EVALUATION OF LEGUME HERBS NUTRITIVE VALUE AS A RUMINANT FEED AND NITROGEN SUPPLY ON SOIL IN WEST TIMOR, INDONESIA

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ABSTRACT:- The four species of legumes used as ruminant feed were *Clitoria ternatea* (CT), *Centrosema pascuorum* (CP), *Dolichos lablab* (DL), and *Macroptilium bracteatum* (MB). The study was conducted in Randomized Complete Block Design. The research showed that the highest NO_3 concentration after planting was in CP (5.72 mg^{-1}), followed by CT (4.21mg^{-1}), MB (3.44 mg^{-1}), and DL (2.83 mg^{-1}). The species of legume was obviously highly significant (P<0.01) to biomass production 90 days after planting. Moreover, dry matter (DM) and organic matter (OM) in vitro digestibility were statistically different among the species of legume (P<0.01). In DL the DM and OM were highest i.e., 74.84 % and 74.37%. Meanwhile, the biomass digestibility of DM and OM was affected by the treatments (P<0.01), being highest in CT (2511.4 g DMm^{-2} and 2172.1 g OMm^{-2}) followed by DL (2351.8 g DMm^{-2} and 2044.9 g OMm^{-2}). Based on this study, CT and DL have potential to develop high biomass production, high digestibility, and adequately contribute NO_3 to the soil.

Key Words: Ruminant; Feed; Nutritive Value Evaluation; Legume; Nitrogen Supply; Soil; Indonesia.

INTRODUCTION

West Timor is directly bordered with the State of Timor Leste and Australia. The population of beef cattle in this province is 720,000 heads. The area of West Timor land is 2,962,571 ha. In addition, its 60% area is dominated by savana which is a natural pasture and its stocking rate is 4-5 cattle km^{-2}. West Timor has the widest pasture and one of the beef cattle centers in Indonesia (Anonymous, 2010). According to Bamualim (1994), the forage production of savana in the rainy season is 1.7t $DMha^{-1}$ $year^{-1}$; it is three times higher than that in dry season (0.54t $DMha^{-1}$ $year^{-1}$). The carrying capacity of beef cattle is 1.4–2.8 $AUha^{-1}$ $year^{-1}$ (Nulik and Bamualim, 1998). This condition is parallel to worldwide grazing island, which is 0.2–7 $AUha^{-1}$ (McIlroy, 1977).

The type of farming system in West Timor is dry land system since dry season dominates there. Oldeman et al. (1980) classified it as climate type D4 as it has 3-4 wet and 7-9 dry months, with a low rainfall rate (<1000 mm); the type of the soil is vertisol; the soil pH is 7; and the average temperature is 27-28 °C. Therefore, the industry of livestock is more dominant than agriculture.

The improvement of natural pasture can be conducted by introducing legume. It is because of some advantages, such as returning the

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soil fertility (natural supply of nitrogen), providing feed during a year, providing water to keep the humidity, and having a high protein content, compared to grass.The common issue of livestock development, particularly on the dry land in West Timor is the lack of forage and water during long dry season, while in the rainy season, a serious erosion occurs as the consequence of the heavy rain, planting legume may provide some advantages to solve the problems.

In dry season, both feed production and quality decreased. The depletion in soil fertility was caused by applying nomade farming system. For land sustainability, introducing legume can solve the problem, either as feed source or soil conservation.

Ley farming system was done as one of efforts to maintain soil fertility. The rotation of corn and legume has good opportunity for it. It was because of the contribution in providing nitrogen for soil. By this system, the farmers were encouraged to apply permanent and sustainable farming system. However the information regarding the legume nutritive value and the effect to the soil is limited. Therefore, present research was to determine legume species that have potential as ruminant feed and high contribution to nitrogen supply of soil.

MATERIALS AND METHOD

The research was conducted, from April to December 2011, in Field Laboratory of Assessment Institute of Agriculture Technology (AIAT) Kupang District West Timor, Indonesia.

Soil Sampling

It was done twice, before planting and after harvesting the legume. The soil sample were taken from the land where legume would be planted upto 150 cm depth. The sampling was done using Soil Coring, which was divided into six layers: viz., 0-15; 15-30; 30-60; 60-90; 90-120 and 120-150 cm. Each layer was analyzed in the laboratory to measure the nitrate (NO_3) concentration, pH, carbon organic matter (C-organic) and phosphate (P_2O_5), so there were 30 soil samples from the five drops. pH was measured by pH meter. C-organic was analyzed according to Kurmise method, and P_2O_5 according to Olsen method (Rowell, 1996).

Planting Legume Herbs

The four species of legume namely *Clitoria ternatea* (CT), *Centrosema pascuorum* (CP), *Dolichos lablab* (DL), and *Macroptilium bracteatum* (MB) were planted as monoculture in the experimental field of AIAT, Kupang, West Timor. Before planting, fertilizer containing phosphate (triple superphosphate) @ 50 kg $ha^{-1}$was added. Watering was regularly done thrice a week by sprinkler.

The study was conducted in Randomized Complete Block Design (RCBD) of 4 treatments and 4 blocks according to the level of soil fertility. The treatments were done according to species of legume (CT, CP, DL, and MB). The area of each experimental unit was 5mx5m.

Nutritive Value of Legumes

The biomass production was

measured 90 days after planting (DAP) by making three quadrates of $1m^2$ for each block. The feed was analyzed by proximate analysis according to AOAC (2011). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin was determined according to Goering and Van Soest (1970). In vitro digestibility of dry matter (DM) and organic matter (OM) was determined according to Tilley and Terry (1963), modified by Van der Meer (1980). The data obtained were analyzed by GenStat (2010).

RESULTS AND DISCUSSION

Soil Nutrients

The result of soil analysis before and after harvesting legume revealed that the soil pH of the location of this study was neutral (Table 1). Foth (1995) stated that pH, 5.5-7.5 is ideal for corn, sorghum, and beans. The pH is one of the important assessment criteria of soil fertility, as it is related to nutritent availability of soil, soil formation process and soil characteristics as well as plants' growth. Therefore, each species of plants has ideal pH for growth and development. Generally, in neutral soils, micro and macro nutritents are adequately available.

Legume contributed to the increase of NO_3 in the soil as the result of fixation process by its roots, which can be used as natural fertilizer in the next planting season. It is evident that NO_3 increased after legumes planting (Table 2).

There were no statistical difference to NO_3 concentration among the treatment (P>0.05). Highest concentration of NO_3 was given by CP (5.72 mg^{-1}). It was followed by CT (4.21 mg^{-1}); MB (3.44 mg^{-1}) and DL (2.83 mg^{-1}). It was because ability of root nodules to tie up more N from the air through rhizobium bacteria as media. CP has more rhizobium and more nitrogen activity so it can produce more nodules compared to the others. Sanginga et al. (1996) reported that CP nodulated in all soils and produced the highest number of nodules and the highest N_2 fixers averaging 250 mg $Npot^{-1}$. In addition, Gardner et al. (1991) declared that amount of N_2 which was fixed depend on the species of legumes, cultivar of legume, strain of bacteria, and soil condition

Table 1. Soil nutrient of experimental plot before and after harvesting legume

Soil depth (cm)	pH	C-organic (%)	P_2O_5 (ppm)	NO_3 before planting (mgl^{-1})	NO_3 after planting ($mg1^{-1}$)
0 - 15	6.9	0.10	43.10	1.50	5.97
15 - 30	7.2	0.10	24.10	3.39	4.07
30 - 60	7.5	0.07	32.80	3.95	4.51
60 - 90	7.5	0.07	6.90	Low	3.82
90 -120	7.2	0.03	5.50	Low	3.51
120 -150	7.3	0.03	17.20	Low	2.55

Table 2. Average concentration of NO_3 of the soil planted with different legume herbs

(mgl^{-1})

Soil depth (cm)	Legume herb			
	Clitoria ternatea	*Centrosema pascuorum*	*Dolichos lablab*	*Macrop tilium bracteatum*
0 - 15	7.67 ± 2.06	7.10 ± 4.17	7.00 ± 1.25	4.80 ± 1.30
15 - 30	1.06 ± 1.84	5.80 ± 3.69	1.60 ± 2.77	3.20 ± 0.47
30 - 60	5.35 ± 3.23	6.70 ± 4.21	2.20 ± 2.23	2.50 ± 1.49
60 - 90	5.27 ± 3.65	5.40 ± 3.50	2.60 ± 2.56	3.10 ± 2.03
90 -120	5.21 ± 3.35	5.60 ± 3.39	1.80 ± 1.93	5.60 ± 4.18
120 -150	0.71 ± 1.22	3.70 ± 3.77	1.70 ± 1.70	1.40 ± 2.48
Average	4.21 ± 0.98	5.72 ± 0.34	2.82 ± 0.56	3.44 ± 1.27

particularly pH and N soil. Ratnawaty (2008) reported that after planting of CT, *Desmanthus pernambucanus* and CP legume, the level of $N0_3$ in soil were 95.2 kgha^{-1}, 42.05 kgha^{-1} and 21.14 kgha^{-1}, respectively.

Biomass Production

The different legume herbs species contributed significantly ($P<0.01$) to the biomass production of legume (Table 3). CT gave the highest biomass (0.66 kg DMm^{-2}) while MB gave the lowest (0.28 kg DMm^{-2}). The species of legume affected biomass production ($P<0.01$) on 90 DAP. It is due to growth of CT which is faster than the other legumes, as well as its bigger size. Budisantoso et al. (2006) reported that the biomass production which was planted in Timor Island such as CP legume was 3.3 DMha^{-1} while in CT it was 1.8 DMha^{-1}. The high biomass production after 45 days growth was given by CP followed by CT, *Desmanthus pernambucanus*, *Macroptilium bracteatum* and *Aeschynomene americana*.

Table 3. Average biomass production of legume herbs on 90 DAP

Legume herbs species	Biomass production (kg DMm^{-2})	Seed kg^{-1} (000)
Clitoria ternatea	0.66^{b} ± 0.19	23
Centrosema pascuorum	0.42^{a} ± 0.23	72
Dolichos lablab	0.46^{ab} ± 0.29	36-43
Macroptilium bracteatum	0.28^{a} ± 0.21	75

Means followed by same letters do not differ significantly (P<0.01)

Ratnawaty et al. (2009) reported that the biomass production of legume planted monoculturally in Tobu Village, Timor Island was 1.1-2.2 DMha^{-1} because of regularly fertilizing and watering thus getting higher biomass production. The biomass can be used as feed particularly in the dry season. It is not only given in fresh form, but also could be kept as hay or silage which depends on the farmers needs in providing feed for their livestock.

Nutritive Value

The analysis of nutritive value of planted legume herbs showed that crude protein content in legumes, ranged from 18.38% to -18.89%, and

Table 4. Nutritive value of the four species of legume herbs

Nutrient	Legume Herb			
	Clitoria ternatea	*Centrosema pascuorum*	*Dolichos lablab*	*Macroptilium bracteatum*
Dry matter (DM)	90.29	90.91	92.40	91.61
Organic matter (OM)	92.44	90.14	87.36	89.51
Ash	7.56	9.86	12.64	10.49
Crude protein (CP)	18.38	18.52	18.39	18.89
Crude fiber	32.99	35.23	27.65	35.82
Crude fat	1.75	1.67	1.94	2.08
Nuetral detergent fibre	51.42	56.36	47.65	52.27
Acid detergent fibre	37.33	36.45	31.23	35.49
Hemicellulose	14.09	19.91	16.42	16.78
Cellulose	25.03	24.83	20.09	23.69
Silica	0.56	0.48	0.67	0.60
Lignin	11.74	11.14	10.47	11.21

lignin content from 10.47% to 11.74% (Table 4). Therefore, the legume is used as a supplement low-quality grass, to contribute to the synthesis of microbial rumen. It was because of the adequate nitrogen. The growth and activity of cellulolytic microbes were same as the other rumen microbes; they need energy, nitrogen, mineral, and the other factors (e.g. vitamin).

Neutral detergent fiber (NDF) which is higher in CP, MB and CT indicate that in DL digestive material (cell content) is higher. NDF is food compound the biggest part of plant's wall. This compound consists cellulose, hemi-cellulose, lignin, silica and several fibroses protein (Van Soest, 1994), thus is utilized by rumen microbes to produce energy for its life needs. Ginting and Tarigan (2005) reported that *Centrosema pubescens* has advantage compared to *Arachis pintoi* based on its chemical composition (crude protein, NDF and ADF). Other study which also report similar result was done by Khamseekhiew et al. (2001), Nasrullah et al. (2002), and Evitayani et al. (2004). Chibinga et al. (2011) reported NDF range of different re-growth stages of *Julbernardia globiflora* from 32.83% to 59.83%, and compared well with those reported by Romero et al. (2000), Bhalahenda (2001), Kuria et al. (2005) and Kamalak (2005).

The digestibility of forage influenced by CP content and OM digestibility could be estimated by NDF and ADF values. The high NDF value which was followed by the high ADF value contributed to cell contents. The increase in NDF and ADF are major determinants of forage quality (Table 4).

In-vitro Digestibility and Biomass Digestibility

Digestibility is one of the indicator of nutritive value of feed for ruminant. The DM and OM digestibility were statistically different (P<0.01) among treatments. DL has the highest DM and OM digestibility, because of the lowest ADF and lignin content (Table 5).

Table 5. In vitro digestibility and the biomass digestibility of dry and organic matter

Legume species	Digestibility (%)		Biomass digestibility production (g^{-2})	
	DM	OM	DM	OM
Clitoria ternatea	65.95^{a} ± 1.58	66.28^{a} ± 1.01	2511.4^{b} ± 308.4	2172.1^{b} ± 215.5
Centrosema pascuoru m	68.68^{b} ± 0.59	66.72^{a} ± 0.68	742.9^{a} ± 388.9	664.0^{a} ± 346.1
Dolichos lablab	74.83^{c} ± 0.70	74.38^{b} ± 0.87	2351.8^{b} ± 299.7	2044.9^{b} ± 271.9
Macroplitlium bracteatum	67.85^{ab} ± 0.59	64.80^{a} ± 0.82	1263.4^{a} ± 234.2	1084.2^{a} ± 199.8

Means followed by same letters do not differ significantly (P<0.01)

Compared to NDF, ADF content had higher correlation to feed digestibility (Van Soest, 1994; Jung and Allen, 1995). Furthermore, lignin content in each species of legumes was relatively high and it might be a limitation on digestibility (Hart and Wanapat, 1992; Van Soest, 1994). Meanwhile, DM digestibility of ruminant feed depended on rumen microbes activity, which is effected by feed quality, feed chemical composition, DM intake, feed supplementation, and chemical treatment before feed is given to the cattle (Dore and Gouet, 1991; Van Soest, 1994). Besides, feed digestibility is also influenced by age and animal factors; young cattle have lower digestibility than adult cattle. The different animal species, age, and sex will effect the digestibility, although the feeds given are the same (Van Soest, 1994).

Ginting and Tarigan (2005) reported DM, OM and CP digestibility of *Centrosema pubescen* as 73.3%; 74.2% and 89.9%. Rubianty et al. (2010) found DM digestibility of *Clitoria ternatea* and *Centrosema pascuorum* cv *cavalcade* in hay form as 50.15% and 53.52% and OM digestibility was 53.47% and 55:67%. Zhou et al. (2011) reported DM digestibility of *Flemingia macrophylla* and *Casia bicapsularis* from 58.18% to 71.81% while OM digestibility ranged between 40.70% and 72.70%. Mlay et al. (2006) reporting herb legume; *Macroptilium atropurpureun* cv *siratrio* organic matter as 65.8%, conform the result in this study.

In the current study, there were significant differences (P<0.01) among the treatment regarding biomass digestibility, which is the product of biomass production and digestibility. The average of DM and OM biomass digestibility of CT and DL were the highest. Both have higher biomass production compared to the others.

It can be concluded that planting of legumes increased NO_3 concentration to the soil. *Clitoria ternatea* and *Centrosema pascuorum* exhibited the best performance regarding biomass production, DM and OM digestibility, as well as biomass digestibility.

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