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Agronomic and Nutritive Evaluation of Jack Beans (*Canavalia ensiformis*) for Fodder in the Derived Savannah Zone of Nigeria

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Abstract: Two experiments were conducted to evaluate the potential use of jackbean (*Canavalia ensiformis*) forage as a feed supplement for West African dwarf goats in the derived savannah zone of Nigeria. In experiment 1, the forage production potential and quality of *Canavalia ensiformis* was investigated at three different spacing in a randomized complete block experiment. In the second experiment, the supplementary feeding value of the herbage in goats was investigated in a completely randomized experiment. Results showed that plant components (leaves, stem and whole) decreased ($p<0.05$) with increasing spacing. Leaf yield were 0.223, 0.209 and 0.109 t ha^{-1} for spacing 50×50, 75×75 and 100×100 cm, respectively. Crude protein contents of the leaves were similar ($p>0.05$) and were; 14.88 15.09 and 15.00% at 50×50, 75×75 and 100×100 cm spacing, respectively. In the second experiment, the total dry matter intake increased with increasing levels of supplementation ($p<0.05$). The total crude protein intake followed a similar trend. Average daily weight gain differed among the treatment groups with 0.18 g day^{-1} gain at the control group. It can be concluded based on herbage dry matter yield, nutrient composition and the animal performance that *Canavalia ensiformis* forage can be usefully incorporated into the dry season feed strategy of WAD goats in the derived savannah zone of Nigeria.

Key words: Spacing, *Canavalia ensiformis*, degradation, WAD goats, density

INTRODUCTION

The livestock industry in Nigeria have contributed substantially to the national wealth and for supplying the populace with essential animal protein required for good health and body maintenance (Upton, 1985). The WAD goats can subsist on household leftovers, resistant to trypanosomiasis and are prolific. Thus with little nutritional intervention, high productivity from WAD goats are inevitable.

Carnavalia ensiformis (Jack bean) is high yielding and produces nutritious pods. It is a food in marginal areas where other pulse had failed and is a high green manure forage (NAS, 1979) and aids in soil erosion control (Smartt, 1990). Jack bean tolerates a wide range of soil texture and fertility (Akpapunam and Sefa-Dedah, 1997). It can grow well on leached and nutrient depleted soil. Once established its deep root system allows the plant to utilize stored soil moisture and thus could survive dry season. The plant produces a large bulk of green fodder (Puseglove, 1974) and the leaf contains adequate level of crude protein (Sridhar and Seena, 2006).

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The seeds of Jack bean are endowed with a multiplicity of protein and other cyanogenic glucosides and tannins (Swain, 1979) and when oven dried or boiled, it has been fed up to 30% in the diet of finisher broilers (Udedibe *et al*., 2002) and up to 20% in the diet of rabbits. The plant could produce a large quantity of green fodder 1-10 t ha^{-1} (Kessler, 1990). The herbage contains 13-16% CP (Diaz *et al*., 1998). The pant is not threaten by insect as it posses secondary metabolite (Swain, 1979) that deter insects.

Omokanye *et al*. (2004) reported that spacing influence herbage yield and quality. However information is scanty on the use of forage from *Carnavalia ensiformis* as supplement in the diet of ruminant animals. The objective of this study was to investigate the influence of three spacing on Canavalia forage yield and nutritional quality for West African dwarf goats.

MATERIALS AND METHODS

Site

The trial was conducted at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, located in the derived Savannah zone of Nigeria.

The site is on Latitude 8°26' and longitude 4°29'E. Average annual rainfall is 1173 mm and usually occurs between June and October. The top soil (0-15 cm) is sandy loam with a pH of 6.7 (H_2O), 0.69% organic carbon and 2.94% total nitrogen and 37 ppm available phosphorus.

Land Preparation/Planting

Canavalia ensiformis seeds were procured from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. About 1.5 t ha^{-1} land space was designated for the agronomic study. The soil was plough and harrowed before the seedbeds were prepared. The seeds were planted by drilling the seeds at the rate of 2 seeds per hole. The 3 different spacing were: 100×100, 75×75 and 50×50 cm. Each spacing was replicated thrice. No inoculums or fertilizer was applied. Weeding was done thrice before harvesting to prevent weeds from competing with the Jack bean for nutrients and to also prevent predators from entering the plots.

Herbage yield was estimated when 50% of the plants had flowered (12 weeks after planting) from each spacings. Total plant harvest of each plots under each spacings were carried out. The harvested plant was separated into different components (whole plant, leave and stem) and weighed. Sub samples of the herbage were taken and oven dried at 60°C for 48 h to calculate the dry matter contents. Herbage dry matter yields at each spacings were estimated using the respective DM levels. The leaves were later dried, bagged and stored in a dry place until required for further studies.

Feeding Trial

A feeding trial involving 12 WAD goats was carried out. Animals balanced for age, weight (8.5±1.2) and sex were randomly divided into 3 treatments of four animals per treatment. Animals were housed in individual pens. Herbage from all the spacings were pooled together since there were no difference crude protein contents among the herbage harvested from the three spacings. *Canavalia ensiformis* forage meal was offered as supplement at 0, 10 and 20% of the daily dry matter allowance of individual animal. The basal diet was *Panicum maximum*. Diet was constituted as 3% of body mass. The animals were allowed an adjustment period of seven days to enable the animals to acclimatize to the feed and pen. Mineral salt lick and clean water was provided *ad libitum*.

In vivo Nutrient Digestibility

Three bucks of comparable weight (10.3±0.67) and age were randomly selected and put in separate metabolic cages. The cages were equipped with facilities that allowed for separate collection of faeces and urine. A 4×4 Latin square experiment was conducted to determine *in vivo* nutrient digestibility. Animals were allowed 7 days of adjustment period and 5 days of data collection per period Canavalia herbage from all spacings pooled together was fed at 0, 10 and 20% levels to a basal diet of P. maximum. Diet was constituted as 0.3 of body weight of individual animals. Feed intake and faecal production was monitored daily. Sub samples of daily faecal production were taken and oven dried at 60°C for 48 h to determine the dry matter level.

Chemical Analysis

Forage samples was analyzed for crude protein, crude fibre, ether extract and ash, Ca, Na, K, Mg, Zn, Cu and Pb. Crude protein analysis was by the micro Kjeldahl method according to AOAC (1990). Mineral analyses were carried out by the use of dry ashing procedure. Mineral elements in the forage were read using an atomic absorption spectrophotometer at appropriate wavelengths.

Statistical Analysis

Data on feed intake was analyzed as a completely randomized design, data on nutrient digestibility as a Latin square while data on agronomic studies was laid out in a randomized complete block design. Both data were then subjected to the General Linear Model (GLM) procedure (SAS, 1985).

RESULTS AND DISCUSSION

Spacing had a significant effect ($p<0.05$) on the forage yield of *Canavalia ensiformis* (Table 1). The 50×50 cm spacing was observed to produce the highest herbage yield which was in the order of 50×50 cm > 75×75 cm > 1×1 m. The jack beans used gave increasing yield with density probably because it is an erect and determinate type and more importantly it produces few branches. A plant with such morphology would be less affected by intraspecific competition, as shading is minimal even when densely populated. It is obvious from this study that with more plants per unit area at high density with a plant type that is low branched, there is more leaf area for photosynthesis and more rapid accumulation of dry matter in all plant parts (Remison *et al*., 1983; Omokanye *et al*., 2004). The result of the proximate composition of biomass is shown in Table 2. There were no differences ($p>0.05$) in CP of the herbage across the treatments. The CP values were 14.9, 15.1 and 15.0 for 5×5, 75×75 and 100×100 cm spacings, respectively. The lack of significant difference in the CP content may be attributed to the high soil fertility. Thus the nutrient (N) available in the soil far exceeded the amount required by plants in the respective spacings. The leaf across all spacings had crude protein

Table 1: Effect of spacing on forage yield of *Carnavalia ensiformis* (1 kg ha^{-1})

Plant parts	Spacing 50×50 (cm)	75×75 (cm)	1×1 (m)	SEM
Leaf	0.2267^{a}	0.2087^{a}	0.1093^{b}	0.3557
Stem	0.5167^{a}	0.1347^{b}	0.2267^{c}	0.2866
Whole	1.1033^{a}	0.4400^{b}	0.3267^{b}	0.2032
Total	1.8467^{a}	0.7833^{b}	0.6633^{b}	0.4139

Means on the same row with different superscript are significantly ($p<0.05$) different

Table 2: Effect of spacing on mineral composition of (*Canavalia ensiformis*) leaves in the derived savanna zone of Nigeria

Spacings (cm)	Ca	Na	K	Mg	Pb	Zn	Cu
	(%)						(ppm)
50×50	0.089	0.048	0.17	0.017	0.25	0.47	0.27
75×75	0.055	0.086	0.32	0.017	0.23	0.41	0.24
100×100	0.049	0.019	0.46	0.011	0.19	0.35	0.24
SEM	0.010	0.001	0.12	0.001	0.14	0.24	0.13

concentration greater than 80 g kg^{-1} DM, the level below which voluntary feed intake of tropical forage is limited (Minson, 1980). The higher CP level of jack bean suggests that it could effectively provide supplemental N when browsed with native pasture or when offered to stall fed animals on low N cereal crop residues diets. However, the availability of the crude protein may depends on the concentration of anti nutritive factors such as condensed tannin (Onwuka, 1992).

Result of mineral composition of the herbage leaf is shown in Table 3. Spacing had no effect ($p>0.05$) on mineral composition of *Canavalia ensiformis* leaf. The overall value of sodium (Na) in the leaf was lower than the critical level (0.18) required by ruminant animals for optimum performance. Average zinc (Zn) value was less than the critical level required for efficient production of the ruminant animals. The calcium level across the spacings was below (0.3%) recommended. However, the value obtained for K in this study fell within the recommended range (0.2-0.6%) for ruminant. The lead (Pb) content of (0.23%) was within the tolerance level of 200 ppm recommended for ruminant animals (NRC, 1985). The implication of these generally low minerals content of the leaf is that an additional mineral supplement may have to be provided when *C. ensiformis* is being used as feed supplement to West African Dwarf goats. The total dry matter and crude protein intakes increased ($p<0.05$) with increased level of supplementation (Table 4). The differential in feed intakes may be accounted for by increased CP intake with increased supplementation level. Higher intake of CP encourages higher proliferation of microbes in the rumen. Higher proliferation of microbes in the rumen normally enhances efficient degradation, high passage rate and thus more feed intake (Crampton *et al*., 1960). Both the weight gains and dry matter digestibility were affected with levels of supplementation (Table 5). The improved dry matter intake and weight gains may be attributed to increased feed

Table 3: Effect of spacing on proximate composition of *Canavalia ensiformis* forage

Composition (%)	Spacings 50×50 (cm)	75×75 (cm)	100×100 (cm)	SEM
Crude protein	14.88	15.09	15.00	0.06
Crude fibre	34.84	34.08	32.94	0.55
Ether extract	1.89	1.82	1.77	0.03
NFE	28.25	28.77	30.66	0.73
Ash	7.56	7.87	8.21	0.19

Means in a row with different superscripts differed ($p<0.05$)

Table 4: Feed intake, *in vivo* digestibility and weight gain of goats supplemented with fresh *Canavalia ensiformis* leaf at three levels of supplementation

Parameters	Levels of supplementation 0	10	20	SEM
Intake (g day^{-1})				
Panicum maximum	214.4^a	205.90^a	189.10^b	13.9
Canavalia ensiformis	-	20.50^b	42.00^a	2.7
Total	214.4	226.40	231.10^b	16.7
Crude protein (g day^{-1})				
Panicum maximum	17.3	16.80	14.70	1.3
Canavalia ensiformis	0.0	2.22	5.31	0.8
Total	17.3	19.00	19.98	1.6

Means in a row with different superscripts differed $p<0.05$

Table 5: *In vivo* digestibility and weight gains of goats fed *Canavalia ensiformis* as supplement

Parameters	Levels of supplementation 0	10	20	SEM
Dry matter	76.60	78.50	76.40	10.20
Crude protein	42.80^c	57.50^b	65.90^a	12.90
Weight gain (g day^{-1})	0.18^c	0.28^b	0.38^a	0.01

Means in a row with different superscripts differed $p<0.05$

intake with advanced level of supplementation. It can be concluded that based on data from biomass yield, feed intake, *in vivo* digestibility and daily weight gains that *Canivalia ensiformis* has a potential role in the dry season feeding strategy for goats in the derived savannah zone of Nigeria. However, further studies needs to be carried out especially on the concentration of anti nutrients in the leaf of the supplement.

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