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Nutritive assessment of different forms of *Piliostigma thonningii* leaves in West Africa Dwarf Sheep diet

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ABSTRACT

Small ruminants are relatively easier to manage and produce than other species of livestock. An experiment was carried out to investigate the performance and nutrient digestibility of West African dwarf growing sheep fed mixture of *Panicum maximum* and different forms of *Piliostigma thonningii* for 60 days feeding trial. A total of twenty (20) WAD sheep were randomly allocated to four treatments (T1= *P. maximum (PM)* 100%; T2= 70% *P. maximum* (PM) + 30% fresh *Piliostigma thonningii* ; T3= 70% *P. maximum* (PM) + 30% wilted *Piliostigma thonningii* ; T4= 70% *P. maximum* (PM) + 30% dried *Piliostigma thonningii*) with five animals per treatment. The experimental diet was fed at 3% body weight of individual animals. The results revealed that animals fed T2 recorded the least weight gain (75.13g/day) while the highest weight gain (77.21g/day) was recorded for T4. The daily weight gain of animals were significantly different across all treatments (P<0.05). The forms of PT leaves had effect on dry matter (DM) and nutrient compositions. DM and NDF were higher (P<0.05) in the dry PT leaves. Mean crude protein (CP) was similar in the fresh (10.79±1.80), wilted (10.74± 0.9) and dry forms (10.26±1.20). Higher value of (620.90± 2.10) neutral detergent fibre (NDF) was obtained for dry leaves and the least value (532.71±1.62) was obtained for the fresh leaves. Mineral contents was reduced in the dry form while the anti-nutrients except for the oxalate was significantly (P<0.05) reduced in the dry form of PT. Results suggest that feed intake, weight change and nutrient digestibility can be improved by feeding of PT leaves to sheep in the dry form, and that the drying reduced most of the secondary metabolites of PT leaves. Further studies is however recommended to determine whether further higher supplementation levels for all forms of PT leaves is necessary for optimum utilization as the dry season feed supplement for sheep.

INTRODUCTION

Lack of all year round good quality feed remains a critical problem in the sustaining high productivity from ruminant, most especially the small ruminant animals in the derived savanna ecological zone (Akinlade *et al* 2002) of Nigeria. The ecological zone has been known for a cyclic change in the availability and nutritional status of forages

Thus the search for sustainable means of ameliorating these feed crises has been continuous. West African Dwarf sheep, predominant in this region is an early maturing, prolific and non-seasonal breeder, with an average of 80% multiple birth and are highly resistant to trypanosomosis (Akusu and Ajala, 2000).

Research findings on a number of multipurpose plants (Smith *et al,* 1995) are well documented. Roggero *et al,* (1996) however suggested that sustainability of multipurpose plants depends on making use of diverse local biological resources. This concept, which has also been advocated by some other researchers (Osagie,1998; Okoli *et al,* 2001), calls for wider use of the diversity of fodder tree species as providers of animal forage. *Piliostigma thonningii* is a leguminous browse plant belonging to the family *Caesalpinicea* found in the sub-humid region of Africa, growing in open woodland and savanna regions (Djuma, 2003).Its common name in English is camel's foot. It has feathery green leaves up to 15-17cm; the fodder is rich in crude protein, minerals and vitamins (Tesemna *et al,* 1993) and can produce a forage yield of 1.5tonnes/annum, thus making it a reliable source of dry season protein supplement for ruminant animals. The seeds when grinded have been fed to cattle during winter (Djuma, 2003). It is widely grown, well adapted and enjoys even distribution in African and Asia (Schuttes and Hoffman, 1973) and other tropical and subtropical ecological zones of the world. Most tropical browse species contain substantial amount of ant nutrient (Makkar, *et al,* 1993). Generally, drying or wilting have been used to preserve leaves of browse species for future use and reduce some of the inherent secondary metabolite present in these leaves, and have also been reported to have significant effects on chemical composition (Eroarome, 2002) as well as voluntary dry matter intake (ILCA,1990).This study therefore investigated the effects of wilting and drying of *P. thonningii* leaves on feed intake by West African dwarf sheep as well as the nutrient composition of the herbage.

MATERIALS AND METHODS

2.1 Site

The research was carried out at the Small ruminant unit of Teaching and Research Farm, Ladoke Akintola University of Technology Ogbomoso, Nigeria. Ogbomoso is located on longitude $4^{o}45^{o}$E and latitude $8^{o}26^{0}$N of Nigeria. It has an annual rainfall of 1247mm and a temperature of 27^{0}C (Chernow*et al*., 1993).

2.2 Housing and management of experimental animals

The housing consisted of open sides that allowed cross-ventilation, concrete floor laced with wood shaving and metallic roofing sheet. Twenty WAD sheep with average pre-trial body weight of 13.00 ± 1.3 procured from the local markets in Ogbomoso and its environment was used for the growth study. Twenty (20) Matured WAD sheep were used for the acceptability study. On arrival, the sheep were given a prophylactic treatment against ecto and endo parasites with 'Ivomec' applied subcutaneously at the rate of 1ml/10kg body weight.

2.3. Experimental Forage procurement

The leaves of *P. thonningii used* for the study were harvested from over 90 stands of *Piliostigma* tree growing within and around the University farm. The plants were mature and were about 10 years old and were observed to be at before flowering stage at the time of harvest. *P.maximum* was harvested at the pre flowering stage from an established paddocks in the University's Teaching and Research Farm.

2.4 Voluntary intake of Piliostigma thonningii by WAD sheep.

Voluntary feed intake of *P. thonningii* as a sole diet by West Africa dwarf sheep was assessed. Twenty (20) Animals were kept in individual cubicles that were made of planks, concrete floor laced with wood shavings. The study lasted for a period of 21 days. Forage was offered at 3% body weight of individual animals on dry matter basis during this period to establish voluntary feed intake by subtracting the feed refusal from the amount originally offered the previous day. The animals were made to undergo an adaptation period of two weeks, followed by a data collection period of 7days, fresh and clean water was made permanently available to the animals throughout the duration of the trial.

2.5 Growth performance of WAD sheep on fresh, dried and wilted Piliostigma thonningii PT mixed with Panicum maximum PM

The trial lasted for 60 days, with an initial adjustment period of 14 days. The animals were weighed at the commencement of the study and subsequently weekly. The animals were balanced for weight and sex and subsequently were divided into four groups of five animals each and were randomly assigned to experimental treatments. The animals were housed in individual pens. There were four experimental diets.

Diet 1 Animal fed with sole *P. maximum* (PM) forage at 100% offered fresh.
Diet 2 consisted 70% *P. maximum* (PM) + 30% fresh *Piliostigma thonningii*.
Diet 3 was 70% *P. maximum* (PM) + 30% wilted *Piliostigma thonningii*
Diet 4 was 70% *P. maximum* (PM) + 30% dried *Piliostigma thonningii*

Feeds were offered in separate feeders at 0.9:00h every day. The proportion of each of the forages in the mixed diet was calculated as a percentage of the total dry matter allowance of 3% body weight of individual animals. Mineral salt block and fresh water was provided at all times. The forage PM was chopped manually into about 5cm lengths and was offered in separate troughs with whole leaves of PT according to each treatment. The daily feed intake was calculated as the differences between the quantity of feed offered and the refusal in the following day for each of the forage. Samples of the forage fed were collected; oven dried at a temperature of 60^0C to a constant weight for dry matter determinations. Samples were thereafter ground and made to pass through 1.00mm sieve and kept at 4^0C until when they were required for laboratory analysis.

2.6. Nutrient Digestibility trial

This was carried out immediately after the completion of growth trial. Animals were transferred to individual metabolic cages that had facilities for separate collection of faeces and urine, and allowed to undergo an adjustment period of 7days. This was followed by a collection period of 5days during which feed intake and faecal output were monitored. The experimental diets were offered at 3% of body weight as in the growth trial. Fresh and clean water was made permanently available to the animals throughout the duration of the trial. 10% of daily faecal output by each animal was taken, dried to constant moisture level and stored at 4^0C until needed for analysis.

2.7. Chemical analysis

Sub-samples of forages and faeces were bulked, re-dried and analyzed for proximate contents using the standard methods of (AOAC, 1990). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to Van Soest *et al*. (1991).

2.8. Mineral Analysis

The mineral elements were analyzed according to the method of Walinga *et al*. (1989). The elements in the sample were brought into solution by wet digestion technique using a mixture of concentrated Nitric, Chloric and Sulphuric acids in the ratio 9:2:1 respectively. Fe, Zn, Ca and Mg were determined by Atomic Absorption Spectrometer while K was determined using atomic emission spectrometer and Phosphorus was determined using Spectrophotometer.

2.9. Anti-Nutritional Factor

Oxalic acid was estimated quantitatively by redox titration with standard potassium permanganate according to the procedure of Day and Underwood (1986). Saponin was determined using the method similar to that of Hudson and El-Difrawl(1981),phytic acid determined in accordance with the procedure of Ruales and Nair (1993). Tannic acid was determined in accordance with the procedure of AOAC (1990).

2.10. Statistical *Analysis*

The data were analyzed using a completely randomized design with animals as replicates using General Linear Model (GLM) procedures of SAS, (1988). Means were separated assuming a probability level of 0.05.

3. RESULTS

The chemical composition of the *Panicum maximum* and different forms of *Piliostigma thonningii* leaves are presented in Table 1. The values obtained from chemical composition showed significant (P< 0.05) differences among experimental diet. High CP% content (11%) was observed for *Panicum maximum* compared to different forms of *Piliostigma thonningii* leaves (fresh; 10.79%., Wilted ;10.26% and dried ;10.72%)., Dried *Piliostigma thonningii* leaves contained more (P<0.05) NDF (59.34%), ADF (57.26%), ADL (43.60%) and energy (2.60cal/g) than *Panicum maximum* and fresh and wilted *Piliostigma thonningii* leaves.

Table 2 shows the mineral composition of the experimental diet. There were significant (P< 0.05) differences among different forms of *Piliostigma thonningii* leaves along with *Panicum maximum* and mineral content of the experimental diet. The mineral content (%) of diet ranged for Ca (0.30-0.62%), P (0.41-0.77%), K (0.30 - 0.62%), Mg (0.18 – 1.18%), Cu (3.04 - 4.13mg/kg), Fe (30.00 - 60.20 mg/kg) and Zn (38.70 - 60.57 mg/kg).

The anti-nutrient contents of different forms of *Piliostigma thonningii* leaves as experimental diet was reported in Table 3. Among the forms, Fresh *Piliostigma thonningii* leaves gave a numerically higher values for Tannin (0.14%), Saponin (0.13%), Phytate (0.030%), Oxalate (0.03%) and Phenol (0.006%).

Voluntary feed intake and Weight gain of West African Dwarf (WAD) Sheep fed *Panicum maximum* supplemented with three forms of *Piliostigma thonningii* leaves is as shown in Table 5. Total dry matter intake was significantly higher (P<0.05) in WAD sheep fed on 70% *Panicum maximum* with 30% Dried *Piliostigma thonningii* leaves (52.65 g/h/day) compared to its counterpart. Neutral Detergent Fibre (NDF) intake in animals fed 70% *Panicum maximum* with 30% Dried *Piliostigma thonningii* leaves was 29.79 g/h/d while least NDF intake was found in animal fed 70% *P. maximum* (PM) + 30% fresh *Piliostigma thonningii* leaves (15.49 g/h/d). Total ADF intake of animal fed dried *Piliostigma thonningii* leaves (20.86 g/h/d) was significantly (P<0.05) higher compared with others treatments. Crude Protein consumption (5.66 g/h/d) and daily weight gain 77.21g/h/day was higher in animals fed 70% *Panicum maximum* with 30% dried *Piliostigma thonningii* leaves than animals of other treatments.

Nutrient digestibility of West African Dwarf (WAD) Sheep fed *Panicum maximum* supplemented with three forms of *Piliostigma thonningii* leaves as shown in Table 6. Significantly (P<0.05) highest value were obtained on animals fed 70% *Panicum maximum* with 30% Dried *Piliostigma thonningii* leaves for CP digestibility (77.15%),NDF(78.04%), and ADF(75.56%), followed by animals fed 70% *Panicum maximum* with 30% wilted *Piliostigma thonningii* leaves and the least value was also observed on animal animals fed 70% *Panicum maximum* with 30% fresh *Piliostigma thonningii* leaves for CP (72.82%), NDF(73.43%), and ADF(73.28%).

Table 1: Effect of Chemical composition of the *P. maximum* and different forms of *P. thonningii*leaves.

	CP%	NDF%	ADF%	ADL%	GE(cal/g)
P. maximum	11.00^{a}	50.47^{d}	41.20^{d}	40.03^{c}	2.10^{a}
Fresh P.thonningii	10.79^{b}	52.07^{c}	41.26^{c}	40.70^{c}	1.60^{b}
Wilted P.thonningii	10.26^{b}	56.26^{b}	47.09^{b}	41.60^{b}	1.40^{b}
Dried P.thonnigii	10.72^{b}	69.34^{a}	57.26^{a}	43.60^{a}	2.60^{a}
SEM	0.01	0.001	0.001	0.01	1.00

[abc] Means with different superscripts within the same row are significantly (P<0.05) different

Table 2. Minerals composition of the *P. maximum* and different forms of *P. thonningii*leaves.

Minerals Composition	Ca%	P%	K%	Mg%	Cu mg/kg	Fe mg/kg	Zn mg/kg
P. maximum	0.14	0.41	0.30	0.21	4.20	30.00	38.70
FreshP. thonningii	0.62	0.77	0.62	1.18	4.13	60.20	60.57
WiltedP.thonningii	0.57	0.69	0.36	0.24	4.11	50.84	50.70
Dried P.thonnigii	0.40	0.48	0.25	0.18	3.04	40.38	40.13
SEM	0.01	0.01	0.01	0.01	0.10	0.01	0.10

[abc] Means with different superscripts within the same row are significantly (P<0.05) different

Table 3: Anti-Nutrients contents of Experimental diet

Experimental diet	**Tannin**	**Saponin**	**Phytate**	**Oxalate**	**Phenol**
P. maximum	-	-	-	-	-
Fresh P. thonningii	0.14	0.13	0.030	0.03	0.006
WiltedP.thonningii	0.01	0.12	0.005	0.02	0.005
Dried P.thonnigii	0.01	0.11	0.004	0.02	0.04
SEM	0.01	0.01	0.01	0.01	0.01

Table 4: Performance of WAD rams fed *Piliostigmathonningii*.

Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**
Average Initial Weight (kg)	*13.20*	*13.20*	*13.18*	*13.18*	*0.02*
Average Final Weight (kg)	17.81	17.71	17.80	17.81	0.20
Average Weight Gain (kg)	4.61	4.51	4.62	4.63	0.20
Daily Weight Gain (g/day)	76.92	75.13	77.01	77.21	1.54

T1: Animal fed with sole *P. maximum* (PM) forage at 100% offered fresh.
T2: consisted 70% *P. maximum* (PM) + 30% fresh *Piliostigmathonningii*.
T3: was 70% *P. maximum* (PM) + 30% wilted *Piliostigmathonningii*
T4: was 70% *P. maximum* (PM) + 30% dried *Piliostigmathonningii*

Table 5: Voluntary Intake and Weight Gain by West African Dwarf (WAD)Sheep fed three forms of *Piliostigma thonningii* supplements

Parameters	Treatments 1 Control	2 fresh	3 dried	4 wilted	SEM
Dry Matter Intake (g/h/day)					
Panicum maximum	112.64[a]	84.79[b]	80.53[d]	82.13[c]	0.01
P. thonningii	0.00[d]	24.96[c]	36.62[b]	52.65[a]	0.01
Total	112.64	109.75	117.19	134.78	0.02
NDF Intake (g/h/day)					
Panicum maximum	61.37[a]	45.85[b]	43.86[d]	44.77[c]	0.01
P. thonningii	0.00[d]	15.49[c]	19.99[b]	29.79[a]	0.01
Total	61.37	61.34	63.85	74.56	0.02
ADF Intake(g/h/day)					
Panicum maximum	46.79[d]	34.97[c]	33.19[d]	33.87[c]	0.01
P. thonningii	0.00[d]	14.29[c]	17.43[b]	20.86[a]	0.01
Total	46.79	49.26	50.62	54.73	0.02
CP Intake(g/h/day)					
Panicum maximum	13.63[a]	10.18[c]	9.72[d]	11.82[b]	0.01
P.thonningii	0.00[d]	2.69[c]	3.75[b]	5.66[a]	0.01
Total	13.63	12.87	13.47	17.48	0.02
Weight gain (g/h/day)	76.92	75.13	77.01	77.21	0.01

[abcd]Means with the same superscripts within the same row are not significantly different (P<0.01)

Table 6: Nutrient Digestibility of WAD Sheep fed three forms of *Piliostigma thonningii*

Nutrients	Treatments Control 1	fresh 2	dried 3	wilted 4	SEM
CP	74.48[c]	72.83[d]	77.15[a]	76.79[b]	0.02
NDF	74.68[c]	73.43[d]	78.04[a]	76.83[b]	0.02
ADF	74.53[c]	73.28[d]	75.56[a]	74.70[b]	0.01

[abcd]Means with the same superscripts within the same row are not significantly different (P<0.01)

4. DISCUSSION

Chemical composition.

The Crude protein of *Panicum maximum was* slightly higher than different forms of *Piliostigma thonningii* leaves. The Crude protein of the forages ranged from 10.26% to 11.00% which will provide ammonia required for rumen micro organism to support optimum microbial activity. Crude protein content (CP%) of different forms of *Piliostigma thonningii* leaves falls within the range of browse plant from West Africa (Rittner and Reed, 1992). All forms of diet used in the current study had a CP above 7% of critical level and can be used to supplement poor quality roughage to increase productivity of ruminant livestock.

Higher values observed from dried *Piliostigma thonningii* leaves for NDF, ADF and Lignin respectively this might occur due to unfavourable reaction which reduced availability of nutrients during drying of the experimental diet (Smith *et al*., 1995). Such reaction has been implicated as causing changes in the cell-wall structures.. The increase NDF concentration in wilted and dried *Piliostigma thonningii* leaves agreed with the reports of (Parachristous and Nastis, 1994). These researchers reported that drying generally increase NDF and lignin content of browse leaves. Generally the low level of NDF can be difficult to achieve in sub tropical/tropical areas due to the predominance of high NDF forages and so 40% is considered a more achievable target in sub tropical grazing system. Jung and Allen (1995) reported that NDF range from (30-80%) in tropical forages. The ADF ranged above 40% in this present study. ADF content refers to the cell wall portion consist of cellulose and lignin. As the ADF increase the digestibility of the forage usually decreases (Albayrak*et* *al*., 2001).Causing consumption of the forage by animal to reduce (Ayin *et al*., 2010). Nussion*et al* (1998) reported that forage with ADF content around 40% or more shows low intake and digestibility.

Mineral Analysis

The mineral analysis of a plant gives the idea of possibility either the plant should be used for any feeding trial purpose. The Calcium content for the diet ranged (0.40-0.62%) and higher than (0.09%) observed for *Canavalia ensiformis* leaves reported by Akinlade *et al*., (2007). The calcium content values found in this study were considered adequate for the optimum performance of ruminants. The different forms of *Piliostigma thonningii* leaves would meet the theoretical Ca requirement of 0.30% Ca diet needed for all form of production in ruminant (ARC, 1980).

Phosphrus (P%) content in the experimental diets ranged between 0.41 to 0.77% and were higher compared to the NRC recommended value of (0.15%) for phosphorus (NRC, 1985). The level of phosphorus in both diet were consistently above the 0.2% level which would satisfy livestock dietary maintenance requirement (NRC, 1985).

The value of Potassium (K%) in the experimental diets ranged (0.25- 0.62%).The level of %K in the diets was higher than 0.18% recommended for grazing animals (Mc Dowell, 1985). However, it has been suggested that ruminants with high productivity may require %K level above (1.0%) under stress particularly heat stress (Khan *et al*., 2005). Potassium help to maintain body weight and regulate water and electrolyte balance in the blood and tissue (NRC, 1985).

The Magnesium (Mg%) content for the experimental diets ranged between 0.21 to 1.18%. The higher forage Mg level found in this present study were above (0.12-0.20%) of requirement of ruminants diet suggested by (NRC, 1985). Magnesium is an important mineral element in connection with its role in circulatory disease such as chronic heart disease and calcium metabolism (Hassan and Umar, 2006).

The Iron (Fe mg/kg) content of the diets (30.00-60.20 mg/kg) were higher compared to (10.58mg/kg) recorded for iron content of *Mucuna utilis* leaves. Iron level obtained in this present investigation could meet the requirement of ruminants for optimal performance. The optimal requirement for ruminant is (50mg/kg).

The concentration of Zinc in the forage fell between (38.70-60.57mg/kg) and higher than (30mg/kg) zinc suggested at critical dietary level, although it has been recommended that concentration of 12-20mg/kg are adequate for growing ruminants(Anonymous, 1980). Zinc is a trace element for protein and nucleic acid synthesis and normal body development during period of rapid growth such as Kid/Lamb and recovery of illness (Melaku*et al.*, 2005).

The Copper Cu content of the experimental diets ranged (3.04-4.13mg/kg). Most of the dietary treatment samples analyzed in the present study fell below the (8 - 14mg/kg) reported by (Khan *et al*., 2005). Forage Cu content decline with forage maturity and is higher in leaf than in stem. High concentration iron and zinc also reduce copper status and may increase copper requirement

Anti-Nutrient Content

The tannin values obtained at different forms of processed *Piliostigma thonningii* leaves ranged (0.01-0.14%). Tannin concentration reported in this work was below the range of 1.43-1.53% reported by Khan *et al*., (2005) in wild edible forages consumed by ruminant. Tannin at this level protects liable plant protein in the rumen and consequently increase the supply of high quality protein into the duodenum (Mcleod, 1974). Saponin values from different forms of processed *Piliostigma thonningii* leaves ranged (0.11-0.13%). Feedstuff containing saponin had been shown to be defaulting agent (Teferedegne, 2000) and capable of reducing methane production (Babayemi*et al*.,2004b). Saponin have effect on erythrocyte hemolysis reduction of blood and liver cholesterol, depression of growth rate, bloat (in ruminant), inhibition of smooth muscle activity, enzyme inhibition and reduction in nutrient absorption. Saponin have been reported to alter cell wall permeability and therefore to produce some toxic effect when ingested (Belmar *et al.* 1999).

The phytate content of the different forms of processed *Piliostigma thonningii* leaves ranged (0.005-0.030%). The phytate content in this present investigation were lower than 1.35% in *Psophocarpus tetragonolobus* leaves reported by Alalade *et al* (2016). The phytic value was lower than the range value of 3.47% and 3.24% reported for some browse legume in Nigeria (Oke, 1969). The negative effect of phytate in nutrition is the chelating of certain essential element such as Ca, Fe, Mg and Zn this contribute to mineral deficiency in people whose dietary on some food rich in phytate for their mineral intake (Hurell, 2005). Nevertheless, phytate are considered as phyto-nutrient providing an antioxidant effect and their mineral binding properties prevent colon cancer by reducing oxidative stress in the lumen of the intestinal tract (Vucenik and Shamsuddin, 2003).Oxalate values of the different forms of *Piliostigma thonningii* leaves in this study ranged (0.02-0.03%). The oxalate content of experimental diet lower than (0.40%) *Parkia biglobosa* leaves reported by Alalade *et al* (2016). Oxalate concentration in the browse plant used was tolerable forage containing oxalate is less of a problem for ruminants but at a high concentration may cause digestive disturbance (Seifert, 1996), kidney failure and death (Acamovic *et al.,* 2004).

The highest values was obtained for drymatter intake, Crude protein intake, NDF intake and ADF intake on animal fed 70% *Panicum maximum* with 30% dried *Piliostigma thonningii* leaves compared to other treatments. These values were higher than the (33.36g/h/d) reported by Arigbede, (2007).The CP, NDF and ADF digestibility values obtained were higher than the values 62.17, 62.48 and 62.29% recorded by Youssuf*et al*. (2005).

5. CONCLUSION

Piliostigma thonnningii leaves can be fed with *P. maximum* in fresh, wilted and dried forms, the secondary metabolites in *Piliostigma thonningii* was further depleted by drying, this however induced higher NDF but did not inhibit intake. Weight gain, Voluntary intake, Nutrient digestibility were favoured with animals fed 70% *Panicum maximum* with 30% dried *Piliostigmathonningii* leaves

It is suggested that *Piliostigma thonningii* could not be used as a sole diet for sheep, but could serve as supplement especially when dry or wilted at up to 30% and used as a reliable dry season short term feed supplement in small holder livestock farming system in the tropics.

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