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Full Length Research Paper

The value of Acacia brevispica and Leucaena leucocephala Seedpods as dry season supplements for calves in dry areas of Kenya

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Two experiments were conducted to evaluate the feed value of Acacia (*Acacia brevispica*) and *Leucaena* (*Leucaena leucocephala* seedpods (whole fruit) during the dry season. In Experiment 1, treatment diets were Rhodes grass (*Chloris gayana*) hay (control) and the hay supplemented with either Acacia or *Leucaena* seedpod meal. In Experiment 2, maasai lovegrass (*Eragrostis superba*) hay (control) was offered alone or with a supplement of *Leucaena* seedpod meal. In Experiment 1, calves supplemented with *Leucaena* meal had higher gain (486 g d^{-1}) than the control (239 g d^{-1}) or those receiving Acacia pod meal (250 g d^{-1}). In Experiment 2, calves on *Leucaena* meal had higher gains (559 g d^{-1}) than the control (276 g d^{-1}) confirming the results obtained in Experiment 1. Seedpods of *A. brevispica* contained only 65% of their seeds, resulting in a lower digestible energy concentration than *Leucaena* seedpods. These data confirm that cattle productivity can be increased if pods of *L. leucocephala* are collected during periods of abundance, stored and used as supplements for growing calves.

Key words: Acacia, *Leucaena*, seedpods, grass hay, calf weight gain

INTRODUCTION

In many parts of the tropics, arid and semi-arid lands constitute a large proportion of the area. Inadequacy of livestock feed in the dry season, particularly lack of protein, is a major constraint to livestock production in these areas (Minson, 1990). This is because conventional supplements such as oilseed cakes and meals made from animal by-products are expensive and not readily available. Under these circumstances, the most practical supplement may be locally available legume trees (Topps, 1992).

Acacia, a genus of indigenous woody legumes, occupies vast areas in semi-arid and arid areas of tropical and sub-tropical countries (NRC, 1979). Studies have indicated that seedpods of some Acacia species, such as *A. tortilis* and *A. albida*, as well as leaves of A. brevispica, when offered as supplements to poor quality roughages, give live-weight gains in livestock comparable with those fed oilseed cake or lucerne (*Medicago sativa*) supplements (ILCA, 1988; 1989; Tanner et al., 1990). Sawe et al. (1998) showed that goats (Capra species) supplemented with leaves or pods of *A. brevispica*, *A. tortilis* and *A. nilotica* grew faster than unsupplemented controls. In a recent study to evaluate the nutritive potential of some Acacia tree leaves, Abdulrazak et al. (2000) found that leaves from *A. nubica*, *A. tortilis*, *A. mellifera*, *A. brevispica, A. seyal* and *A. nilotica* had moderate to high crude protein (CP) concentrations. Based on their observation of goats browsing, the authors concluded that leaves have potential as livestock fodder. However, tannins in Acacias (Woodward and Reed, 1989; Reed, 1995) may bind protein, making it unavailable to rumen microbes and thus affecting dry matter (DM) intake and digestibility (Kumar and D'Mello, 1995). These effects on animal performance have been shown to be both positive (Ben Saleem et al., 1999) and negative (Degen et al., 1998; Maasdorp et al., 1999).

Leucaena leucocephala is a versatile, drought tolerant, tree legume recommended for use in tropical and sub-tropical countries (Gutteridge and Shelton, 1994). Several

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studies have demonstrated that *Leucaena* forage, when fed as a supplement to poor quality roughages, resulted in body weight gains comparable to those obtained using conventional supplements such as oilseed cakes, animal byproduct meals and cereal by-product (Saucedo et al., 1980; and Manidool, 1983). Chemical analysis of *L. leucocephala* seedpods from Nigeria (Adeneye, 1979) and India (Damothiran and Chandrasekaran, 1982) revealed that they are of high nutritive value indicating the possibility of them as a source of cattle feed. Naseeven et al. (1989) showed that cracked *L. leucocephala* seeds are as good a protein source for fattening cattle as cottonseed cake.

Both *A. brevispica* and *L. leucocephala* are prolific producers of seedpods which can be harvested and fed to cattle. There is limited information on the nutritive value of seedpods, particularly those from *A. brevispica* and *L. leucocephala*, and their value as dietary supplements for calves is unknown. Objectives of this study were to assess the effects of maturity on nutritive value of seedpods of these legumes and to determine the effect of feeding seedpods as a dry-season supplement on intake and weight gain of calves in smallholder crop-livestock mixed farming and agro-pastoral farming systems.

MATERIALS AND METHODS

Nutritive value of seedpods

Seedpods of *A. brevispica* and *L. leucocephala* were sampled at the immature (5 weeks after pod formation), dough (9 weeks), mature (13 weeks), and dry (15 weeks) stages. Bulk samples were taken from a group of trees, oven dried at 60^0 C for 2-3 days, and ground before being analyzed for crude protein (CP), ash, neutral detergent fiber (NDF) and acid detergent fiber (ADF). Dry fruits only were separated into seed and pod fractions, were ground in a Christy Norris hammer mill to pass 1-mm screen and analyzed for CP, ash, NDF, ADF, ether extract (EE), and in vitro dry matter digestibility (IVDMD). Analytical procedures are described below. Data were not analyzed statistically because chemical analyses were conducted on bulked samples not samples from replicated plots.

Experimental animals and treatments

Two feeding experiments were conducted at the University of Nairobi Field Station, Kabete, Kenya, using Boran (*Bos indicus*) cross-bred calves balanced for sex. In Experiment 1, 18 calves aged between five and nine months with an average weight of 132 kg (range 91 to 150 kg) were used. The calves were assigned to three treatment groups balanced for age, initial live weight and sex. The three experimental diets were: grass hay harvested from the University Field Station supplemented with wheat (*Triticum aestivum*) bran (Control-1); grass hay supplemented with either Acacia or *Leucaena* seedpods mixed with wheat bran (ASM and LSM-1, respectively). In Experiment 2, 16 calves aged between 5.5 and 9 months, with an average weight of 131 kg (range 102 to 162 kg) were used. The calves were assigned to two treatment groups balanced for age, initial live weight and sex. The treatments were grass hay supplemented with wheat bran (Control-2) or with *leucaena* seedpod meal plus wheat bran (LSM-2).

Experimental feeds

Rhodes grass (*Chloris gayana*) and maasai lovegrass (*Eragrostis superba*) hays were used as basal diets in Experiments 1 and 2, respectively. Both hays were harvested at the University of Nairobi Dryland Field Station, Kibwezi, Kenya, in a semi-arid area classified as being in ecological zone five (Pratt et al., 1966*).* Maasai lovegrass is a native species in arid and semi-arid areas and is an important source of feed. A predominantly Maasai lovegrass hay was harvested from a native stand. Rhodes grass is a high yielding planted grass used in reseeding denuded grassland areas. The Rhodes grass was harvested from a reseeded pasture that had not been cut for two growing seasons. Both hays were mature and consisted mainly of stem. They were chaffed into approximately 5-10 cm pieces to facilitate handling and feeding.

Dry seedpods of *A. brevispica* and *L. leucocephala*, collected at the National Range Research Center, Kiboko, Kenya, in ecological zones four and five (Pratt et al., 1966), were sun-dried for 2-3 d before grinding to make a meal. Pods were collected using hooked sticks or by pruning and lopping trees, in which cases some branches were left for continued growth. The *A. brevispica* seedpods collected contained approximately 65% of their seeds. Most of the *L. leucocephala* seedpods collected contained all their seeds.

Experimental procedures

All calves were dewormed using valbazen and sprayed against ectoparasites using stelladone. Calves were confined in individual pens throughout the experimental period. The basal hays were offered ad libitum between 0600 and 1430 hours each day. The seedpod meal supplements were mixed with 0.6 kg of wheat bran and a mineral mixture. Supplements were fed at 0500 hours at 1.5 kg d^{-1} (ASM) or 1.2 kg d^{-1} (LSM-1 and LSM-2) to supply equal amounts of N. At the same time the control calves received 0.6 kg d^{-1} of wheat bran, equivalent to the amount used in formulating the supplements. Water was freely available at all times. Daily records were kept of hay and supplement offered and orts. Calves were weighed weekly using a weighbridge following a 13-hour overnight food and water fast. There was a 14-day adjustment period to the diets at the start of both experiments. The experimental period lasted for five and four weeks in experiments 1 and 2, respectively.

Chemical and statistical analyses

Chemical analyses were carried out on samples of seedpods at four phenological stages to monitor changes in nutrient profiles with maturity and on separated seedpod components to determine the contribution made by seed and the empty pods to the nutritive value of the whole seedpod. Total nitrogen concentration was determined by the Kjeldahl technique and CP calculated as N x 6.25. Ash and EE were determined by the conventional methods of AOAC (1990) and ADF and NDF by the methods of Van Soest et al. (1991). The IVDMD was carried out using the method of Tilley and Terry (1963). Tannins were determined using the vanillin-hydrochloric acid method of Burns (1963; 1971).

Weekly live weights of individual animals were adjusted using

Table 1. Concentrations of CP, Ash, NDF and ADF in *L. leucocephala* and *A. brevispica* seedpods at four phenological stages.

	CP	Ash	NDF‡	ADF‡
	--------------- g kg^{-1} -----------			
A. brevispica				
Immature (5)†	186	44	423	361
Dough (9)	184	50	490	366
Mature (13)	178	45	509	342
Dry (15)	143	41	550	335
L. leucocephala				
Immature (5)	272	54	292	200
Dough (9)	208	55	468	344
Mature (13)	203	59	533	422
Dry (15)	186	57	561	421

† Number in parenthesis denotes age in weeks after pod formation.
‡ NDF = Neutral detergent fiber, ADF = Acid detergent fiber.

covariance analysis based on initial live weights (SAS, 1996). Computed average daily weight gain and hay intake data were subjected to one-way analysis of variance using the general linear model of SAS and the treatment means separated using Duncan's multiple range test (SAS, 1996).

RESULTS

Chemical analysis

Concentrations of CP, ash, NDF and ADF in *A. brevispica* and *L. leucocephala* seedpods were determined at four phenological stages (Table 1). For both species the concentration of CP declined while that of NDF increased with maturity. In *leucaena* seedpods ADF followed the same trend as NDF, but with the acacia ADF was greatest at the dough stage and least at the dry stage. There was no consistent trend in total ash in both seedpods, and the levels did not fluctuate much with age.

Nutrient composition in separated dry seedpod components of both *A. brevispica* and *L. leucocephala* are shown in Table 2. Seeds of both trees contained more CP and EE and had greater IVDMD and estimated digestible energy (DE) concentration than empty pods, but seeds were lower in fibre and total ash than empty pods. Seedpods of L. *leucocephala* had a higher concentration of tannins than *A. brevispica*, where most of the tannin was found in the empty pods.

Nutrient composition of feed ingredients, supplements and hay used in Experiments 1 and 2 are reported in Table 3.In Experiment 1, *leucaena* seedpod meal and formulated LSM-1 supplement (including wheat bran) had higher total ash, lower fiber, higher IVDMD and greater estimated DE concentration than acacia seedpod meal and the formulated ASM supplement, respectively. The LSM-2 supplement used in Experiment 2 had slightly lower CP, higher NDF and lower IVDMD than LSM-1 supplement. Both hays used contained similar concentrations of CP, ash, and fiber, but IVDMD was higher in maasai lovegrass in Experiment 2 than Rhodes grass in Experiment 1.

Intake and live-weight gain

Calves on the LSM-1 diet had significantly ($P < 0.01$) higher average daily gains (ADG; 486 g d^{-1}) than those on the ASM (250 g d^{-1}) and Control-1 (239 g d^{-1}) diets (Table 4). Average daily gain of calves on the ASM diet was not statistically different $P > 0.05$) than the control. In Experiment 2 calves receiving LSM-2 had greater ADG (559 g d^{-1}) than Control-2 calves (276 g d^{-1}) ($P < 0.01$) (Table 5).

Supplementation of hay diets with legume seedpod meal maintained or tended to increase grass hay intake in Experiment 1 (Table 4). Total DM intake was 2490, 3400, and 3360 g d^{-1} for Control, ASM, and LSM-1 treatments, respectively. This resulted in average CP and DE intakes being 65 and 34% above that of Control-1. In Experiment 2, ADG responses to LSM-2 (Table 5) were similar to those for LSM-1 in Experiment 1 (Table 4). Grass hay intake was not different for Control-2 and LSM-2 suggesting that the effect of supplementary feeding was primarily additive (Table 5). The relative increases in CP and DE intake of the LSM-2 vs. Control-2 treatments were 40 and 9%, respectively, in Experiment 2.

DISCUSSION

In agreement with the literature (FAO, 1981; Getachew et

Table 2. Chemical composition of *L. leucocephala* and *A. brevispica* separated dry seedpod components.

	Constituent (dry matter basis)†							
	CP	Ash	EE	NDF	ADF	IVDMD	DE‡	Tannin*
	------------------------ g kg^{-1} -------						Kcal kg^{-1}	g kg^{-1}
Whole pod								
L. leucocephala	186	57	44	561	421	530	2.41	17.6
A. brevispica	143	41	38	550	335	547	2.50	0.90
Empty pod								
L. leucocephala	57	78	23	737	620	212	0.63	20.3
A. brevispica	85	51	22	785	581	215	0.65	1.80
Seeds								
L. leucocephala	282	42	91	413	193	726	3.51	15.5
A. brevispica	186	33	42	307	160	809	3.97	0.50

† CP = Crude protein, EE = ether extract, NDF = Neutral detergent fibre, ADF = Acid detergent fibre, IVDMD = in vitro dry matter digestibility, DE = Digestible energy

‡ Estimated using regression equation, DE (Kcal kg^{-1} DM) = -0.559 + 0.056X; r^2 = 0.966 and SE = 0.083 (Heaney and Pigden, 1963) where, X = digestible organic matter in g 100 g^{-1} DM

* Expressed as catechin equivalent

Table 3. Nutrient composition of feed ingredients, experimental diets and hay used in Experiments 1 and 2.

	Constituent (dry matter basis) †						
	DM	CP	Ash	NDF	ADF	IVDMD	DE
	---------------------g kg^{-1} -------------						Kcal kg^{-1}
Experiment 1							
Acacia seedpod meal	891	121	49	637	490	400	1.68
Leucaena seedpod meal	899	177	55	527	386	548	2.51
Wheat bran	889	160	69	535	164	725	3.50
Rhodes grass	942	41	87	792	493	418	1.78
ASM Supplement (ASM)‡	918	140	65	590	326	560	2.58
LSM Supplement (LSM-1) ‡	921	166	73	528	251	669	3.19
Experiment 2							
Leucaena seedpod meal	906	153	59	597	477	486	2.16
Wheat bran	892	190	68	439	138	753	3.66
Maasai love grass	914	36	83	780	530	534	2.43
LSM Supplement (LSM-2) ‡	887	172	72	507	294	646	3.06

† DM = Dry matter, CP = Crude protein, NDF = Neutral detergent fibre, ADF = Acid detergent fibre, IVDMD = In vitro dry matter digestibility, DE = Digestible energy (Kcal kg^{-1} DM) = -0.559 + 0.056X; r^2 = 0.966 and SE = 0.083 (Heaney and Pigden, 1963) where, X = digestible organic matter in g 100 g^{-1} DM.

‡ Supplements were seedpod meals plus wheat bran.

al., 1994) CP of legume seedpods decreased and fibre generally increased with advancing maturity. The decline in CP was greatest between 13 and 15 weeks after pod formation for *A. brevispica*, and between 5 and 9 weeks for *L. leucocephala*. These results suggest that *A. brevispica* could be utilised best not later than 13 weeks after pod formation, whereas *L. leucocephala* pods can be utilised even at the dry stage. This is because dry Acacia seeds are damaged by the Bruchid beetle (Southgate, 1983) and the pods of *A. brevispica* dehisce their seeds easily when

Table 4. Calf body weight gain and intake of Rhodes grass hay, supplement, crude protein and estimated digestible energy (DEI) in Experiment 1.

Response	Treatment			SE	CV
	Control-1	ASM	LSM-1		
Body weight gain (g d^{-1})	239[a†]	250[a]	486[b]	42	32
Intake					
Hay (g DM d^{-1})	1940[a]	2060[a]	2250[a]	135	36
Hay (g DM kg^{-1} $BW^{0.75}$ d^{-1})	50.8[a]	50.3[a]	53.3[a]	6	11
Supplement (g DM d^{-1})	554	1340	1110	nd[‡]	nd
Total CP (g d^{-1})	165	271	275	nd	nd
Estimated DEI (Kcal d^{-1})	5.48	7.12	7.53	nd	nd

[†] Treatment means within a row followed by the same letter superscript do not differ significantly (P <0.01).
[‡] nd = not determined.

Table 5. Calf body weight gain and intake of masaai lovegrass hay, supplement, total CP and estimated digestible energy (DEI) in Experiment 2.

Response	Treatment		SE	CV
	Control-2	LSM-2		
Body weight gain (g d^{-1})	276[a†]	559[b]	51	34
Intake				
Hay (g DM d^{-1})	3210[a]	3130[a]	104	35
Hay (g DM kg^{-1} $BW^{0.75}$ d^{-1})	79.8[a]	77.4[a]	6	7
Supplement (g DM d^{-1})	533	1060	nd[‡]	nd
Total CP (g d^{-1})	212	296	nd	nd
Estimated DEI (Kcal d^{-1})	9.93	10.9	nd	nd

[†] Treatment means followed by the same letter superscript in the same row do not differ significantly (P <0.01).
[‡] nd = not determined.

dry (Lamprey, 1967). Acacia pods contained less CP and higher NDF and ADF than that reported for leaves (Abdulrazak et al., 2000), but data were generally within the range found in other studies (Tanner et al., 1990; Sawe et al., 1998; Abdulrazak et al., 2000). The lower CP concentration of intact dry pods of *A. brevispica* compared to the value reported by Sawe et al. (1998) could be due to location and seasonal differences (Larbi et al., 1998) and stage of maturity at harvest. Dry pods of *L. leucocephala* also contained lower CP and higher fibre than reported for leaves (Wiegand et al., 1996), but the CP was similar to *leucaena* forage reported by Larbi et al. (1998).

The nutritive value of feeds depends mainly on the digestible energy concentration. Whole *A. brevispica* pods had a lower CP concentration and lower IVDMD than *L. leucocephala.* Acacia seedpod meal used in Experiment 1 contained approximately 65% of its seeds a likely cause of the lower DE concentration compared to *Leucaena* seedpod meal, which contained most of its seeds. The daily intakes of CP by calves on ASM and LSM-1 diets were similar, yet differences (P <0.01) were observed in calf gain, most likely attributable in part to the higher intake of DE of calves on LSM-1 (7.53 vs. 7.12). Crude protein concentrations of the grass hays in these experiments were well below requirements of growing calves. Supplementation of low quality basal roughage diets with legume forage increases essential nutrients, especially nitrogen, available to the rumen microbes, thereby increasing the amount and rate of rumen breakdown and fermentation, resulting in increased rates of passage of both particulate and liquid matter phases and increases in intake and, consequently, in animal performance (Norton and Poppi, 1995). The voluntary DM intake of grass hay by calves supplemented with LSM-1 in Experiment 1 was 16% greater than those fed the Control-1 diet. Additive effects of supplementation on hay intake suggest that LSM-1 increased gain by overcoming the protein deficiency resulting in greater intake of CP, DM, and DE compared to Control-1.

The higher intake of hay and hence total CP and DE in Experiment 2 was expected because the maasai lovegrass hay had higher IVDMD than the Rhodes grass hay used in

Experiment 1. However because the hay used in Experiment 2 had higher IVDMD and the hay was offered ad libitum, supplementation with LSM-2 did not increase intake of the basal hay, but resulted in higher CP intake, and significantly (P <0.01) increased ADG. This positive response could be attributed to the supplement overcoming the depressing effect of the low CP concentration of hay on intake (Minson and Milford, 1967).

The greater gain by calves supplemented with LSM-2 than the Control-2 calves in Experiment 2 confirmed the results obtained in Experiment 1, and is in agreement with the results of Naseeven et al. (1989), who found that cracked seeds of *leucaena* were comparable to cottonseed cake as a supplement for cattle. Similar live-weight gain responses have been obtained when *L. leucocephala* forage was offered as a supplement to low quality roughages (Masama et al., 1997; Kaitho et al., 1998).

CONCLUSION

On communal African rangelands, which are often chronically overstocked, under nutrition leads to reduced growth rates and poor reproductive performance of cattle during the dry season. The results of this study indicate that seedpods of *L. leucocephala* can be used by smallholder crop-livestock farmers and agropastoralists in arid and semi-arid areas to provide a locally available feed that is cheap and high in protein. These seedpods can be used as supplements to low quality forages, resulting in better utilisation of the forage and improved live-weight gains in cattle. The lower CP and IVDMD of *A. brevispica* pods, due in part to lower seed retention, than in *L. leucocephala*, limit its potential for use as a supplement, especially as dry pods. Less mature pods are higher innutritive value and may have greater impact, although they were lower in nutritive value than *L. leucocephala* pods across the entire range of maturities evaluated. Further work is needed to determine the effect of mature seedpods on cattle gains when most of the seeds are retained before they dehisce their seeds and also to determine the effect of feeding increasing levels of seedpods of both legumes on animal performance.

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