METHODOLOGICAL ASPECTS IN RUMINAL DIGESTION STUDIES.
2. EFFECT OF THE DIETARY ROUGHAGE[1]

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ABSTRACT - An experiment was conducted to examine the effect of two different tropical grasses (sugarcane tops and elephant grass), fed to a rumen-fistulated steer, upon the *in situ* digestion of eight types of pigeon pea forage. In one experimental period, the animals were fed sugarcane tops supplemented with pigeon pea forage and sorghum grain (2.2, 0.5 and 0.4 kg DM/100 kg LW/day, respectively). In a second period, elephant grass was substituted for the sugarcane tops. The pigeon pea forage samples were dried, ground to 1mm size particles and placed in nylon bags (3 bags per sample) which were incubated in the rumen during 48 h. The disappearance of dry matter was calculated as the *in situ* digestibility of the sample. The statistical analysis revealed a highly significant effect ($P \leq 0.03$) of the roughage fed upon the *in situ* digestibility of the pigeon pea forages. When the elephant grass ration was fed, the average *in situ* digestibility of pigeon pea dry matter was 42.3 ± 2.10%; with sugarcane tops, the digestibility averaged 38.4 ± 3.38%. Based on this result and in view of the literature it is concluded that a supplementary legume not only has a positive effect on the digestion of poor roughages but these, in turn, affect the digestibility of the legume. Thus, it is important to take this into account in digestion studies, especially those designed for the nutritional characterization of feeds.

Index terms: bovine, *in situ* digestibility, tropical grasses, pigeon pea.

ASPECTOS METODOLÓGICOS EM ESTUDOS DE DIGESTÃO RUMINAL.
II. EFEITO DO VOLUMOSO NA DIETA

RESUMO - O presente experimento foi conduzido com o objetivo de testar o efeito de duas gramíneas tropicais (ponta de cana-de-açúcar e napier), fornecidas a um novilho fistulado no rúmen, sobre a digestão *in situ* de oito tipos de forragem de guandu. Num período experimental foi fornecida a ponta de cana suplementada com forragem de guandu e grão de sorgo (2,2; 0,5 e 0,4 kg de MS/100 kg de peso vivo/dia, respectivamente). No segundo período, a ponta de cana foi substituída pelo napier. As amostras de forragem de guandu foram secadas, moídas a 1 mm de tamanho e colocadas em bolsas de nylon (três bolsas por tipo de forragem), as quais foram incubadas no rúmen durante 48 horas. O desaparecimento da matéria seca foi calculado como digestibilidade *in situ* da amostra. A análise estatística mostrou efeito altamente significativo ($P \leq 0,03$) da gramínea na dieta sobre a digestibilidade *in situ* das amostras de guandu. Quando a ração baseada em napier foi usada, a média de digestibilidade *in situ* do guandu foi de 42,3 ± 2,10%; no caso da ponta de cana, a digestibilidade foi de 38,4 ± 3,38%. Com base neste resultado e nas evidências da literatura, concluiu-se que uma leguminosa suplementar tem efeito positivo sobre a digestão de forrageiras de baixa qualidade, e estas, por sua vez, afetam a digestibilidade da leguminosa. Conseqüentemente, é importante levar isto em consideração nos estudos de digestão, especialmente nos que visam caracterizar nutricionalmente os alimentos.

Termos para indexação: bovino, digestibilidade *in situ*, gramíneas tropicais guandu.

INTRODUCTION

It is widely known that tropical roughages (including many crop residues) are of limited nutritional value (Minson 1981). Various attempts have been made to improve their quality and, consequently, animal productivity. Ndlovu & Buchanan-Smith (1985) summarized the methods as being of three types: improvement by physical treatments, by chemical means and by proper supplementation. Experimentation with any of these alternatives, in terms of production experiments, involves high costs and time. A relatively recent technique, the *in situ* digestion of feeds, is being used for a more rapid initial evaluation of the nutritional potential of feeds and treatments without incurring much expense.

Supplementation of tropical roughages with pro-

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tein or energy sources has generally resulted in improved animal performance. Priego & Lora (1978) have suggested that the benefits obtained from supplementation may be due to faster rumen turnover rate and liquid flow, concomitant to increased voluntary intake, rather than improvements in the digestibility of the ration. Nevertheless, Ndlovu & Buchanan-Smith (1985) showed that the rumen digestibility of coarse roughages was significantly improved when supplemented with alfalfa. Similar results were obtained by Soofi et al. (1983) comparing alfalfa-based rations vs. a soybean stover-based ration containing only 5.7% crude protein. On the other hand, when energy is supplemented, negative effects on the digestibility of the ration or basal roughage are obtained (Hughes-Jones & Peralta 1981, San Martín et al. 1983, Fernández et al. 1984). San Martín et al. (1983) showed that energy supplementation at low levels (less than 21% of the diet) did not affect the digestibility of sugarcane tops and that, furthermore, digestibility was reduced when higher levels of the energy supplement were used.

Another view of the interaction of one feed over another at the rumen level is given when a specific roughage is studied under different feeding regimes. In this case, the literature is clear in the sense that widely varying diets cause different rates of degradation of the roughage (Kempton 1980, Hughes-Jones & Peralta 1981, Weakley et al. 1983). Even when feeding different grasses, differences in the digestion of the test material may also be noted, for example, in the work of Orskov & Hovell (1978), who compared sugarcane and pangola hay. In contrast to the above findings, it is necessary to point out that Faria & Huber (1984) found no significant changes in the digestibility of forages even when the protein content of the diet varied from 8% to 13% and the level of corn was 0%, 30% or 60% of the ration; however, the forages used were of good quality.

The need to ascertain whether or not there is a diet effect on the digestibility of the supplement under tropical environments is twofold: first, if there is an effect, the experimenter should standardize or at least inform of the dietetic conditions when *in situ* digestibility trials are conducted and, second, the interactions between the basal diet (or roughage) and the supplement should be properly characterized. The objective of this experiment was, therefore, to generate information towards the elucidation of the abovementioned aspects by studying the effect of sugarcane tops (*Saccharum officinarum*) and elephant grass (*Pennisetum purpureum* cv. Cameroon) upon the *in situ* digestibility of pigeon pea forage (*Cajanus cajan*).

MATERIALS AND METHODS

One Nelore steer, fitted with a rumen cannula and weighing approximately 375 kg was housed in concrete-floor enclosure with the feed trough partitioned for the separate administration of roughage and a mixture of pigeon pea forage plus sorghum grain. In a first period, preceded by a one week adaptation phase, the animal received ration S (sugarcane tops as roughage source); after another adaptation phase, ration E (elephant grass) was used (Table 1). These rations constituted the treatments in a randomized complete block design (Steel & Torrie 1960). The blocks were constituted by eight samples of pigeon pea forage differing according to plant part and plot treatment (Table 2). The samples were dried at 65°C and ground to 1 mm-size particles. For each ration, three nylon bags per sample were used for the *in situ* digestion study according to the methodology described by Ruiz & Thiago (1988). After a 48-h incubation period, the bags were removed, washed and dried at 65°C. The loss in sample weight was calculated as *in situ* dry matter digestility (ISDMD). The analysis of variance was based on the means for every sample in each treatment.

RESULTS AND DISCUSSION

The results and corresponding statistical analysis are presented in Tables 3 and 4.

There was a significant effect ($P < 0.01$) due to sample, reflecting a consistently low dry matter (DM) digestibility value for leaves and for thick stems as compared to the fine stems or pods. This observation may have an important nutritional connotation as the parts that are normally used for feeding animals are the leaves and fine stems and, to a lesser extent, the pods. The literature shows that in legumes the digestibility of the stems is lower than the digestibility of leaves (Terry & Tilley 1964, Mowat et al. 1965, Jones 1969) which is correlated with a higher tannin content in the leaves as compared to the stems (Donnelly & Anthony 1973). However, in high-tannin legumes there may be an overlap in DM digestibility values

TABLE 1. Rations (tratments) used in the experiment and some chemical characteristics.

Ingredient	As-fed basis, kg/100 kg LW[1]		Composition (%)		
	Ration S	Ration E	DM[2]	CP[3]	NDF[4]
Sugarcane tops (IFN 2-17-517), fresh, chopped	6.40	0.00	34.6	2.62	63.6
Elephant grass (IFN 2-15-489), fresh chopped	0.00	6.40	29.8	3.49	71.5
Pigeon pea forage (IFN-2-03-715), fresh chopped	0.84	0.84	59.8	6.41	65.4
Sorghum grain (IFN 4-13-558), ground	0.43	0.43	84.3	8.14	14.8

[1] LW = Liveweight
[2] DM = Dry matter
[3] CP = Crude protein
[4] NDF = Neutral detergent fiber

TABLE 2. Characterization of the eight samples of pigeon pea forage used for the *in situ* digestibility determinations.

Sample	Identification	Treatment applied to the plot[1]	Composition, dry basis (%)	
			CP	NDF
2AV	Pods with seeds, plot 2	*160 kg P_2O_5 /ha/yr, rows 0.93 m apart*	*13.4*	*58.4*
4AH	Branches > 6 mm diameter, plot 4	160 kg P_2O_5/ha/yr, rows 0.93 m apart	5.3	79.6
9Ah	Branches < 6 mm diameter, plot 9	100 kg P_2O_5/ha/yr, rows 0.40 m apart	8.6	69.8
10Ah	Branches < 6 mm diameter, plot 10	100 kg P_2O_5/ha/yr, rows, 3.00 m apart	9.0	73.7
11Ah	Branches < 6 mm diameter, plot 11	100 kg P_2O_5/ha/yr, rows 1.70 m apart	7.5	69.5
11AF	Leaves with petioles, plot 11	100 kg P_2O_5/ha/yr, rows 1.70 m apart	17.8	54.2
12Ah	Branches < 6 mm diameter, plot 12	100 kg P_2O_5/ha/yr, rows 1.70 m apart	9.9	67.6
12AF	Leaves with petioles, plot 12	100 kg P_2O_5/ha/yr, rows 1.70 m apart	19.3	52.7

[1] All plots were sown in December 1983 and the first cutting (used in the experiment reported herein) was obtained in June 1984. All plots were treated alike with respect to limestone and minor elements.

TABLE 3. Means for 48-h *in situ* dry matter digestibility of various pigeon pea forage samples as affected by diet.

Sample	ISDMD (%)	
	Ration S	Ration E
2AV	55.5	52.1
4AH	29.2	37.0
9Ah	40.3	46.3
10Ah	39.8	43.9
11Ah	38.8	42.4
11AF	27.5	35.7
12Ah	46.4	45.8
12AF	29.9	35.4
Mean	38.4	42.3
Sx	3.38	2.10

TABLE 4. Analysis of variance for ISDMD (*in situ* dry matter digestibility).

Source of variation	d.f	Mean square	F value
Samples	7	117.83	14.38**
Treatment	1	60.88	7.43*
Experimental error	7	8.19	

* Significant at $P \leq 0.03$.
** Significant at $P \leq 0.01$.

for leaves and stems (Donnelly & Anthony 1973) which may be the case for pigeon pea (no values for tannin content in this legume were found in the literature). Also, Terry & Tilley (1964) showed the specific case of young alfalfa where the digestibility of the stems was higher than the digestibility of leaves; the young alfalfa stems referred to by these authors may be comparable to the thin stems in the present study.

The digestibility values obtained in the study reported herein are slightly higher than those reported by Rodríguez (1968) for various botanical parts of the pigeon pea plant including a 20% ISDMD fo leaves and 18.9% ISDMD for stems after a 70-h incubation period.

The roughage used in the ration significantly ($P < 0.03$) altered the extent of the ISDMD of the pigeon pea materials. Elephant grass induced a more extensive ruminal digestion of the legume than did the sugarcane tops (42.3 vs. 38.4%). Despite the fact that Mertens (as cited by Varga & Hoover 1983) found a significant correlation between rate and intake, an estimate of dry matter rumen digestion alone will not be sufficient to assign a feeding value to any given feed, or treatment, as other factors must also be taken into account (Ellis 1978); however, the technique is an aid in gaining some foresight as to the direction which follow-up tests should take. In addition, in the particular case of this study, the results suggest that efforts should be made to standardize (or at least clearly define) the feeding conditions when the objective is to characterize the digestibility of particular feeds.

It seems that elephant grass, as compared to sugarcane tops, would be preferable as a companion roughage for the pigeon pea forage. Although ration E had a slightly higher (4.62%) CP content than ration S (3.89% CP), perhaps this difference does not completely explain the higher digestibility of pigeon pea forage when the E ration was used, as both rations were markedly defficient in crude protein. A more plausible explanation of the difference in ISDMD, favoring the E ration, may be in the finding by Akin (1979) that different grass species differ in the type of bacteria associated with their degradation. Thus, bacteria associated with the ruminal degradation of the elephant grass would be more efficient than the ones associated with sugarcane tops in digesting the pigeon pea forage. If that were the case, and not ignoring other digestive phenomena, a superior animal performance with elephant grass-pigeon pea rations may be expected.

CONCLUSION

A supplementary legume not only improves the utilization of poor quality roughages but the nature of these, in turn, affects the extent of utilization of the legume *per se*. This latter point should be taken into account when planning digestion studies especially in those where the objetive is to define the nutritional characteristics of feeds.

ACKNOWLEDGEMENT

The author is thankful for the technical help received from Miss Cristina Gonzaga, a trainee at the EMBRAPA-CNPGC, Campo Grande, MS, Brazil.

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