Intake and Digestibility of *Calopogonium mucunoides*-Based Diets Fed to Draft Donkeys during the Dry Season

A. Asongwed-Awa[1] O. Abakar[1] E. Vall[2]

Key words

Donkey – Draft animal – *Calopogonium mucunoides* – Crude protein – Palatability – Digestibility – Nutritive value – Cameroon.

Summary

During the dry season in semiarid regions, animals are maintained on low quality forage residues with a need for protein supplement, when animal productivity is to be considered. In this study, *Calopogonium mucunoides* hay was fed to donkeys during the dry season to test its palatability and nutritive value. Twelve adult donkeys were allotted to three groups and fed different rations as follows: Group A received corn straw and 0.5 kg supplement mixture (corn bran and cottonseed cake), Group B received *Calopogonium mucunoides* hay and 0.25 kg supplement mixture, and Group C received *Calopogonium mucunoides* hay and 0.5 kg supplement mixture. Forage and water intake, body weight, and fecal dry matter were measured. There was no significant difference in intake of the three rations but digestibility was significantly higher ($P < 0.001$) in the *C. mucunoides*-fed groups. Notwithstanding its low palatability or acceptability by livestock species, *C. mucunoides,* as forage legume, is a high crude protein source which could effectively replace agro-industrial protein supplements, which are becoming more difficult to find by smallholders.

■ INTRODUCTION

Poor nutrition is an important limiting factor in the development of livestock production in the semiarid regions. This is evident in the seasonal fluctuation of the body weight of animals within the year in response to variation in feed availability, attributed to reduced and irregular rainfall (850-1100 mm), and low soil fertility. Natural pastures that constitute the main source of feed for livestock in this region also change in nutrient content with the seasons. These pastures in North Cameroon, consisting mainly of annual grasses, are often low in crude protein (CP) especially at maturity.

1. Institute of Agricultural Research for Development, PO Box 1073, Garoua, Cameroon

2. Cirad-emvt, TA30/A, campus international de Baillarguet, 34398 Montpellier Cedex 5, France

The donkeys are considered as desert or arid zone equids, tolerant to high radiant heat, poor forage and restricted water. They have been shown to maintain themselves as adequately as goats or camels on low quality roughage (10). Their work output could however be significantly reduced as a result of poor feed. In 1999, the donkey population of the North and Far North Provinces of Cameroon was estimated at about 25,500 head, 70% of which were found in the rocky areas of the cotton producing region of Cameroon (3). Draft donkeys, which are relatively cheap to obtain, are used there for transportation of products to and from farms and the market, and to a lesser extent for ploughing and weeding. They constitute a major work force in these smallholder crop/livestock systems (3). Their fitness during the dry season is therefore crucial for timely and effective land cultivation for the next cropping season.

Dry season feed supplementation of draft donkeys with a low cost mixture composed of cottonseed cake and corn bran has been

suggested for use in this region. (15), but optimal results have not yet been achieved. Legume hay can therefore provide an inexpensive alternative as most legume species can maintain a CP content of more than 8% even in the dry season (4, 6, 7).

Calopogonium mucunoides is a trailing or twining perennial legume that regenerates freely from seeds and is well adapted to this region (2, 5, 12, 16). It grows well in mixtures with grasses and although it is low in palatability (14) its CP content is quite high, ranking highest among some selected green plants available to livestock in the dry season (Table I) (4).

This species has been widely introduced to farmers in this region for use as cover crops for soil regeneration and improvement, where dry matter (DM) yields of over 7 t/ha have been obtained (5, 16). Apart from its use in soil protection and fertility improvement, *C. mucunoides* can also be used to improve the ration of livestock by providing the proteins required for maintenance especially during the dry season.

The main objectives of the present study were therefore to test the palatability of *Calopogonium mucunoides* and its effect on the liveweight of draft donkeys. More specifically, the study aimed at determining the best ration that can be used to cover the need for protein supplements in resting donkeys during the dry season.

■ MATERIALS AND METHODS

This trial was carried out on-station at the Institute of Agricultural Research for Development (IRAD), Garoua, located in the Sudano-Sahelian belt (latitude 9.3° N) of Cameroon, at an altitude of 200 m above sea level. Ambient temperatures during the trial months (February and March) were between 30 and 40°C. Average annual rainfall is around 1000 mm.

Experimental design

Twelve adult donkeys weighing on average 112 ± 7 kg each were used for the trial and were allotted to three groups of four each in such a manner as to equilibrate the groups by weight. These groups were then randomly assigned to different treatments and fed as follows:

– Group A received 0.5 kg supplement mixture (cottonseed cake/corn bran) + 2.5 kg corn straw (standard diet) (15), and served as control;

– Group B received 0.25 kg supplement mixture + 2.5 kg *Calopogonium mucunoides* hay;

– Group C received 0.5 kg supplement mixture + 2.5 kg *Calopogonium mucunoides* hay.

Clean drinking water was provided to individual animals in buckets in the mornings and afternoons. Corn straw was harvested after grain harvests and stacked in November, while *Calopogonium mucunoides* hay was harvested in the dry season, about seven months after regeneration. Corn straw was chopped into bits of 30-40 cm long before serving.

Animals and management

Animals were penned individually overnight throughout the trial. After their morning feed ration, they were released into a fenced area of about 500 m^2 where they freely played from about 10 a.m. to 1 p.m. before they were brought back to the pens. During this period they had no access to pasture or any other feed. They were closely monitored by attendants who identified and weighed feces deposited by each individual animal for digestibility analysis. Pens were cleaned every morning of urine, feces and food remains. The trial lasted for two months.

Measurements

Intake

Corn straw and *Calopogonium mucunoides* hay were weighed daily and distributed to individual animals. Leftover forage was gathered each morning and weighed to determine intake. Water intake was also measured every morning and afternoon to obtain total intake per day.

Weight

The animals were weighed at the beginning and subsequently twice a week to obtain weight changes during the trial period.

Digestibility

In the third week, feces were collected daily from individual animals and weighed each morning. Samples were extracted, weighed and oven dried at 65°C to a constant weight to determine DM content of feces. At the end of the seven-day collection period, the daily dried samples were mixed and a sample sent to the laboratory (CIRAD-EMVT, Montpellier, France) for analysis.

Table I

Nutrient composition of some selected forage species (matured leaf samples) available to livestock in the dry season in the semiarid region

Species	CP	Ca	Mg	P	K	Na	Mn	Fe	Cu	Zn
			(g/kg DM)					(mg/kg DM)		
Calopogonium mucunoides	243	12	2	1	21	1	114	112	10	108
Eleusine indica	129	2	2	1	29	1	131	66	4	156
Vigna unguiculata	162	24	3	2	39	1	31	121	9	118
Cajanus cajan	211	8	2	2	15	1	48	133	8	42
Gliricidia sepium	202	20	4	2	32	1	61	128	5	21
Terminalia catappa	189	17	3	2	24	1	29	69	12	32
Sida acuta	176	24	5	3	35	1	91	108	5	8

Adapted from Ikhimioya and Olagunju, 1996, *Tropicultura*

CP: crude protein; DM: dry matter

Calculations and statistical analysis

Apparent digestibility was calculated from total feed dry matter intake and fecal dry matter output over the seven days. Feed intake, digestibility and weight changes were compared using ANOVA (SAS).

■ RESULTS

The nutrient composition of the different feeds offered is presented in Table II. Clearly noticeable are the high protein and mineral levels in *C. mucunoides* compared to those in corn straw. The high protein levels in *C. mucunoides* refusals may have been due to the fact that they were mainly fallen leaves which are higher in nutrient content than the stems.

Forage and water intake

The forage intake was slightly higher in Group A (corn straw + supplement mixture) (Figure 1) though the difference was not significant, indicating thus that the higher supplement content in diets A and C had no effect on the intake (Table III). The water intake increased and the feed intake decreased in all groups with the increase in temperature (Figure 2).

Maintenance of live weight

There was a 3% increase in weight in Group C compared to 1 and 2% in Groups A and B, respectively (Table IV). However, when these weights were adjusted with respect to initial weights, a better performance was noted in Group B (Figure 3).

Digestibility of nutrients

The digestibility coefficients of nutrients in the basal diets are shown in table IV. The results show low levels of crude protein and other minerals in the control Group A ration as compared to the very high levels in the *C. mucunoides* rations. The difference in digestibility was highly significant ($P < 0.001$) in the various rations, the highest being in group B (67%) compared to 54 and 62% in groups A and C, respectively. Digestibility of other components was also highest in group B animals (Table V).

Table III

Effect of legume basal diet on feed intake by draft donkeys

Variables	Ration A	Ration B	Ration C
Forage DMI* (kg)	3.2 ± 0.2	3.1 ± 0.06	3.1 ± 0.1
Total DMI (kg)	3.5 ± 0.2[a]	3.3 ± 0.06[b]	3.4 ± 0.1[ab]
Total DMI/100 kg	2.8 ± 0.15	2.8 ± 0.23	2.9 ± 0.24
Total DMI ($g/w^{0.75}$)**	92.2 ± 4.9	91.3 ± 5.2	92.3 ± 6.5
DDMI ($g/w^{0.75}$)***	52.3 ± 8.9[b]	60.2 ± 7.7[a]	49.5 ± 4.4[b]

* Dry matter intake; ** In grams per metabolic weight; *** Digestible dry matter intake (grams per metabolic weight)

[ab] Means with different superscripts in the same row are significantly different ($p < 0.05$)

Table II

Nutrient composition of feeds offered

Sample	DM	NDF	ADF	ADL (g/kg DM)	Crude protein	Crude fiber
Calopogonium mucunoides offered	921	604	456	108	126	419
C. mucunoides refusal	931	467	347	97	147	298
Corn straw	909	615	377	163	34	423
Supplement mixture	861	329	165	–	239	135

DM: dry matter; NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL: acid detergent lignin

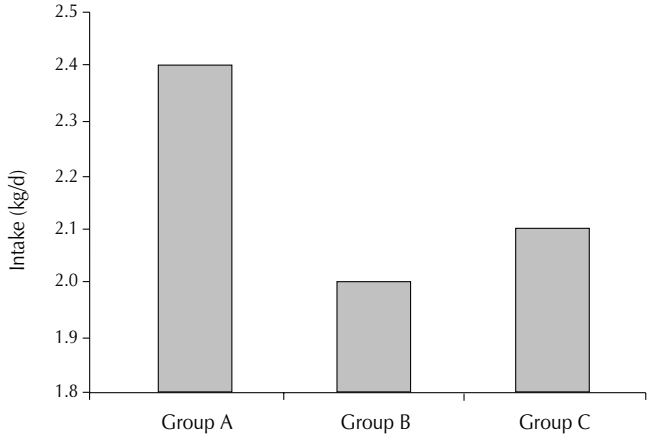

Figure 1: *Mean daily dry matter intake.*

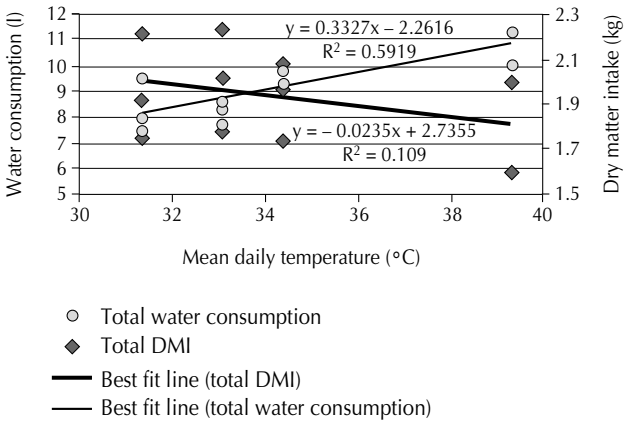

Figure 2: *Trends of dry matter intake (DMI) and water consumption as a function of mean daily ambient temperature at 1 p.m.*

Table IV

Effect of *Calopogonium mucunoides*-based diet on feed utilization

Variables	Ration A	Ration B	Ration C
Digestible CPI (g/d)	317 ± 6.0^{c}	510 ± 8.1^{b}	621 ±14.2^{a}
NDFI (kg/d)	2.1 ± 0.1^{a}	1.9 ± 0.04^{b}	2.0 ± 0.07^{ab}
Digestible NDFI (%)	1.1 ± 0.2	1.1 ± 0.2	0.9 ± 0.1
ADFI (kg/d)	1.3 ± 0.07^{b}	1.5 ± 0.03^{a}	1.5 ±0.05^{a}
Digestible ADFI (%)	60 ± 0.1^{a}	80 ± 0.1^{b}	70 ± 0.09^{b}
Live weight gain (%)	1.4 ± 4.6	1.9 ± 7.6	2.8 ± 3.6

CPI: crude protein intake; NDFI: neutral detergent fiber intake; ADFI: acid detergent fiber intake

^{ab} Means with different superscripts in the same row are significantly different ($p < 0.05$)

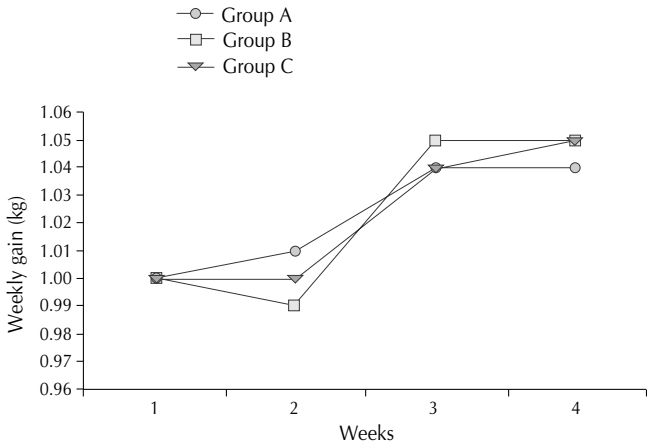

Figure 3: *Adjusted body weight changes in the different treatments.*

Table V

Apparent digestibility of the nutrient components

Sample	DM	OM	Hemi	Crude fiber	NDF	ADF	Crude protein
Ration A	0.54	0.58	0.49	0.26	0.32	0.34	0.43
Ration B	0.67	0.72	0.67	0.71	0.67	0.68	0.47
Ration C	0.62	0.66	0.35	0.34	0.33	0.33	0.34

DM: dry matter; OM: organic matter; Hemi: hemicellulose; NDF: neutral detergent fiber; ADF: acid detergent fiber

■ DISCUSSION

These results showed a highly significant difference in digestibility between the corn straw/supplement ration and the *C. mucunoides*/supplement rations. Significant differences were also noted in the digestibility of all the other nutrient components, meaning thus a better utilization of the legume-based diets.

A low intake of this species had been reported in another study with lactating cows in this region (1). This difference in intake was however not significant with draft donkeys, thus supporting the fact that they are hardy animals, capable of sustaining very difficult conditions, and hence their adaptation to arid and semiarid zones (13). The slightly low intake noted (Figure 1) may have been due to its low palatability (14) or acceptability (8). Palatability of *C. mucunoides* seems to improve as the forage matures (4). This may be because of the tiny brownish hairy nature of its fresh leaves, which improves its acceptability. This stage of maturity coincides with the dry season period in semiarid regions when grasses are all dry and of very low quality. Animals often select even in nature species that can provide essential nutrients at that point in time, and legume species such as *C. mucunoides*, which survive and maintain high nutrient levels during this period, are a sure choice.

Studies in Zimbabwe showed that supplementation of the draft oxen ration in the dry season with groundnut husks for one to two months produced a significant weight increase, and these animals exerted more energy and ploughed larger areas per day than the non-supplemented ones (13). Groundnut husks, like *C. mucunoides* hay, are high in CP and other essential minerals that are lacking in cereal straw. In a study with lactating cows in Cameroon, cows grazing C. *mucunoides* and *Stylosanthes hamata* for five hours a day produced a significant increase in milk yield compared to those on natural pastures alone (1). These affirm the superior quality of legumes over other feed resources such as corn straw and natural pastures.

Njoya (11) observed a 16% increase in forage intake when steers were supplemented with 0.5 kg cottonseed meal during the dry season. This, however, did not improve with a higher amount (1 kg) of the protein supplement but instead digestibility was depressed. He suggested that higher amounts of protein in the diet might have caused some unbalance in the digestive tract leading to poor utilization. This is in line with the better utilization obtained in this trial with group B animals, which were fed half the quantity of protein supplement as compared with groups A and C.

Digestibility is an important factor that affects animal productivity. This is often depressed at high levels of dry matter consumption because the forage is in the rumen for a limited period of time. The higher level of digestibility in the Group B diet is an indication of better utilization, even though the trial did not last long enough for this to be expressed in terms of weight gain. The diet which contained half the supplement mixture offered in the other two diets turned out to be the best utilized and hence the cheapest as a result of the extra protein obtained from *C. mucunoides.*

■ CONCLUSION

There was higher digestibility in the *C. mucunoides* based diets showing thus a better utilization by the animals. This is an indication that this species can effectively supply the protein required for maintenance during periods of stress. Other factors such as palatability and acceptability of the species may initially have an effect on intake. Improving productivity of pastures by the introduction of high yielding legume species is a strategy that will positively impact on animal productivity. The high nutrient content of *C. mucunoides* and its adaptability to this region are qualities that should be developed and used for the benefit of livestock and its productivity in the semiarid regions where feed quality and availability are major constraints to productivity.

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Résumé

Asongwed-Awa A., Abakar O., Vall E. Ingestion et digestibilité des rations à base de *Calopogonium mucunoides* par les ânes de trait pendant la saison sèche

Pendant la saison sèche en régions semi-arides, les animaux sont maintenus sur des fourrages de pauvre qualité, nécessitant certaines formes de complémentation protéique pour améliorer leur productivité. Dans cette étude, le *Calopogonium mucunoides* a été distribué à des ânes de trait pendant la saison sèche pour tester son appétibilité et ses valeurs nutritionnelles. Douze ânes adultes ont été répartis en trois groupes alimentés de la manière suivante : groupe A a reçu des tiges de maïs et 0,5 kg d'une provende domestique constituée d'un mélange de son de maïs et de tourteau de coton, groupe B a reçu du *C. mucunoides* et 0,25 kg de provende, et groupe C a reçu du *C. mucunoides* et 0,5 kg de provende. La consommation de fourrage, d'eau et le poids vif des animaux ont été enregistrés. Les résultats n'ont montré aucune différence significative dans la consommation des fourrages. Une différence très significative ($P < 0,001$) a été observée en matière de digestibilité avec la plus importante digestibilité dans les groupes alimentés avec du *C. mucunoides*. En dépit de sa faible appétibilité ou acceptabilité par d'autres espèces d'animaux d'élevage, le *C. mucunoides*, comme légumineuse fourragère, présente un taux élevé de matières azotées brutes et pourrait efficacement remplacer des compléments protéiques agro-industriels que les paysans ont de plus en plus de difficultés à se procurer.

Mots-clés : Ane – Animal de trait – *Calopogonium mucunoides* – Protéine brute – Appétibilité – Digestibilité – Valeur nutritive – Cameroun.

Resumen

Asongwed-Awa A., Abakar O., Vall E. Consumo y digestibilidad de *Calopogonium mucunoides*-dietas de base administradas a burros de carga durante la estación seca

Durante la estación seca, en las regiones semi áridas, los animales son mantenidos con residuos de forraje de baja calidad, necesitando un suplemento en proteínas, si se quiere considerar la productividad animal. En el presente estudio, los burros fueron alimentados con heno de *Calopogonium mucunoides*, durante la estación seca, con el fin de probar su palatabilidad y su valor nutritivo. Doce burros adultos fueron separados en tres grupos y alimentados con diferentes raciones: el Grupo A recibió paja de maíz y 0,5 kg de mezcla de suplemento (cereal de maíz y torta de algodón), el Grupo B recibió heno de *Calopogonium mucunoides* y 0,25 kg de mezcla de suplemento y el Grupo C recibió heno de *Calopogonium mucunoides* y 0,5 kg de mezcla de suplemento. Se midieron el consumo de forraje y de agua, el peso corporal y la materia fecal seca. No hubo diferencia significativa en el consumo de las tres raciones, pero la digestibilidad fue significativamente más alta ($P < 0,001$) en los grupos alimentados con *C. mucunoides*. A pesar de su baja palatabilidad o aceptabilidad por las especies domésticas, *C. mucunoides*, legumbre forrajera, representa una importante fuente de proteína cruda, la cual podría reemplazar efectivamente los suplementos proteicos agro industriales, cada vez más difíciles de obtener para los pequeños productores.

Palabras clave: Aso – Animal de tiro – *Calopogonium mucunoides* – Proteina bruta – Palatabilidad – Digestibilidad – Valor nutritivo – Camerún.