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Production and Nutritive Value of *Indigofera zollingeriana* and *Leucaena leucocephala* in Peatland

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Abstract. This study was aimed to determine and compare the dry matter yield and nutrient content of Indigofera and Leucaena grown in peatland. This experiment was conducted in peatland type soil (type *sapric*) in Pekanbaru city, DM yield and nutrient contents data were analyzed by 2x3 factorial design with 3 replication. Two treatments compared were *Indigofera zollingeriana* (Indigofera) and *Leucaena leucocephala* (Leucaena). Indigofera was proven significantly higher than Leucaena in all harvest regarding dry matter (DM) of leaf and stem of 29.9% and 25%, respectively, crude protein (CP) of 23.1% and 17.6%, respectively. While neutral detergent fibre (NDF) and acid detergent fibre (ADF) content of Indigofera leaf (35.9% and 25.1%, respectively) was significantly lower than those of Leucaena leaf (40.9% and 29.3%, respectively). It was concluded that the production and nutritive value of *Indigofera zollingeriana* was superior to *Leucaena leucocephala* in peatland (type sapric).

Key words: Legume tree, Sapric, nutrient content, In vitro digestibiliy

Abstrak. Penelitian ini bertujuan menentukan dan membandingkan bahan kering dan kandungan nutrisi Indigofera dan Leucaena yang tumbuh di lahan gambut. Percobaan ini dilakukan di lahan gambut di Pekanbaru menggunakan pola faktorial 2x3 dengan ulangan 3 kali. Dua perlakuan yang dibandingkan adalah *Indigofera zollingeriana* (Indigofera) dan *Leucaena leucocephala* (Leucaena). Indigofera terbukti secara nyata lebih tinggi daripada Leucana di semua periode panen, berkaitan dengan kandungan BK (bahan kering) daun dan batang berturut-turut 29,9% dan 25%, dan protein kasar (PK) 23,1% dan 17,6%. sedangkan neutral detergent fibre (NDF) dan acid detergent fibre (ADF) daun indigofera berturut-turut 35,9% dan 25,1%, lebih rendah secara nyata daripada daun Leucaena, yaitu 40,9% dan 29,3%. Disimpulkan bahwa produksi dan nilai nutrisi *Indigofera zollingeriana* lebih tinggi dari *Leucaena leucocephala* di lahan gambut (jenis saprik)

Kata kunci: Pohon legume, Saprik, Kandungan Nutrisi, Kecernaan in vitro

Introduction

Farmers in the tropics face inadequate supply of quality feed for their ruminant stocks under intensive farming, particularly during the long dry season (Noula et al., 2004). As a result, the use of alternative feed sources has become an increasingly important approach of feeding ruminants to ensure the animals are able to maintain good body condition through the periods of uncertain supply of quality feed. Legume trees and shrubs represent an enormous potential source of protein for ruminants in the tropics (Mbomi et al., 2012). *Indigofera zollingeriana* and *Leucaena leucocephala* are two fast-growing nitrogen-fixing trees particularly promising as browse. *Indigofera zollingeriana* (Indigofera) contains high crude protein (CP) and energy potentially as rumanant feed (Simanuhuruk and Sirait, 2009). Indigofera herb contained 27.60% of CP, produced leaf of 4,096 kg DM /ha/harvest at 68 days of maturity, and its in vitro dry matter digestibility was 67-81% (Abdullah and Suharlina, 2010). Indigofera tolerated to drought, light floods and moderate salinity (Hassen et al., 2008).

Leucaena leucocephala, commonly known as leucaena, is a considerably potential multipurpose trees and widely used as a valuable fodder shrub to increase animal production in the tropics (Aganga and Tshwenyane, 2003). Leucaena has a suitable potential as supplements for sustainable ruminant nutrition strategies during rainy and dry seasons (Gonzalez-Garcia et al., 2009). The dry matter (DM) yield of Leucaena was 7.75 ton/ha for 14 month after planting (Odedire and Babayemi, 2007) and contained 24.6% CP, 45.8% NDF and 24.5% ADF (Foroughbakhch et al., 2012).

Productivity and nutritive value of forage are associated with soil type (Vendramini et al., 2007). In general, peat is a type of soil with low fertility because of the low chemical fertility and relatively high level of acidity. This limitatiaon causes not all type of forages can adapt well in peatland. Leucaena and indigofera are leguminous and nitrogen-fixing occurs naturally as trees and shrubs, thus expected to grow well in soil with low chemical fertility. This study was carried out to determine and compare the dry matter yield and nutrient content of Indigofera and Leucaena grown in peatland.

Materials and Method

Sites and experimental design. This study was conducted at research farm of Faculty Agriculture and Animal Science of UIN Suska Riau, Pekanbaru and Laboratory Research Center of Biological Resources and Biotechnology, PAU, Bogor Agricultural University, Indonesia from October 2011 to November 2012. Pekanbaru city is located between 101°4´- 101°34´ East longitude and 0°25´- 0°45´ North latitude, with the altitude ranges from 5-50 meters and tropical climate. During the study, maximium and minimum temperature was 31.2-33.7^{o}C and 22.3-23.6^{o}C, respectively, while maximum and minimum humidity was 94.3-97.5 and 56.2-68.9%, respectively. Monthly average rainfall was 227.1 mm with total rainfall per year of 2660 mm, and the study was conducted during rainy season. The experiment was set up in randomized complete block design with two treatments and three blocks. Two treatments compared were *Indigofera zollingeriana* (Indigofera) and *Leucaena leucocephala* (Leucaena).

Plot, planting density and fertilizing. The experiment was conducted in peatland type soil (type *sapric*). The soil chemical properties were 5.54 pH, 0.14% N, 7.20% C, 51.43 C/N, 2.48 me/100 g K and 0.030% available P (Bray). The size of experimental land was 11x63 m divided to three blocks, each sub-divided into 2 plots (each plot was 1.5x63 m) namely Indigofera and Leucaena plots. The forages were cultivated in September 2011. The plot had a planting density of 43 plants/plot (planting space was 1.5x1.5 m) and was maintained under rain-fed condition. The basal fertilizer was organic fertilizer (cattle manure) applied at the rate 10 t/ha and was applied two weeks before planting, and inorganic fertilizers (NPK) at the rate of 50 kg/ha/yr of was applied two weeks after planting (surrounding the plant).

Propagating, pruning, harvesting and sample procedure. Indigofera and Leucaena was propagated by seed. Pruning was done after 2 months of grown in experimental plot. The forages were trimmed approximately 100 cm above the ground using garden shears. This would allow a new and uniform re-growth from where the experimental samples were later harvested. The forages were harvested three times a year with 120 days cutting interval according to DM production potential. Harvest 1, 2 and 3 were carried out on February 29, June 28, and October 26, 2012, respectively. The plants were cut approximately 100 cm from the ground from each plot and directly weighed to determine the fresh yield.

Chemical analysis. Fresh herbage samples of legumes from each plot (about 500 g) were dried in air-forced oven at 60°C for 48 h, and ground to pass through a 1 mm sieve for chemical analysis. The dry matter (DM) and crude protein (CP) were determined according to the AOAC (2005) procedure. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were estimated according to the method of Van Soest et al. (1991).

Statistical analysis. DM yield and nutrient contents data were analyzed by a 2x3 factorial design with 3 replication. DM yield, CP, NDF and ADF content of legumes (Indigofera and Leucaena) were affected by the harvest time (harvest 1, 2 and 3). Significant differences were tested using Duncan's Multiple Range Test (DMRT) at 5% level of significance differens.

Result and Discussion

Plant Height. Plant height of legumes from harvest 1 to harvest 3 is presented in Figure 1, indicating that Indigofera was significantly (P<0.05) higher or grew faster than Leucaena in all harvests, namely 236.4 cm compared to 161.6 cm in harvest 3. It was probably because Indigofera could survive better against defoliation. Stür et al. (1998) reported that forage tree legumes differ in their ability to withstand repeated defoliation. The ability of a plant to re-growth after defoliation will affect the growth and production of plant.

Plant height of Indigofera and Leucaena in the present study was higher than 127 cm and 102 cm reported by Man et al. (1995) for 5-month maturity. Differences in plant height was caused by difference of environmental, soil vertility and the developmental stage of the plant.

Dry matter yield. Dry matter (DM) yield of Indigofera and Leucaena herbage is shown in Table 1. Production of Indigofera (leaf and stem) was significantly (P<0.05) higher than Leucaena, indicating Indigofera's stronger capability to grow in peatland. Indigofera is a type of legume tree with excellent adaptation to a range of environments (Hassen et al., 2008). Abdullah and Suharlina (2010) reported that Indigofera has high herbage productivity. This high yield may be supported by availability of bud meristem after defoliation (Stür et al., 1998) and it can be attributed to its high rate of leaf (Edward et al., 2012), its plant height (Figure 1) and leaf to stem ratio (Table 1).

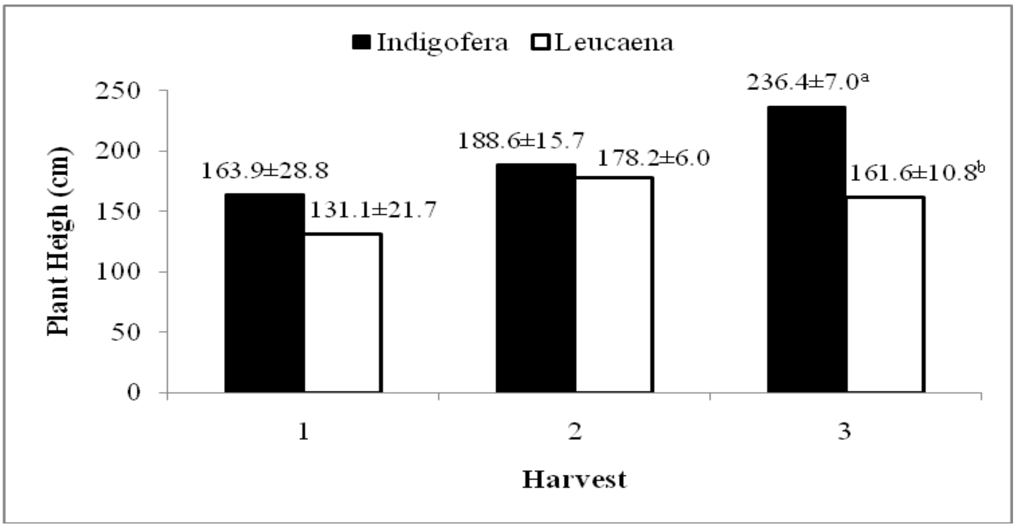

Figure 1. Plant height (cm) of Indigofera and Leucaena on harvest 1, and 3 in peatland. Mean with different superscript at same harvest differ significanftly (P<0.05)

Significant ($P<0.05$) two-way interaction between legume type and harvest time for DM yield of leaf (Figure 2) was observed, where DM yield of Indigofera leaf was higher than Leucaena at all harvest, and harvesting time influenced DM yield of Indigofera leaf. Figure 2 shows that DM yield of Indigofera leaf significantly ($P<0.05$) increased on harvest 2 due to increment of the leaves number marked by leafy plants. However, DM yield significantly ($P<0.05$) decreased on harvest 3 due to reduced leaf stem ratio (Table 2). Reduction in leaf to stem ratio was strongly influenced by the increase in part stems of plants.

DM yield of Indigofera leaf found in this study was comparable with Abdullah (2010) reporting 6.0 to 7.9 t/ha DM on the second harvest. The DM yield of Leucaena leaf found in the present study was comparable with Cook et al. (2005) reporting general 2-6 t/ha/yr in extensive hedgerow plantings in the dry tropics and subtropics.

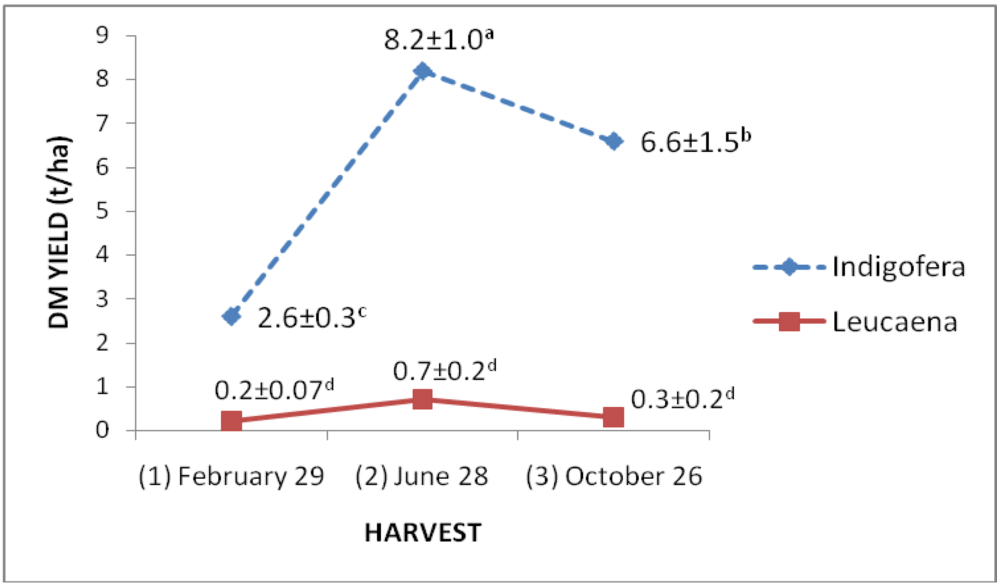

Figure 2. Dry matter yield of Indigofera and Leucaena leaf at harvest 1 (February 29, 2012), 2 (June 28, 2012) and 3 (October 26, 2012 in peatland. Values bearing different superscript show significant different ($P<0.05$)

Table 1. DM yield and leaf to stem ratio of Indigofera and Leucaena herbage in peatland

Legumes	DM Yield				Ratio Leaf/stem
	g/plant/yr		t/ha/yr		
	Leaf	Stem	Leaf	Stem	
Indigofera	3.815 ± 96^{a}	4.080 ± 916^{a}	17.4 ± 0.4^{a}	18.6 ± 4.2^{a}	0.9
Leucaena	256 ± 89^{b}	438 ± 186^{b}	1.2 ± 0.4^{b}	2.0 ± 0.8^{b}	0.6

Values bearing different superscript within column differ significantly ($P<0.05$)

Tabel 2. Leaf to stem ratio of Indigofera and Leucaena at harvest 1, 2 and 3 in peatland

Legumes	Leaf/Stem Ratio		
	Harvest 1	Harvest 2	Harvest 3
Indigofera	1.4	1	0.8
Leucaena	1.2	0.6	0.5

Chemical Composition

Dry Matter (DM). The effect of legume type and harvest time on DM, CP, NDF and ADF content of legumes leaf is presented in Table 3**.** There is considerable variation in the moisture content of forages. The present study found that the DM content of Indigofera leaf (29.9%) was significantly (P<0.05) higher than that of Leucaena (25%). This result indicated that the legume type affected DM content of leaf. Variation in DM content may be caused by the differences in either nutrient content of legumes leaf (Table 3) or structural component of the plant.

Crude Protein (CP). Protein is an important nutrient for ruminant. It supports rumen microbes that consequently degrade forage (Newman et al., 2009). This study found that the CP content of Indigofera leaf (23.1%) was significantly (P<0.05) higher than that of Leucaena leaf (17.6%) (Table 3). This result was in line with Hassen et al., (2008) and Abdullah et al., (2012) who reported that Indigofera has a high protein content. Similarly, Tjelele (2006) and Abdullah and Suharlina (2010) reported Indigofera CP of 24.61-26.1% and 20.47-27.60%, respectively. The CP content of Leucaena leaf in the present study was lower than 25-26.02% by Abdulrazak et al. (2006) and Nasrullah et al. (2003). It implied that CP content of legume was influenced by type of legume, environment, land condition and soil fertility (Jayanegara and Sofyan, 2008; Newman et al., 2009). Significant (P<0.05) two-way interaction between legume type and harvest time on CP of leaf is presented in Figure 3 with the fluctuations in the CP content of Leucaena throughout the year. The CP content of Leuacaena leaf decreased on the second harvest and increased on the third harvest. This study noted that harvest time did not influence CP content of indigofera leaf, therefore suggested that CP content of Indigofera was not affected by stage of defoliation so relatively constant throughout the year.

Neutral Detergent Fibre (NDF). NDF content is an estimation of the percentage of cell wall material or plan structure material. Forage NDF is a major factor affecting feed intake (Kendall et al., 2008). NDF content result in this study found was 35.9%, significantly lower than that of Leucaena leaf (40.9%), accordingly Leucaena had a higher fibre fraction compared to Indigofera. Newman et al. (2009) reported that the NDF values represent the total fiber fraction (cellulose, hemicellulose, and lignin) that make up cell walls (structural carbohydrates or sugars) within the forage tissue. Generally, the lower the NDF value the better. It is inversely related to intake (Arelovich et al., 2008). The lower NDF content would encourage a greater intake of the forage. The NDF content of Indigofera leaf found in this study was relatively lower than 38.30-51.05% by Abdullah (2010) of Indigofera grown Bogor. NDF content of Leucaena leaf in the present study was higher compared to NDF content of Leucaena grown in South Sulawesi reported by Nasrullah et al. (2003). There was significant (P<0.05) two-way interaction between legume type and harvest time on NDF content of leaf (Figure 4).

Figure 4 shows that NDF content of Indigofera and Leucaena decreased at second harvest and increased at third harvest. The fluctuations in the NDF content throughout the year may be affected by weather fluctuation. Newman et al. (2009) reported that weather condition is one of primary factors affecting quality of forage. The variation in NDF content between Indigofera and Leucaena may be affected by genetic.

Acid Detergent Fibre (ADF). The ADF values represent cellulose, lignin, and silica (if present) (Newman et al., 2009). ADF is an index of the percentage of highly indigestible plant material in a forage. This study found that the ADF content of Indigofera leaf (25.1%) was significantly lower than those of Leucaena leaf (29.3%), indicating that the digestibility of Indigofera was higher than that of Leucaena. Low ADF concentration is associated with increased digestibility (Eskandari et al., 2009; Albayrak et al., 2011). Low NDF content of Indigofera leaf may be because genetically Indigofera can absorb nutrient better than Leucaena especially nitrogen that leads to develop more cell content (sugar, starches, fat, protein, NPN and pectin) that allows the plant to be more succulent and have less cell wall components (Abdullah, 2010). The ADF content of Indigofera leaf found in this study was relatively lower than 26.23-37.82% by Abdullah and Suharlina (2010) of Indigofera grown in Bogor. ADF content of Leucaena leaf in the present study was higher than 31.67% reported by Nasrullah et al. (2003) of leucaena grown in South Sulawesi was. It showed that region, soil type environmental condition and climate influenced cell wall (NDF and ADF) of legume. There was no significant (P>0.05) two-way interaction between legume type and harvest time on NDF content of leaf (Figure 5). Figure 5 shows no difference in ADF content of Indigofera and Leucaena leaf at all harvest. The ADF content of both legumes significantly (P<0.05) decreased at second harvest and significantly increased (P<0.05) at third harvest. This trend was comparable to NDF content with fluctuation probably influenced by weather condition which affected avaibility of soil mineral and water for plant (Kreuzwieser and Gessler, 2010).

Table 3. Chemical composition of Indigofera and Leucaena leaf at harvest 1, 2 and 3 in peatland

Chemical Composition (%)	Treatments	
	Indigofera	Leucaena
DM	29.9[a]	25.4[b]
CP	23.1[a]	17.6[b]
NDF	35.9[b]	40.9[a]
ADF	25.1[b]	29.3[a]

Values bearing different superscript within row differ significantly (P<0.05)

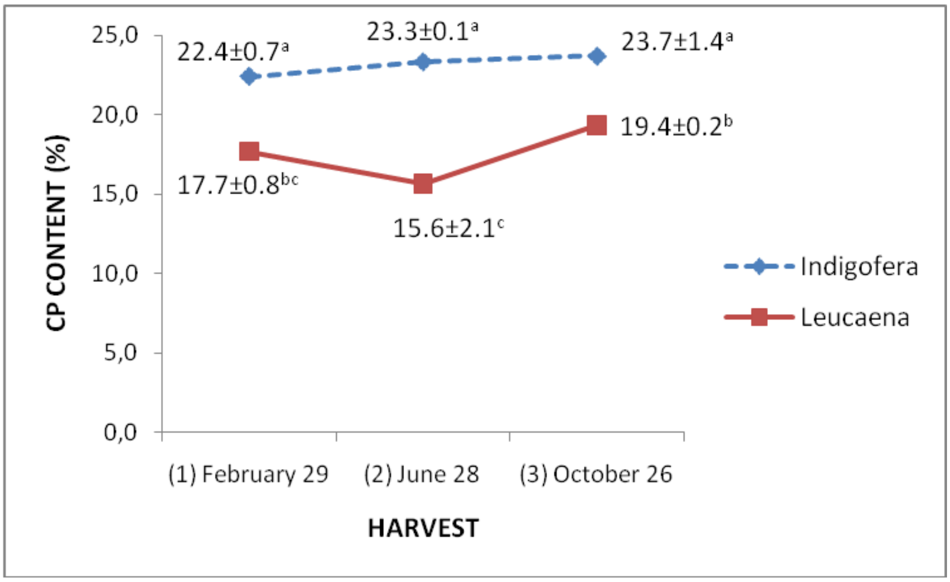

Figure 3. CP content of Indigofera and Leucaena leaf at harvest 1 (February 29, 2012), 2 (June 28, 2012) and 3 (October 26, 2012) in peatland. Values bearing different superscript show significant different (P<0.05)

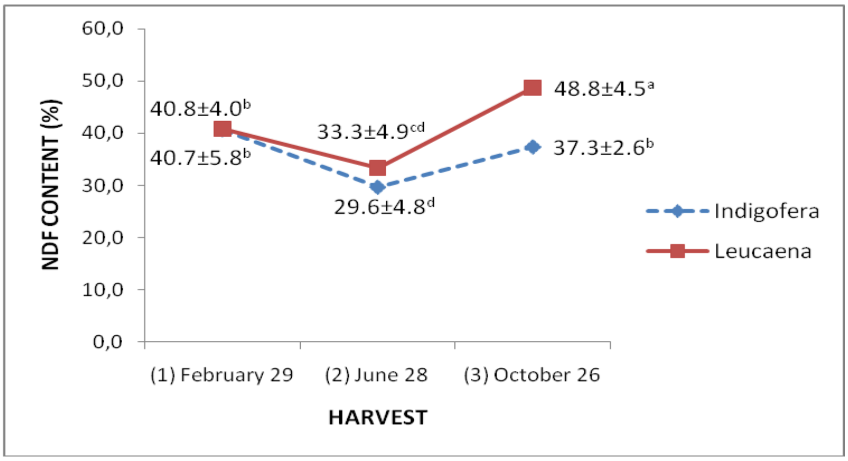

Figure 4. NDF content of Indigofera and Leucaena leaf at harvest 1 (February 29, 2012), 2 (June 28, 2012) and 3 (October 26, 2012) in peatland. Values bearing different superscript show significant different (P<0.05)

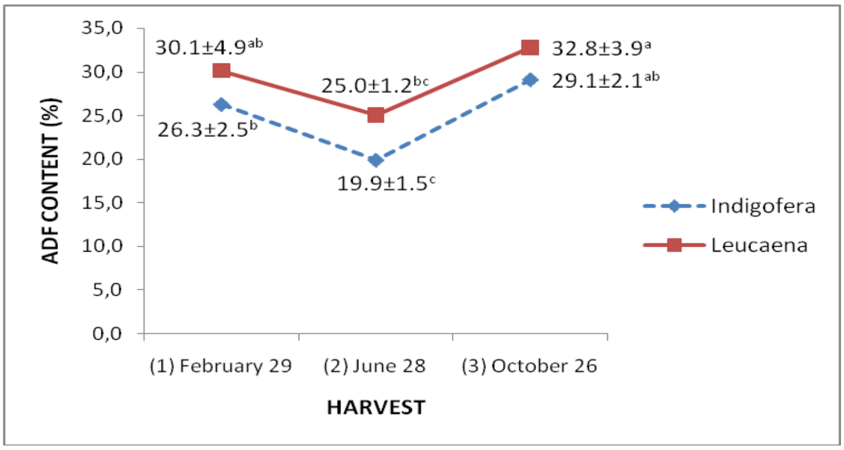

Figure 5. ADF content of Indigofera and Leucaena leaf on harvest 1 (February 29, 2012), 2 (June 28, 2012) and 3 (October 26, 2012) in peatland. Values bearing different superscript show significant different (P<0.05)

Conclusion

DM yield and CP content of Indigofera was relatively higher but NDF and ADF content was relatively lower than those of Leucaena. Conclusively, the production and nutritive value of *Indigofera zollingeriana* was superior to *Leucaena leucocephala* in peatland (sapric type).

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