Comparative Rumen Degradability of Some Legume Forages between Wet and Dry Season in West Sumatra, Indonesia

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ABSTRACT : An experiment was conducted to evaluate the potential nutritive value of five legume forages (leaves and twigs) in West Sumatra during wet and dry seasons. The chemical composition, *in vitro* dry matter (IVDMD), organic matter (IVOMD) and crude protein digestibility (IVCPD), *in vitro* gas characteristics and estimated metabolizable energy (ME) showed variation among legume forages and between different seasons. Crude protein (CP) ranged from 14.2 to 27.8% DM in the wet season, with a significant ($p<0.05$) reduction in dry season. *C. pubescens, G. maculata, L. leucocephala* and *P. phaseloides* showed the least reduction in CP content. The NDF, ADF and lignin were about 39.0, 26.5 and 6.1% DM, respectively in the wet season, and significantly ($p<0.05$) increased in the dry season, except for NDF of *C. mucunoides* and *C. pubescens.* For IVDMD, IVOMD and IVCPD significantly increased in the wet season, but values remained as high as over 50.0% of DM. The *in vitro* gas characteristics and metabolizable energy were significantly ($p<0.05$) higher in wet season than the dry season. During both seasons, the rate of constant (c) for *G. maculata* and ME content for *C. pubescens and P. phaseloides* were not significantly ($p<0.05$). Results demonstrated that *P. phaseloides* and *L. leucocephala* have a good nutritive value during both wet and dry seasons. Further studies on feeding trials are needed to quantify the animal responses when offered these legume forages. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 8 : 1107-1111)***

Key Words : Wet Season, Dry Season, Legume Forages, Nutritive Value, Ruminants

INTRODUCTION

There are many areas in Indonesia that are characterized by dense population of livestock and one of these areas in west Sumatra. Animal keeping in the west Sumatra is a major and the most important source of income for the majority of the population. Over 70% of the total population is directly or indirectly engaged in livestock rising. Natural pasture and crop residues contribute about 75% of the nutrient requirements for ruminants in Indonesia, which are estimated at an increment of 3.94% per year was 66.3 million heads of cattle, sheep, goats and buffalo (Indonesia Statistical Bureau, 2001a). The nutritive value of pasture and range in Indonesia is affected greatly by seasonal changes. Elginaid (1997) indicated that as long as the grasses provide sufficient feed supplies during the rainy season and beginning of dry season, utilization of the legume species is only intermittent. At the time when grazing offers animals only dry grasses at its least palatable and poor feeding value in dry season, the legume species could be the main constitute of livestock feed. In fact this role of the legume species become more important as the dry season progresses, lasting 5 to 11 months annually, or even longer in case of a drought. Legumes have a significant role in many farming systems of the tropic through their contribution to enhanced nutritive value of the animal diet, biological nitrogen (N) fixation and landscape stability (Humphreys, 1995). Legumes have great potential to increase the productivity of livestock in the humid tropics. In the dry season, therefore, legume species become an important source of nutrients for livestock in west Sumatra. El-Hag (1985) reported that grasses increased their levels of fibrous fractions with a high ash concentration, while decreased their levels of crude protein and total soluble sugars as the dry season progressed, which resulted in poor nutritive value for animals. The grazing situation is so pathetic during the dry season where animals depend entirely on low quality forages especially crop residues. Smallholder farmers cannot afford to procure protein supplementary feeds due to their high cost. Leguminous plants like *L. leucocephala*, *G. maculata*, *P. phaseloides*, *C. mucunoides* and *C. pubescens* which are available in the country can be used as a cheap protein supplement. Leaves of legume species may have a potential for providing supplemental nitrogen and energy to animals in the dry season. However, the influence of the seasons and legume species must be known in order to design the proper supplementary regime. The objectives of this study was to evaluate the nutritive value of legume species in West Sumatra, Indonesia and to determine effects the wet and dry seasons had on their nutritive value.

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Table 1. Organic matter, crude protein and total extractable phenolics contents in legume forages

	OM			CP			TEPH		
	Wet	Dry	Se[#]	Wet	Dry	Se[#]	Wet	Dry	Se[#]
C. mucunoides	89.0	93.3	**	14.2	13.9	***	1.5	2.9	***
C. pubescens	91.6	92.2	*	18.7	13.8	***	2.3	1.7	***
G. maculata	88.9	90.2	**	24.4	19.7	***	2.2	3.6	***
L. leucocephala	89.9	90.7	*	25.9	21.4	***	7.0	8.2	***
P. phaseloides	89.9	91.6	**	27.8	25.5	**	2.1	3.7	***
SEM	0.26	0.29		1.06	1.26		1.09	2.03	

[#] Effect of seasons. * p<0.05, ** p<0.01, *** p<0.001. SEM: Standard error of mean.

MATERIALS AND METHODS

Study area

The study was conducted in West Sumatra an area of Indonesia which is located in Padang. The annual precipitation is 2,289 mm of rainfall per year with annual temperatures ranging between 22 to 32°C with humidity about 86%. West Sumatra has two seasons during the year, the dry season begins from May to October and the wet season begins from November to April in 2001. Also, the average of rainfall in dry season 192.2 mm/month while in wet season 298.4 mm/month, respectively.

Sample collection and preparation

Leaves and twigs from five legume species, *C. mucunoides*, *C. pubescens*, *G. maculata*, *L. leucocephala* and *P. phaseloides* were colleted in wet season (December, 2001) and dry season (July, 2001). Legume forages were selected under consideration of the feeding behavior and the preference of animals and species that were dominant. Samples were collected by hand picking from randomly selected, *L. leucocephala* and *G. maculata* leaves and twigs were collected from at least 15 different trees. Other leguminous plants like *P. phaseloides*, *C. pubescens* and *C. mucunoides* were collected randomly from the grazing lands. Samples were thoroughly mixed and ground in hammer mill to pass a 1 mm screen for chemical analysis, *in vitro* gas production and a 2.5 mm screen for *in vitro* digestibility.

Chemical analysis and *in vitro* digestion

The proximate components were determined according to AOAC (1990). The sample fiber contents namely Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL), *in vitro* dry matter digestibility (IVDMD), organic matter (IVOMD) and crude protein (IVCPD) for 96 h with rumen microbes were determined by methods Goering and Van Soest (1970). The extraction of phenolics was done using 70% aqueous acetone. Total extractable phenols (TEPH) were determined using Folin Ciocalteu according to Julkunen-Titto (1985).

*In vitro g*as production study

Samples were incubated *in vitro* with rumen fluid in calibrated glass syringes following the procedure of Menke and Steingass (1988). Rumen liquor was obtained from three sheep fed with 800 g DM timothy hay and 200 g DM concentrates, twice daily and had free access to water and mineral mix. About 200±5 mg of 1 mm milled samples were weighed into 100 ml calibrated glass syringes in triplicate. About 30±0.5 ml of rumen-buffer mixture was added into each syringe and then all the syringes were incubated in a water bath maintained at 39±0.1°C. The syringes were gently shaken every hour during the first 8 h incubation and reading was recorded after 3, 6, 12, 24, 48, 72 and 96 h. The mean gas volume readings were fitted to the exponential equation $p=a+b\ (1-e^{-ct})$ by ∅rskov and McDonald (1979). Where p=gas production at time t; a+b=the potential gas production, c=the rate of gas production and a, b and c are constant using Neway computer program (Macaulay Institute, Aberdeen, UK).

The metabolizable energy content of the forages was estimated according to the following equation (Menke and Steingass, 1988): ME (MJ/kg DM)=2.2+0.136 (GP_{24h})+0.057 (CP)+$(0.00029\ EE)^2$. Where: ME= metabolizable energy; GP=gas production at 24 h incubation time; CP=crude protein content of the forage (g/kg DM); EE=ether extract (crude fat) content of the forage (g/kg DM).

Statistical analysis

Results of the chemical composition, *in vitro* digestibility, *in vitro* gas production and metabolizable energy were analyzed using General Linear Model (GLM) procedure for computations of means and standard errors according to SAS/Statview® (1999). The mean comparison between the species of legumes and seasons were compared using probability of difference. The following statistical model was used in the analysis: $Y_{ijk}=\mu+S_i+F_k+e_{ijk.}$ Where: $Y_{ijk=}$dependent variable (general observation); μ=the overall mean; S_i=effect of i^{th} season; Fk=effect of k^{th} species; e_{ijk}=error term.

RESULTS AND DISCUSSION

The OM, CP and TEPH contents are presented in Table 1. The OM showed a fairly constant level of around 90.0% of DM among legume species and between the periods of

Table 2. Fibrous fraction content (% of DM) of legume forages

	NDF			ADF			Lignin		
	Wet	Dry	Se[1]	Wet	Dry	Se[1]	Wet	Dry	Se[1]
C. mucunoides	39.1	41.3	NS	28.2	31.4	***	5.5	7.6	***
C. pubescens	51.0	51.4	NS	31.1	39.7	***	5.8	6.1	***
G. maculata	29.4	50.0	***	20.3	25.6	***	5.1	10.2	***
L. leucocephala	37.2	41.0	***	25.8	21.5	***	8.3	9.0	***
P. phaseloides	38.4	41.3	***	27.1	20.5	***	5.7	4.8	***
SEM	1.92	1.50		1.09	2.08		0.34	0.56	

[1] Effect of seasons. * p<0.05, *** p<0.001. SEM: Standard error of mean.

Table 3. *In vitro* digestibility of legume forages in wet and dry seasons

	IVDMD			IVOMD			IVCPD		
	Wet	Dry	Se[1]	Wet	Dry	Se[1]	Wet	Dry	Se[1]
C. mucunoides	58.3	57.7	*	60.6	58.3	**	66.1	64.8	**
C. pubescens	62.5	53.6	***	69.3	58.1	***	62.6	58.3	**
G. maculata	66.5	55.9	***	68.1	60.6	**	70.1	69.0	*
L. leucocephala	69.5	62.6	**	68.1	64.0	**	72.1	67.9	***
P. phaseloides	65.7	64.6	*	67.9	66.1	*	73.5	66.4	***
SEM	0.66	0.74		0.75	1.04		1.73	1. 03	

[1] Effect of seasons. * p<0.05, ** p<0.01, *** p<0.001. SEM: Standard error of mean.

seasons, with some variation. The concentration of CP and TEPH showed a significant variation among the legume forages between seasons. Three species of legume species namely *G. maculata*, *L. leucocephala* and *P. phaseloides* contained more than 20.0% DM of CP content in wet and dry seasons. When the dry season progressed, the CP content declined to the level of 13.8% for *C. pubescens* and 13.9% DM for *C. mucunoides*, but remained relatively higher in the wet season. The CP content in wet season increased more significantly (p<0.05) than in dry season. The CP content in wet season ranged between 14.2% (*C. mucunoides*) and 27.9% (*P. phaseloides*) while in dry season 13.8 (*C. pubescens*) and 25.5% (*P. phaseloides*). The lower CP content during the dry season than wet season was in agreement with other reported studies and that the minimum CP content of fodder tree species at dry season was more than twice that of the grasses at wet season (Skarpe and Bergstrom, 1986; Mohammed and Salih, 1991). Also, CP content of legumes ranges from 15 to 30% (D`Mello, 1992; Topps and Oliver, 1993) with an average of approximately 17% (D`Mello and Devendra, 1995) during growing season, declining to 11% in the dry season (Topps and Oliver, 1993). The TEPH content in wet season ranged from 1.5% for *C. mucunoides* to 7.0% for *L. Leucocephala* in the wet season while significant (p<0.05) increased in dry season from 1.7% for *C. pubescens* to 8.2% for *L. Leucocephala*. Similar results were reported by Abdulrazak et al. (2001); Fadel et al. (2002), Apori et al. (1998) and Topps (1992). It is worthwhile to note that the antinutritional factors in legume species have resulted into low intakes (Abdulrazak et al., 2001). Feeding trials are required to quantify the animal responses when offered these forages.

Fibrous fractions such as NDF, ADF and lignin were about 29, 20 and 5% of DM, respectively at the wet season and significantly increased at the dry season period in all legume species, except for the ADF and lignin of *L. leucocephala* and *P. phaseloides* (Table 2). The increment of NDF, ADF and lignin in wet season ranged from 29.4 % (*G. maculata*) to 51.0% (*C. pubescens*); 20.3 to 31.1% and 5.1 to 8.3% (*L. leucocephala*) while in dry season ranged from 41.0 (*L. leucocephala*) to 51.4% (*C. pubescens*); 20.5 (*P. phaseloides*) to 39.7% and 4.8 to 10.2% (*G. maculata*), respectively. Generally, fibrous fractions including lignin were greater in wet season than dry season, which agrees with (Bulo et al., 1994; Fariani 1997; Fadel et al., 2002; Nasrullah et al., 2003). The increase in fibrous fractions in dry season reflected a decrease in CP content and phenolics compound. The differences between season in fiber components suggested that in dry season, due to high intensity of solar radiation and less amount of rainfall, the maturity of legume forages was faster compared in wet season, thus the legume forages contained high cell wall constituents but less in cell contents. It is well known that the average of rainfall is in dry season 192.2 mm/month while in wet season 298.4 mm/month (Indonesia Statistical Bureau, 2001b).

The IVDMD, IVODM and IVCPD content of legume species in wet season significantly (p<0.05) increased compared to the dry season. However the values remained as high as over 50% for all legume species in both seasons. The highest value was recorded for *L. leucocephala* (69.5); (68.1) and *P. phaseloides* (73.5%) in wet season while *C. pubescens* (65.7); (66.1) and *G. maculata* (69.0%) in dry season (Table 3). However, the lowest value was recorded for *C. mucunoides* (58.3); (60.6) and *C. pubescens* (62.6%) in wet season while *C. pubescens* (53.6); (58.1) and (58.3%) in the dry season, for IVDMD, IVODM and

Table 4. *In vitro* gas production parameters and metabolizable energy (ME) in legume forages

	(a+b)[1]			c[2]			ME[3]		
	Wet	Dry	Se[4]	Wet	Dry	Se[4]	Wet	Dry	Se[4]
C. mucunoides	36.0	33.2	***	6.9	5.3	***	6.9	6.4	*
C. pubescens	36.5	33.9	***	7.1	5.5	***	6.7	6.5	NS
G. maculata	40.7	39.3	**	5.7	5.5	NS	7.7	6.9	***
L. leucocephala	35.7	34.7	**	8.1	9.8	***	7.8	7.6	*
P. phaseloides	42.5	38.4	***	5.0	6.2	***	7.8	7.8	NS
SEM	0.66	0.74		0.56	0.28		0.15	0.10	

NS: Not significant (p>0.05), * p<0.05, ** p<0.01, p<0.001. SEM: Standard error of mean.
[1] Potential gas production (ml/200 mg DM). [2] Gas production rate of constant (%/h). [3] MJ/kg DM. [4] Effect of seasons.

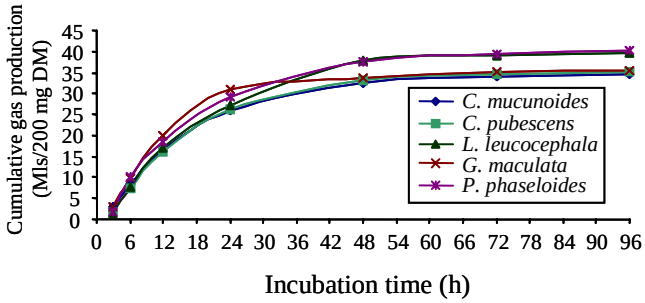

Figure 1. *In vitro* gas production of legume forages in wet and dry seasons.

IVCPD respectively. In contrast, depressing significant correlations between *in vitro* digestibilities and cell wall components. Increase in CP content; decrease in TEPH and fiber fractions in wet season and reflected an increase in IVDMD, IVOMD and IVCPD. Similarly, result with present study, *in vitro* degradability of tropical legumes has been reported (Bulo et al., 1994; Fariani, 1997; Abdulrazak et al., 2001; Fadel et al., 2002; Nasrullah et al., 2003).

Table 4 shows the result of gas production characteristics of potential gas production (a+b), rate of constant (c) and metabolizable energy (ME) of legume species in wet and dry seasons. The potential gas production (a+b) and rate of constant (c) of legume species in wet season significant (p<0.05) higher than in dry season, except the rate of constant (c) for *G. maculata*. The highest of (a+b) and (c) of legume forages in wet season was recorded for *P. phaseloides* (42.5%) and *L. leucocephala* (8.1%/h) while *G. maculata* (39.3%) and *L. leucocephala* (9.8%/h) in dry season. However, the lowest of (a+b) and (c) of legume species in wet season was recorded for *C. mucunoides* (36.0%) and (5.7%/h) while in dry season was recorded for *C. mucunoides* (33.2%) and (5.3%/h). The difference of gas production characteristics between wet and dry season could be due to the low N content of forages in dry season resulting in low rumen ammonia concentrations (Bonsi et al., 1995), which reduced microbial growth. Finally, from the Figure 1 that the ranking of gas production of five legume forages was: *L. leucocephala>P. phaseloides>G. maculata>C. mucunoides >C. pubescens*. The ME content of legume species in wet season significant (p<0.05) higher than in dry season, except for *C. pubescens and P. phaseloides.* The results of ME content of legume forages ranged from 6.7 for *C. pubescens* to 7.8 MJ/kg DM for *P. phaseloides* in wet season and from 6.4 for *C. pubescens* to 7.8 MJ/kg DM for *P. phaseloides*. The highest ME content of legume forages in wet season compared with in dry season similarly with some result by Fadel et al. (2002), Walker (1980) Krishnamoorthy (1995), Sen et al. (1978) and Nouregia et al. (1999).

CONCLUSION

The five tropical forage legumes showed seasonal variation in chemical composition, degradability, gas production characteristics and metabolizable energy. The results of present indicated that *P. phaseloides* and *L. leucocephala* have a good potential nutritive value for wet and dry seasons feed or supplement, while *C. mucunoides* and *C. pubescens* tend to be less promising as a potential feed. The legume forages had showed better nutritive value with less phenolics compound. The substantial amounts of rumen degradable dry matter could result in increase in microbial protein synthesis, subsequently post ruminal supply of microbial protein when fed to ruminants. Further study is needed to evaluate the availability of legume forages as a supplementary feed for dry grasses and crop residues. There is also a need to quantify these values for feeding trials to justify the intake response when animals are fed with these legume forages.

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