Tropical and Subtropical Agroecosystems

PERFORMANCE OF GROWING LAMBS SUPPLEMENTED WITH *Mucuna pruriens*

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SUMMARY

The objective of this study was to evaluate the effect of supplementation with *Mucuna pruriens* on the performance of growing lambs. Two studys were conducted. In Study 1, *Mucuna* bean was offered as a supplement in a basal diet of Napier grass (*Pennisetum purpureum*). Twelve entire males were allocated to three experimental diets where the forage supplied 60% of the total DM intake and the supplementation the remainder 40%. In Diet 1 (Control), animals were supplemented with the conventional concentrate of sorghum and soybean meal; Diet 2 was supplemented with half of the conventional concentrate and half with ground *Mucuna* (including both the grain and the husk of the bean); Diet 3 was supplemented with only *Mucuna.* In Study 2, four of the lambs from the previous study were fed a diet of entirely velvet bean for 10 d. In Study 1, a significant reduction in the intake of the supplement was observed with increasing level of velvet bean, being 300, 293 and 200 g DM a^{-1} d^{-1} for groups with diets 1, 2 and 3, respectively. Similar trends were found in the total DM intake (forage and supplement) and the digestibility. However, the apparent DM digestibility did not differ ($P>0.05$) among the experimental diets being 70, 68 and 64 % for groups with diets 1, 2 and 3 respectively. In Study 2, no negative short-term impacts were found in lambs consuming a diet that was entirely based on *Mucuna*. Average intake across the experimental period was 680 g DM a^{-1} d^{-1}. Animals eating only *Mucuna* spent less time eating and ruminating than animals eating *Mucuna*-forage diet, presumably because their diet contained less neutral detergent fiber (NDF). It is concluded that velvet bean can be used to substitute more expensive supplements without a significant reduction in animal digestibility. To eliminate any possibility for negative long-term effects from diets containing high levels of *Mucuna*, a study involving more animals of longer duration should be conducted.

Key words: *Mucuna pruriens*, sheep, voluntary intake, supplementation, *in vivo* digestibility.

INTRODUCTION

In tropical areas ruminant livestock production is based on seasonal grass production. In these systems, pastures are abundant during the rainy season but inadequate in quantity or quality during the dry season. To overcome this problem, supplementation of animals during critical periods is a practical alternative. Unfortunately, in many cases this strategy is sustained by importation of agricultural products and by-products both nationally, and also at farm level. Dependence of this kind makes livestock systems non-sustainable in the long term and at best, animal products will become too expensive and therefore not accessible to the poor.

In order to solve this problem, NGOs and scientists worldwide are looking for solutions from the farmers' and the environment's points of view. In this framework, research on the use of green manure/cover crops has gained popularity in the tropics and some promising bean crops such as the *Mucuna pruriens* have been identified as suitable crop for smallholder conditions (Anderson *et al.*, 1997; Buckles *et al.,* 1999; CIDICCO, 1999).

Similarly, in the southeastern tropical regions of Mexico and particularly in the state of Yucatan, there is an increase in the adoption of velvet bean in the traditional maize-based *milpa* system of the Mayan people. As a consequence of this adoption, there is an increased availability of *Mucuna* beans. *Mucuna* grain and husk have good nutritional characteristics (Ayala-Burgos *et al*., 2003) with which to supplement ruminant livestock in critical periods, an alternative particularly valuable for the smallholders keeping goats and sheep in their back yard. However, the use of *Mucuna* as an animal feed has been restricted by the anti-nutrients in the grain. It is not known whether the anti-nutrients are degraded in the rumen. The current study was proposed to evaluate the impact of *Mucuna* on the performance of growing lambs. Two studies were carried out. In Study 1, intake and *in vivo* DM digestibility of twelve male growing lambs was evaluated at three levels of *Mucuna* supplementation (substitution of 0, 50% and 100% of the supplement) of a diet based on forage. In Study 2, during ten days,

four lambs were fed a diet that was entirely based on *Mucuna* to observe their intake, behaviour, and any signs of toxicity.

MATERIALS AND METHODS

Study 1

The study was carried out in the Department of Animal Nutrition of the Veterinary Faculty of the Autonomous University of Yucatán, México. Twelve entire male growing lambs weighing approximately 20 kg LW were used in this study. Each animal was individually housed in a metabolic crate. The basal diet consisted of fresh Napier grass (*Pennisetum purpureum*) which was about 90 days of re-growth and more than 2 m height. At harvesting, the forage was chopped and offered to the animals in amounts approximately 25% below the previously recorded intake under *ad libitum* feeding conditions. This restriction in offered forage was made to minimize the effect of differences in intake over digestibility across treatments. The offered amount of forage was estimated to be 60% of the total DM intake during digestibility measurements. The remaining 40% of the expected DM intake was covered by supplementation to form three experimental diets as follows. Diet 1 (Control) included a supplement containing sorghum (55%) and soybean (45%) meal. Diet 2 (50% MB) included half of the control supplement and half of ground *Mucuna*. Diet 3 (100% MB) included a supplement based entirely on ground *Mucuna*. In order to reduce dustiness, 200 g fresh matter (FM) of sugar cane molasses was added and mixed per kg of each of the supplements described above.

Diets supplemented with *Mucuna* bean used the whole pods containing the grain and husk, which were ground in a hammer mill with a 3 mm diameter sieve. The *Mucuna* bean used in this study was harvested in the south of Yucatan state during 2001. The seed of this type of *Mucuna* has a grey-brown light colour and probably came originally from Central America. Its chemical composition was described by Ayala-Burgos *et al*. (2003). It should be noted that the lambs were fed with the same experimental diets during twelve weeks in a previous trial where the animal growth was assessed. During this previous study, the lambs were housed in the Department of Animal Nutrition in pens of 4 by 5 m, with concrete floor, metal roof and containers for water and food.

To evaluate the digestibility, the animals were housed in individual metabolic crates for 10 days. The first five days were for adaptation to routine management. During the last five days, faeces were collected for 24 h for each animal (4 per treatment). Fresh faeces were weighed and a sub-sample was dried in a forced-air oven at 60ºC for about 48 h until constant weight was reached. Samples of offered and refused forage and supplement were taken daily and dried. The weight of the offered and refused food for each animal was used to derive the DM intake.

The respective supplement was offered at 08:00 h in a plastic box inside the trough of the metabolic crate. Three hours later, the forage was offered in the trough, but the plastic box with the residual supplement remained accessible to the animal until the next day. Fresh water was always available. Dry matter (DM) intake of the forage and of the supplement and the faeces DM excretion were recorded for each animal in a daily basis. DM digestibility was calculated for each animal within diets according to standard procedures (McDonald *et al.*, 1995) and compared by analysis of variance according to a completely randomized design (Mead and Curnow, 1983).

Study 2

In this study, four animals were selected from Study 1. Animals were entire males of about 25 kg LW and 7 months of age. *Mucuna* (grain and husks) was processed as above. The study was undertaken during March 2002 in the Department of Animal Nutrition of the FMVZ-UADY, in Merida, Yucatan, Mexico. The lambs were housed together in a 4 by 4 m pen, which had a concrete floor, metal roof, wall divisions of wire net and concrete troughs for food and water. During mornings, the ground *Mucuna* was offered *ad libitum* to the animals as the sole diet. Five kg FM of the ground *Mucuna* was offered each day to the group of four animals. This amount was mixed with 300 g sugar cane molasses in order to improve palatability and to reduce the dustiness of the supplement. Refusal of the food was taken only at the end of the ten days since the criterion was to ensure that *Mucuna* was always available to the animals. Water was always available also, but no other feed than *Mucuna* was offered to the animals during the ten days. In the last 48 h of the trial, the behavior of the animals was observed every 15 min (Jensen *et al*., 1986). Activities recorded were: eating, rumination and resting (i.e., any other activity than the first two). Recording consisted of the number of animals in each activity at each observation time. Data of the two days was pooled and presented as daily average. To compare the results, these data are presented together with data on intake behavior recorded in sheep supplemented with *Mucuna* bean (40% of the DM intake) in a previous study in our institute.

RESULTS AND DISCUSSION

Study 1

The Napier grass used as the basal forage had a mean composition of 750 g NDF kg^{-1} DM and 63 g CP kg^{-1}

DM. The intake of the forage, supplements, and the apparent digestibility *in vivo* are presented in Table 1.

The intake of the supplement was depressed when *Mucuna* was the only supplement (100% MB) in comparison to the other two treatments. Considering a proportion of 60% grain and 40% husk for *Mucuna* pods, the intake of the grain was 88 and 120 g DM a^{-1} d^{-1} and that of the husk was 59 and 80 g DM a^{-1} d^{-1} for treatments 50% MB and 100% MB, respectively. The content of L-Dopa has been reported to be about 6% of the grain DM. Thus, an L-Dopa intake of about 5 to 7 g a^{-1} d^{-1} can be expected for treatments 50% MB and 100% MB, respectively. The total DM intake was statistically different as a result of the different quantities of the supplement intake among the treatments.

Table 1. Dry matter intake (g a^{-1} d^{-1}) and apparent dry matter digestibility in growing lambs fed Napier grass basal diet and supplemented with different levels of *Mucuna*.

	Dry matter intake (g)			*In vivo*
	Forage	Supplement	Total	digestibility (%)
Control	436a	300a	736ab	70.4a
50% MB	483a	293a	776a	67.8a
100% MB	446a	200b	646b	63.9a

Means with different letters within a column are significantly different ($P<0.05$).

The DM digestibility did not differ statistically between treatments; however, there was a tendency for the digestibility to decrease as the level of *Mucuna* in the diet increased. Two factors might explain this trend: as the level of *Mucuna* increases, there is 1) an increase in fibre (NDF) from the husk and 2) an increase in L-Dopa from the grain. The animals were under the same diet for several weeks before the study and no signs of toxicity that can be attributed to L-Dopa (i.e., neurological symptoms) were observed before and during the trial. Therefore, it is possible that the additional intake of fibre from the husk slightly depressed the digestibility. The effect of a decrease in digestibility as fibre in the diet increased has been reported by Minson (1990). In relation to the objective of this study, we can conclude that *Mucuna* supplementation can substitute the use of conventional supplements for growing lambs without a significant reduction in feed digestibility with basal diets of forage. In this study we did not record animal behaviour however, no signs of abnormal behaviour were observed in animals during the digestibility measurements.

Study 2

After ten days of consuming a diet based entirely on *Mucuna*, the animals did not show any neurological symptoms (i.e., symptoms that could be attributed to L-Dopa). The average *Mucuna* intake of the four animals during the ten days was 680 g DM a^{-1} d^{-1}. Assuming that grain constitutes 60% of the pod (Castillo *et al.*, unpublished), grain intake was 408 g DM a^{-1} d^{-1} which, at 6% of L-Dopa, would be about 950 mg L-Dopa kg^{-1} LW d^{-1}.

A summary of the behavior of the animals in this and in a previous trial in our institute is presented in Table 2. With the diet based entirely on *Mucuna*, less time was used for eating and rumination whereas more time was dedicated to rest. This can be presumably explained by the lower intake of neutral detergent fiber (NDF) in the diet based only on *Mucuna*. Considering the NDF of grain (260 g kg^{-1} DM) and husk (598) in *Mucuna* (Ayala-Burgos *et al.*, 2003), it is estimated that in the diet consisting only of *Mucuna*, NDF intake was 262 g a^{-1} d^{-1} whereas in the *Mucuna* and forage diet, it was 449 g a^{-1} d^{-1}. In addition, animals consuming the *Mucuna* and forage diet "invested" a larger part of the day eating (33 vs. 19 % of the day). Since DM intake per day was similar for the two diets (about 700 g DM a^{-1} d^{-1}), the rate of DM intake for animals consuming only *Mucuna* was much higher (at 262 vs. 91 g DM a^{-1} h^{-1} in the *Mucuna* and forage diet). Therefore, intake behavior with the diet of only *Mucuna* is similar to what has been reported for concentrate diets where the animal uses less time to eat and ruminate because of the low fiber content (McDonald *et al.*, 1995). These results suggest that animals with a functional rumen could make good use of larger quantities of *Mucuna* bean than previously expected. However, due to the limited nature of this study (10 d), a longer study is required before recommendation regarding feeding growing lambs diets based solely on *Mucuna* can be given.

Table 2. Proportion of the day spent eating, in rumination, or resting by growing sheep fed with diet consisting of only *Mucuna* or forage-*Mucuna* (60:40) diet.

Activity (%)	Ground *Mucuna* (%)	Forage-*Mucuna* (%)
Eating *Mucuna*	11.0	6.4
Eating forage	0.0	26.4
Eating total	11.0	32.8
Rumination	19	33
Resting	70	34

REFERENCES

Anderson, S, Ferraes, N, Gundel, S, Keane, B, Pound, B. 1997. Cultivos de cobertura: componentes de sistemas integrados. Taller Regional Latinoamericano. FMVZ UADY. México.

Ayala-Burgos AJ, Herrera-Díaz PE, Castillo-Caamal JB, Rosado-Rivas CM, Osorno-Muñoz, L, Castillo-Caamal, AM. 2003. Rumen degradability and chemical composition of the velvet bean (*Mucuna spp.*) grain and husk. This volume.

Buckles, D, Triomphe, B, Sain, G. 1999. Los cultivos de cobertura en la agricultura en laderas. Inovación de los agricultores con mucuna. CIMMYT, México.

CIDICCO. 1999. Uso de leguminosas tropicales en la alimentación animal. CIDICCO, Tegucigalpa, Honduras.

Duke, JA. 1981. Handbook of legumes of world economic importance. Plenum Press, New York.

Jensen P, Algers B, Ekesko, I. 1986. Methods of Sampling and Analysis of Data in Farm Animal Ethology. Birkhauser Verlag, Stuttgard, Germany.

McDonald I, Edwards, RA, Greenhalg, JFD, Morgan CA. 1995. Animal Nutrition. Longman, Essex, UK. Pp 607.

Mead R, Curnow, RN. 1983. Statistical methods in agriculture and experimental biology. Chapman and Hall, London, UK. 335 pp.

Minson, DJ. 1990. Forage in ruminant nutrition. Academic Press Inc., California, USA. 483 pp.

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