Bulletin of Animal Science, Special Edition, 1995 ISSN 01260 - 4400

In-Sacco Degradability of Various Legume-Tree Leaves from Limestone and Non-Limestone Areas in Malang

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ABSTRACT: This research aimed to determine the dry matter (DM), organic matter (OM) and crude protein (CP) degradation in sacco of various legume tree leaves from limestone and non - limestone areas in Malang. Five samples of legume tree leaves namely :leucaena, calliandra, gliricidia, sesbania and erythrina were incubated at 0,4,8,12,16,24, and 48 hours in the rumen of three fistulated fat-tail sheep (± 28,4 kg live weight, the pH of the rumen fluid 6,8 and NH_3 3,43 mM). Those fistulated animals were fed the ammoniated rice straw freely (CP 11,7%, DM intake 633,1 g) and susu PAP concentrate (CP 18,3% , DM intake 268,0 g). The formula that has been used to calculate the DM, OM and CP degradability at the time "t" is expressed as:p = a + b (1 - e^{-ct}) for t_0, the similar modified formula has been used this experiment expressed that : (a' + b') = the potential degradability of the feed; a' constant = the feeds that loss during washing; b' constant = (a+b) - a'; c' constant = the degradation rate. The result of this experiment showed that the locational factor gave a higly significant (P<0,01) effect to a' value at DM (39,5% and 38,3%) and CP (44,0% and 40,3%); b' at CP (29,1% and 35,2%), but not significant either to a' at OM; b' at DM and OM; (a'+ b') and c' at DM, OM and CP. Based on those result it could be said that the locational factor do not affect the degradability differently. The legume-tree leaves taken from two location showed a significant response (P<0,05) to the a' , b', (a'+ b') and c' values at DM, OM and CP. It can be concluded that the rank-order of legume tree leaves from two locations were sesbania, gliricidia, erythrina, leucaena and calliandra. Sesbania was the best. The low degradation rate of leucaena and calliandra possibly associated with the relatively high content of tannin. In purpose of supplementations of low quality basal-diets, it is recommended to offer sesbania, gliricidia or erythrina leaves.

Key Words : Limestone and Non-Limestone Areas, Legume Tree, *In Sacco*, Leaves, Degradability

Introduction

Scarcity of protein supplement for herbivores is a major problem faced by small holders in Indonesia, especially during the dry season when quantity and quality of forages decrease drastically (Nitis, 1982). So that, it is not surprisingly that in the dry season, the ruminants performance are very low as compared to that of rainy season. For that reason, efforts have to be make to obtain reasonable feedstuffs for animal production purposes. It was suggested that legume leaves such as gliricidia, leucaena and some other legume leaves as protein supplement for ruminants (Devendra, 1981).

Leucaena, gliricidia, calliandra, erythrina and sesbania are legume trees recommended by the goverment to be planted with regard to the re-forestation program. It was expected that those trees could be used as protein supplements for livestock (Heyne, 1950; Manan, 1978; NAS, 1979; Johanes, 1982).

It is well known that soil characteristics, fertilization, climatic condition, stage of growth, sampling metode and processing directly affect the chemical composition of forages (Crowder and Chheda, 1982). The number of rhizobium in the nodules of the legume-trees play an important role in the growth of legume. Whiteman (1974) stated that the growth of root-nodules of legume-trees require Ca, P, S, Co and Mo.

The *in-sacco* degradability of the protein supplement for ruminant is important to be measure as it informs the quantity of undegradable protein supplement in the rumen (Foster et al., 1983). According to Ørskov (1982), the rate of degradability is the quantity of digested feed per unit

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of time, and this can be measured using the in-sacco technique. This technique has some advantages i.e. relatively cheap, easier and fast way to get the feed degradability feature (Ørskov et al., 1980 and Soejono, 1990).

Materials and Methods

The sample of fire legume-tree leaves (leucaena, gliricidia, calliandra, sesbania and erythrina) were taken from the two different place in Malang namely the limestone and non-limestone areas. The altitude of these places range between 300 to 500 meters above the sea- level. The former has Ca-content of 0.93% and pH = 6.80, while the other has Ca-content = 0.50% and pH = 6.15.

All of five legume tree leaves were incubated in the rumen of the three fistulated fat-tail male sheep for periods of 0, 4, 8, 12, 16, 24 and 48 hours. In average, the animals had 28.4 kg live weight, 6.8 rumen-pH and 3.43 mM NH_3 concentration. The 4% urea-amoniated rice straw (CP = 11.7 %, DMI = 633.1 g) and susu PAP (CP = 18.3%, DMI = 268.0 g) were fed to animals. Variables to be measured are the degradability of DM, OM and CP. The percentage of feed degradation during time "t" was calculated using the exponential equation from Ørskov and McDonald (1979) i.e. $p = a + b\ (1-e^{-ct})$, $t \geq 0$ (p = % degradation at the time t_0; b = % degradable insoluble part of the feed; t = incubation period 0 - 48 hours). The modified formula has been used in this experiment expressed by McDonald (1981), that: (a'+ b') = the potential degradability of the feed; a' constant = the feed that loss during washing; b' constant = (a'+b')-a'; c' constant = the degradation rate.

The Nested Randomized-Block Design was the experimental lay-out (Sudjana, 1985). The two locations, five legume tree leaves and three fistulated fat-tail male sheep initially were the block factors. The SYSTAT-Statistical Package Program was used as a tool to analyse the data, and when there was a different between treatments, the Duncan's Multiple Range Test (Steel and Torrie, 1982) was applied.

Result and Discussion

Chemical composition and tannin content

Chemical composition and tannin content of the five forages are presented on Table 1. that shows the DM, OM, CP, Ca-content, P-content and tannin content of the forages grown in the limestone area are higher as compared to that of the non-limestone area. Calliandra of the both places gave the highest DM and tannin content, and the lowest CP content, whereas sesbania gave the lowest DM content and the highest CP content.

Table 1. Chemical composition and tannin content of forages from limestone and non-limestone area.

Location	Species	DM	Chemical composition (% DM)								Tannin*
			OM	CP	CF	NFE	EE	Ash	Ca*	P*	
		%									
Limestone area	Leucaena	28,30	89,96	24,32	17,97	45,86	1,81	10,05	0,075	0,012	0,68
	Gliricidia	19,30	90,94	24,53	15,41	48,90	2,10	9,07	0,090	0,004	0,29
	Calliandra	30,96	92,42	19,85	18,63	51,47	2,48	7,59	0,046	0,028	1,67
	Sesbania	16,76	90,34	29,31	14,96	43,93	2,14	9,66	0,087	0,021	0,35
	Erythrina	17,23	90,72	28,23	22,83	38,43	1,22	9,29	0,076	0,023	0,50
	Mean	22,46	90,88	25,25	17,96	45,72	1,95	9,13	0,748	0,176	0,698
Non-limestone area	Leucaena	24,22	90,22	23,10	17,41	48,22	1,49	9,79	0,043	0,011	0,37
	Gliricidia	19,41	90,39	23,10	17,06	47,37	2,87	9,61	0,057	0,009	0,16
	Calliandra	30,82	92,72	21,58	17,04	51,56	2,54	7,28	0,044	0,005	0,85
	Sesbania	18,25	90,85	26,72	14,59	47,07	2,46	9,15	0,056	0,021	0,27
	Erythrina	18,46	89,81	25,48	23,86	38,83	1,64	10,19	0,044	0,019	0,38
	Mean	22,23	90,80	23,99	17,99	46,61	2,20	9,20	0,488	0,128	0,406

Table 2. Mean values of DM degradation factors from the exponential equation $p = a+b\ (1-e^{-ct})$ of forages from limestone and non-limestone areas.

Location	Species	a' (g/100g)	b' (g/100g)	a' + b' (g/100g)	c' (%/jam)
Limestone	Leucaena	$36,06^{b}\pm1,09$	$27,93^{a}\pm4,37$	$63,98^{a}\pm3,30$	$4,03^{b}\pm1,43$
area	Gliricidia	$47,30^{d}\pm0,41$	$32,50^{a}\pm3,09$	$79,79^{b}\pm2,78$	$3,06^{b}\pm0,12$
	Calliandra	$31,70^{a}\pm0,28$	$34,65^{a}\pm4,15$	$66,35^{a}\pm4,34$	$1,40^{a}\pm0,10$
	Sesbania	$41,41^{c}\pm0,38$	$49,23^{b}\pm1,79$	$90,64^{c}\pm1,68$	$2,72^{ab}\pm0,23$
	Erythrina	$40,77^{c}\pm0,93$	$33,38^{a}\pm6,24$	$74,15^{ab}\pm5,34$	$3,63^{b}\pm1,46$
	Mean	$39,45^{b}\pm5,89$	$35,54^{a}\pm8,06$	$74,98^{a}\pm10,78$	$3,08^{a}\pm1,46$
Non-limestone	Leucaena	$39,06^{b}\pm1,57$	$37,26^{b}\pm5,91$	$76,32^{b}\pm5,16$	$2,09^{a}\pm0,99$
area	Gliricidia	$42,36^{c}\pm2,22$	$42,26^{b}\pm10,31$	$84,62^{b}\pm8,13$	$2,53^{c}\pm0,96$
	Calliandra	$27,87^{a}\pm0,66$	$19,78^{a}\pm4,78$	$47,66^{a}\pm4,48$	$2,47^{a}\pm1,10$
	Sesbania	$43,21^{c}\pm1,20$	$44,50^{b}\pm2,50$	$87,71^{b}\pm1,43$	$4,21^{b}\pm1,88$
	Erythrina	$39,02^{b}\pm0,56$	$43,89^{b}\pm14,57$	$82,91^{b}\pm14,46$	$1,76^{a}\pm0,86$
	Mean	$38,30^{a}\pm6,13$	$37,54^{a}\pm10,33$	$75,84^{a}\pm16,30$	$2,77^{a}\pm0,90$

[a-d] The different superscript in the same column shows the highly significant differences ($P<0.01$), except on the value of c' in non- limestone area that shows the significant ($P<0.05$).

Table 3. Mean values of OM degradation factors from the exponential equation $p = a+b\ (1-e^{-ct})$ of forages from limestone and non-limestone areas.

Location	Species	a' (g/100g)	b' (g/100g)	a' + b' (g/100g)	c' (%/jam)
Limestone	Leucaena	$27,44^{b}\pm1,79$	$32,21^{a}\pm4,79$	$59,65^{a}\pm3,37$	$4,08^{bc}\pm1,70$
area	Gliricidia	$36,88^{c}\pm0,16$	$46,61^{bc}1\pm0,78$	$83,49^{b}1\pm0,92$	$3,56^{abc}\pm1,21$
	Calliandra	$24,80^{a}\pm0,41$	$32,96^{ab}\pm9,70$	$57,76^{a}\pm9,30$	$1,76^{a}\pm0,47$
	Sesbania	$23,69^{a}\pm1,82$	$53,49^{cd}\pm7,82$	$77,19^{b}\pm8,66$	$5,59^{c}\pm1,59$
	Erythrina	$35,02^{c}\pm0,60$	$39,53^{ab}\pm4,38$	$74,55^{b}\pm3,79$	$3,18^{ab}\pm0,81$
	Mean	$29,57^{a}\pm6,02$	$40,96^{a}\pm9,10$	$70,53^{a}\pm11,29$	$3,63^{a}\pm1,39$
Non-limestone	Leucaena	$27,22^{b}\pm1,89$	$43,12^{b}\pm3,34$	$70,34^{b}\pm1,64$	$3,17^{a}\pm0,33$
area	Gliricidia	$34,83^{d}\pm1,66$	$47,14^{b}\pm8,57$	$81,97^{b}\pm7,01$	$2,37^{a}\pm0,52$
	Calliandra	$18,63^{a}\pm0,86$	$23,87^{a}\pm5,62$	$42,49^{a}\pm5,74$	$3,32^{a}\pm1,33$
	Sesbania	$35,21^{d}\pm0,87$	$46,94^{b}\pm2,72$	$82,15^{b}\pm3,38$	$6,21^{b}\pm1,22$
	Erythrina	$31,08^{c}\pm1,09$	$42,75^{b}\pm5,74$	$73,83^{b}\pm6,76$	$2,19^{a}\pm0,24$
	Mean	$29,39^{a}\pm6,83$	$40,76^{a}\pm9,67$	$70,16^{a}\pm16,30$	$3,45^{a}\pm1,62$

[a-d] The different superscript in the same column shows the highly significant differences ($P<0.01$).

Table 4. Mean values of CP degradation factors from the exponential equation $p = a+b\ (1-e^{-ct})$ of forages from limestone and non-limestone areas

Location	Species	a' (g/100g)	b' (g/100g)	a' + b' (g/100g)	c' (%/jam)
Limestone	Leucaena	$44{,}70^{b}\pm0{,}23$	$24{,}95^{ab}\pm2{,}81$	$69{,}65^{b}\pm2{,}46$	$3{,}67^{cd}\pm0{,}39$
area	Gliricidia	$49{,}85^{c}\pm1{,}93$	$31{,}55^{b}\pm6{,}43$	$81{,}40^{cd}\pm4{,}98$	$4{,}47^{d}\pm0{,}26$
	Calliandra	$27{,}46^{a}\pm0{,}71$	$18{,}47^{a}\pm4{,}98$	$45{,}93^{a}\pm5{,}50$	$2{,}09^{a}\pm0{,}65$
	Sesbania	$49{,}35^{c}\pm0{,}85$	$39{,}35^{c}\pm4{,}89$	$88{,}70^{d}\pm4{,}51$	$4{,}77^{d}\pm0{,}95$
	Erythrina	$48{,}78^{c}\pm0{,}64$	$31{,}35^{b}\pm6{,}44$	$80{,}12^{cd}\pm6{,}66$	$3{,}29^{bc}\pm1{,}93$
	Mean	$44{,}03^{b}\pm9{,}48$	$29{,}13^{a}\pm7{,}85$	$73{,}16^{a}\pm16{,}67$	$3{,}66^{a}\pm1{,}06$
Non-limestone	Leucaena	$36{,}46^{b}\pm2{,}47$	$43{,}14^{b}\pm4{,}41$	$79{,}60^{b}\pm4{,}32$	$2{,}35^{a}\pm0{,}44$
area	Gliricidia	$44{,}69^{c}\pm1{,}34$	$43{,}91^{b}\pm1{,}43$	$88{,}60^{b}\pm2{,}53$	$2{,}77^{a}\pm0{,}49$
	Calliandra	$28{,}29^{a}\pm1{,}25$	$13{,}01^{a}\pm2{,}92$	$41{,}30^{a}\pm4{,}16$	$2{,}96^{a}\pm0{,}86$
	Sesbania	$49{,}01^{d}\pm1{,}15$	$38{,}60^{b}\pm6{,}81$	$87{,}61^{b}\pm7{,}92$	$5{,}04^{b}\pm1{,}41$
	Erythrina	$42{,}91^{c}\pm0{,}59$	$37{,}08^{b}\pm1{,}76$	$80{,}00^{b}\pm1{,}90$	$2{,}59^{a}\pm0{,}36$
	Mean	$40{,}27^{a}\pm8{,}08$	$35{,}15^{b}\pm12{,}71$	$75{,}42^{a}\pm19{,}53$	$3{,}14^{a}\pm1{,}08$

[a-d] The different superscript in the same column shows the highly significant differences (P<0.01), except on the value of c' that shows the significant (P<0.05).

Statistical analysis showed that the value of a', b', (a'+b') and c' in DM, OM and CP of the limestone area did not differ from that of the non-limestone area, except for a' value in DM and CP and b' value in CP which show a highly significant differences (P<0.01).

The mean value of a' in DM and CP of limestone area was higher as compared to the non-limestone area. It means that the solubility of DM, OM and CP of the forages taken from the limestone area were higher than the non-limestone area. It was supposed that the quality of the forages taken from the limestone area was better as compared to the other, especially with regard to their DM, OM and CP content. In addition to that, the content of the Non Protein Nitrogen (NPN) of the forage from the limestone area were higher than the other, whereas their CF content were lower. So that the cell-wall structure was relatively spacius, and consequently their solubility were higher. The other reason was that the Ca-content in the limestone area was higher as compared to the non-limestone area. As the result, the nitrogen fixation process and the root- nodulation was relatively better. Finally the CP-content and solubility of the forage were higher. The respons of the species of legume in accordance with the two locations gave a highly significant difference (P<0.01) on the value of a', b', (a'+b') and c' in DM, OM and CP, except the c' value in DM of non-limestone area and the c' value in CP of both location which gave a significant difference (P<0.05). It could be explained that the difference genetic potential of the forage (Crowder and Chheda, 1982), the content of condensate lignin (McClear, 1974 and Barry, 1988), the association of lignin and silicate (Goering and Van Soest, 1970), and the content of cellulose, hemicellulose and lignin of the different respons between forage-species.

Calliandra had the lower value of degradability factors on DM, OM, and CP (Table 2) as compared to the other. It was suspected that the content of tannin, lignin, and silica were much higher (forage tannin content of the limestone area = 1.67% while the other was 0.85%). The work Soebarinoto (1986) show that the tannin, lignin and silica content of calliandra leaves was the highest as compared to the other (tannin = 1.58%, lignin = 12.40% and silica = 3.50%). Ahn et al. (1989) reported that the condensate-tannin in calliandra was high (=11.07%). The condensate-tannin binds carbohydrate and protein as the complex-compounds which very stable and in soluble component. Consequently, its solubility and its DM, OM and CP degradability were low (McLeod, 1974; Jones and Manan, 1977 cited by Barry, 1988). Both lignin and silica which present and the cell-wall of the forage formated the complex-compound with cellulose and hemi-cellulose that inhibit the digestion processes in the rumen (Goering and Van Soest, 1970; Cullison, 1978 and Rhoades, 1979). In general, it can be said that the DM, OM and CP degradability of calliandra was the lowest, whereas sesbania was the highest.

Implication

It was concluded that there was no slight difference of DM, OM and CP degradability between legume-forages as protein supplement for ruminant neither from limestone nor non-limestone area.

It was concluded that the rank of degradability of various legumes beginning from the best to the worst was sesbania, gliricidia, erythrina and calliandra. It was predicted that a high content of tannin in leucaena and calliandra directly related to the relatively low degradability. Sesbania, gliricidia or erythrina was recommended to be used as protein supplement for ruminants.

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