the rumen, or mixing it with the leaf, or offering it separately before gliricidia feeding.

Methods of administration of cottonseed meal								
Parameters	administered into the rumen		mixed with the leaf		fed before gliricidia leaf		control	
	lsmean	se	lsmean	se	lsmean	se	lsmean	se
Rumen NH_3-N (mg/L)	318^{b}	38	253^{b}	38	357^{b}	38	93^{a}	44
VFA (mmol/L)	45^{b}	6.6	35^{ab}	6.6	46^{b}	6.6	20^{a}	7.4
Molar proportions (%)								
Acetic acid	76.5^{a}	7.91	77.4^{a}	7.91	70.8^{a}	7.91	72.3^{a}	7.91
Propionic acid	15.0^{b}	2.83	15.8^{b}	2.83	17.8^{b}	2.83	6.4^{a}	3.20
n-butyric acid	3.8^{ab}	0.65	3.4^{a}	0.65	5.6^{b}	0.65	2.5^{a}	0.73
Iso-butyric acid	1.77^{a}	0.38	2.21^{a}	0.38	2.17^{a}	0.38	2.57^{a}	0.43
Iso-valeric acid	1.87^{a}	0.58	1.80^{a}	0.58	1.74^{a}	0.58	1.75^{a}	0.66
n-valericacid	0.69^{a}	0.39	0.95^{a}	0.39	0.72^{a}	0.39	1.47^{a}	0.44

ab within rows, least square means with dissimilar notations are different (P<0.05). se = standard error of least square means.

DISCUSSION

Intake of gliricidia leaf increased by 67% in trial 1 during intra-ruminal administration of cottonseed meal compared to the control diet. This increased intake might have been associated with a postingestive feed back from nutrients which in turn may increase the liking for food paired with it (gliricidia). Similar results were also observed by Burritt and Provenza (1992) in lambs, which

acquired strong preferences for the flavour of a solution that was paired with glucose compared to when saccharin was given, or for straw flavoured with a novel odour or taste (onion or oregano) when it was eaten during intra-ruminal infusion of energy (starch or glucose) or nitrogen (urea, casein or gluten). In contrast to the first trial, none of the dietary manipulations in trial 2 increased intake of gliricidia leaf. Intra-ruminal administration of cottonseed meal at the same level increased intake of the leaf by only 20%, and the difference was not significant. However, intake of the leaf was highest when cottonseed supplement was offered separately from the leaf (59%) and the difference approached significance (P=0.052).

It was also noted that mixing the leaf with the supplement increased intake of the leaf by only 10% compared to the control diet. This result was also observed in the earlier trial when an attempt to mask the taste of gliricidia leaf by mixing it with cottonseed meal did not result in an increased intake of leaf. The reason for the poor intake of leaf due to intraruminal administration of cottonseed meal in this trial was not known, but may be due to the adaptation of animals from consuming small amounts of leaf. The use of cottonseed meal supplements to gliricidia seems to have good prospects for future research. This method of administering supplements is practicable. The tendency in an increase of intake of leaf may be explained by positive post-ingestive feedback due to the consumption of the supplement which may create a preference for the alternative feed as suggested by Provenza (1996). The higher molar proportions of propionic acids in the rumen fluid of supplemented sheep may be related to the supplements that are

probably metabolised to produce glucose which may condition a preference as suggested by Ralph *et al.* (1995).

Increases in the intake of gliricidia were not observed during intra-ruminal administration of ground barley grain. These results contrast with the findings of Provenza (1995) who observed the development of strong preferences for straw flavoured with onion or oregano during intraruminal. infusion of starch or glucose. The cause of this difference is not known, but may be related to changes in the ruminal environment. Ground barley grain supplies rapidly fermentable starch which may create an adverse effect such as low rumen pH rather than its effect on conditioning a preference. The lack of response to administration of metoclopramide may be because this antiemetic drug is specifically effective for ergoalkaloids, as suggested by Aldrich *et al.* (1993).

Rumen ammonia-N concentration across treatments was higher than the suggested value of 50 mg NH_3-N/L which is considered to be sufficient for fibre digestion in *vitro* (Satter and Slyter, 1974). However, total volatile fatty acid concentration was much lower in these diets compared to normal values obtained with conventional diets which is between 70 to 130 mM (Leng, 1970; France and Siddons, 1993*)* and other browses (Rohan-Jones *et al.,* 1972). The low value of volatile fatty acids may indicate rumen fermentation was below optimum. This follows since the sheep ate less than 200g gliricidia DM and 0.5 % body weight of cottonseed meal on the day when the rumen samples were collected.

It is concluded that gliricidia is not a palatable feedstuff, and its intake by sheep can be manipulated through creating postingestive feedback that may be

conditioning a preference. This can be done through feeding a small amount of protein supplements such as cottonseed meal before offering the leaf.

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