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Exploration of Nutritional Value of Indigofera Shoot Leaves Based on Different Ages

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Abstract

Time of harvest is one of the factors that affects the nutritive value of Indigofera. The purpose of this study was to determine the effect of harvest time on the content of dry matter, organic matter, crude protein, ether extract, crude fiber, nitrogen free extract, ADF, NDF, cellulose, hemicellulose, and lignin of Indigofera shoot leaves. The study was organized based on Randomized Group Design (RGD) with 3 treatments and 4 groups, grouping based on stem height and diameter. Harvesting time treatments were carried out based on uniform days after pruning (DAP) at the age of 90 days post transplanting. The harvest times observed were 40 DAP (P1), 60 DAP (P2) and 80 DAP. Analysis of variance on shoot leaves showed that harvest time had no significant effect (P>0.05) on the content of dry matter, organic matter, crude fiber, crude protein, cellulose, hemicellulose and lignin but had a significant effect (P<0.05) on the content of ether extract, nitrogen free extract, ADF, and NDF of shoot Indigofera leaves. It is concluded that Indigofera leaf shoots were harvesting at the age of 40 - 80 DAD very high in nutrient value and are a good source of feed as a basal feed and concentrate. It can be used as a green concentrate and substitute forage for ruminants and non-ruminants as well.

Keywords: *Indigofera zollingeriana*, Nutrient, Shoot leaf, Different ages

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1. Introduction

Indigofera is one type of legume that can be utilized as a forage and has multipurpose for farmers. This forage type is a basal feed for ruminants and green concentrates for non-ruminant feed. Despite its higher protein content than other legumes, it is also more tolerant to drought, making it an alternative source of feed during the dry season [1]. An advantage of Indigofera is that it is expected to produce forage throughout the year with a high nutritional content compared to others t legumes. The content of crude protein is 27.60%, calcium (Ca) 1.16%, phosphorus (P) 0.26%, ADF 35.24%, and NDF 43.56% [2]. Crude fiber (CF) 17.85%, organic matter (OM) 15.56% and nitrogen free extract (NFE) content 38.65% [3]. [4] Reported that the protein content of Indigofera at the harvest age of 45 days was 26.22%, harvest age 60 days 24.67%, harvest age 75 days 23.01%, while for the age of 90 days it was 21.54%.

Pearson and Ison (1997) stated that nutritional value depends on species/variety, environment (soil, climate, grazing), plant organs, and plant age. Plant age and growth phase at the time of pruning will affect the productivity and nutritional quality of feed crops (Nelson and Moser, 1994). Furthermore, the fraction composition of the plant, such as the ratio of leaves or stems (Ugherughe, 1986). A high leaf to stem ratio in mature forage can be described as an indicator of its better nutritional quality and a decreasing leaf/stem ratio will reduce nutritional value and production. Indigofera leaves are one of the local feed ingredients that have the potential to be a source of protein. Indigofera has high productivity and good nutritional content, especially protein content that is higher than other legumes. [5] stated that the dry matter production of 60 days *Indigofera sp* were 1.0 m cutting height was 31.2 tons/ha/year, which was the highest production when compared to older or younger cutting ages. The leaves, especially the shoots of a plant usually have better nutritional content when compared to other parts. Top leaves are characterized by a lighter green color and are located at the end of the branch ranging from 3 - 5 leaves.

The separation of shoot leaves for poultry rations by making Indigofera Shoot Leaf Flour (ISLF) was reported by [6] by separating ISLF for laying hen rations through soybean meal substitution. The shoot of the leaves usually have better nutrient content when compared to other parts. Selection of Indigofera leaf shoots based on the right cutting time to find out the right harvest time to produce ISLF feed ingredients as a source of green concentrate from Indigofera leaves. The right harvest age gives high nutrient quality of Indigofera, because the quality of nutrients is strongly influenced by the composition of shoot and old leaves. The dynamics of composition between young and old leaves occurs according to pruning time [6] Pruning time affects fresh and dry matter production of forage. Pruning generally increases the absorption of N allocated for leaf growth obtained from roots and old leaves.

Prosea (1992) states that forage should be harvested at the age of 40-45 days during the rainy season and 50-60 days during the dry season. The harvest carried out more than 60 days lowers the nutrient content because the forage stems are getting harder, and the crude fiber is quite high. Conversely, if the cutting interval is short, the protein content is high, the water content is also high, while the production is low [4]. Lazier (1981) reported that the maximum yield that can be utilized as feed for tree legumes is a short cutting interval. Nutritional value is very important for compiling rations and calculating the availability of feed for livestock needs so that agronomic research, the effect of pruning management/ harvest time of Indigofera on land at different pruning times both in the rainy and dry seasons.

2. Materials and methods

2.1 Methods

Field trials were conduct at laboratory field station in Faculty of Animal Science Hasanuddin University and in Belabori Village, Parangloe District, Gowa Regency. Nutritional value were analyze at Chemical Feed Faculty Animal Science UNHAS. The study began with the germination process of *I. zollingeriana* seeds starting from soaking the seeds with hot water (80°C), for 24 hours, and then drained and placed on a tray with wet tissue. After forming germination, the seedlings were transferred to the seeding tray until age 30 days. Seedlings were transferred to 30 x 40 cm polybags until 64 days of age. Transplanted plants in Belabori Village, with planting holes 30 cm deep planted north-south direction with a distance of 1 m x 1.5 m, each hole is filled with 1 kg of compost and planting media remaining pot. The plantations were grouped according to the height and diameter of the plants. Harvesting time treatment of shoot leaves based on days after pruning (DAP), namely P1 (40 DAP), P2 (60 DAP) and P3 (80 DAP) with 4 groups.

Plant spacing between plants was 1 × 1.5 m. Uniform pruning was carried out at 90 days after transplanting, the next harvest was adjusted to each treatment, namely 40, 60 and 80 DAP. Harvesting was done by trimming the stems and leaves then separating the top leaves and old leaves. Shoot leaves are characterized by a lighter green leaf color and are at the end of the branch ranging from 3 - 5 strands, while old leaves are characterized by a darker leaf color and are closer to the stem of the Indigofera plant. To determine the dry matter, the samples were separated according to the treatment, 1000 g fresh shoot leaf were oven dried for 72 hours at 60°C. The analysis of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), and nitrogen free extract (NFE) was analyzed according to AOAC (2019) and acid detergent fiber (ADF), neutral detergent fiber (NDF), cellulose, hemicellulose, and lignin contents were analyzed according to [30].

2.2 Research design

This study was designed by using a Randomized Group Design (RGD)) consisting of 3 treatments 4 groups (harvest time each treatment was repeated 4 times. All data were analyzed by analysis of variance and if it showed a significant effect, it was continued with the DMRT test [23].

3. Results and Discussions

3.1 Dry Matter (DM) Content of Indigofera Shoot Leaves

The correct timing of harvesting is an important factor, as it will affect the ratio of leaves and stems in mature forage can be described as a nutritional quality and crop quality indicators. *Indigofera zollingeriana* has a high production reaching 33 - 51 tons BK/ha/year with the highest quality at 60 days pruning interval [5][1]. Increased production of dry matter forage due to an increase in the process of transportation and storage of nutrients in the forage. The content of nutrients such as carbohydrates, crude protein, crude fiber, and ether extract is produced from the metabolic process and photosynthetic activity of forages. Extended harvest age will provide more time for forages to carry out metabolic processes, photosynthesis activities, and nutrient retention. Therefore, the total nutrients obtained from these processes impacted on the average DM production of Indigofera shown in Table 1.

Variance analyze showed that harvest period had no significantly different result on the DM content of Indigofera shoot leaves ($P>0.05$). No differences were found in DM in this research despite harvesting at various times because the leaves that were compared were similar shoots with presumably the same growth period of the leaves. DM Shoot leaf was likely significantly higher at 60 days of leaf age than at 40 DAP, Nevertheless, the age of the cell was younger and the water content higher. With the older age of the plant, its water content decreases and the content of dry matter increases. The content of plant dry matter increases with the age of the plant [7] and [8]. For forage with a higher age will decrease in the moisture content and have a higher proportion of cell walls than the content of their cells. Therefore, the components of the cell wall are higher, dry matter content will also increase.

Comparatively less dry matter content in 80 DAP Indigofera shoots, indicated that the productivity and nutritional content of forage were influenced by various factors which were representative of ecological and technical condition of cultivation. The nutrient value of a forage is also influenced by season and growth phase (Papachristou and Papanastasis, 1994). The harvest time of 80 DAP occurred shading from other plants around the growing environment that were not trimmed, because the plants had begun to grow lush around the sample plants. According to [9] and [10] the area of plant spacing and the number of individuals in a plot affect the development of plants. Plant density causes shading so that there is a decrease in production, which affects dry matter [11].

Increasing plant age causes the percentage of DM to increase, slower harvesting reduces water content (WC) leaf as the plant ages and lignification occurs. These results are in accordance with research. Salisbury et al. (1995) stated that plant age could affect the WC in plants, dry matter content increases with the older the age of the plant. An older plant experiences thickening of the cell wall, which results in increased DM content and decreased moisture content. Some researchers reported that the highest total biomass yield was obtained at a longer pruning age, although with a lower leaf-stem ratio (Horne et al., 1986; Blair et al., 1990; Stür et al., 1994). In addition to plant age, environmental factors such as rainfall, temperature and nutrient availability in the soil during grass growth are positively correlated with increased dry matter. Longer harvesting time increases DM content if water availability in the rainy season and causes nutrient absorption and nutrient availability in the soil can be absorbed optimally.

3.2 Organic Matter (OM) Content of Indigofera Shoot Leaves

The variation of analysis showed that the nutrition contents of top leaves of Indigofera with different harvest ages were not significantly different (P>0.05) to the content of organic matter of top leaves of Indigofera. The relatively high content of the organic matter of the shoot leaves of Indigofera (92.49%) was generated in the 80 DAP harvesting time. The composition is correlated with the DM, and the difference between these two contents is the ash contents. With a longer harvest time, relative OM contents are higher. This suggests the formation rates of organic matter are higher than the inorganic absorption in the shoot leaves of Indigofera.

The content of OM Indigofera increases with the age of the crop. An increase in the OM content was due to decreasing the contents of ash or other inorganic contents. [29]. According to Kartasapoetra (1991), the longest time the leaves were not trimmed, the longer the photosynthesis process so as to increase the production of simple sugars which resulted in increased OM content. Tillman (1989) states that the results of photosynthesis in the form of CP, EE, NFE and CF are complex compounds of OM components. In this study, averages OM content of Indigofera shoot leaves showed that very high photosynthates produce the nutrition required for livestock. Increasing the content of OM and dry matter production in line with increasing age of cutting also results in an increased yield of OM.

3.3 Crude Fiber (CF) Content of Indigofera Shoot Leaves

The result of variance analysis show that harvesting time had no significant effect (P>0.05) on the CF content of Indigofera shoot leaves. Meanwhile, the content of CF Indigofera shoot leaves at 40 DAP, 60 DAP and 80 DAP were not significant (P>0.05). [1] stated the right harvest age to produce Indigofera with the best quality. They also stated that at 60 days of cutting, the crude fiber content was 10.97% - 21.40%. This highest CF content of Indigofera shoot leaves produced from this study is at the range of the content as reported in [1]. The later harvest time the crude fiber content increased. The age of the plants, the higher the level off crude fiber. This was due to the age of the plants, which were getting higher in the cell wall components. Regarding the maturity of forage (plant age), the fiber concentration will also be increased. The content of CF of Indigofera shoot leaves in this study varied from 16.37 -17.40%. Previously [3], reported crude fiber content was 15.25%, 17.8%, 20.72 to 25.41, [12] 20.72 - 25.41% with trimming time of 40 - 60 days, 14.96% [13], 15.25% [6].

3.4 Crude Protein (CP) Content of Indigofera Shoot Leaves

The variance analysis indicated that the harvesting age did not have a significant effect (P>0.05) to the content of CP of Indigofera Shoots (Table 1). It was found that at the age of 40 days of harvest the CP content tended to be lower. The content the CP of Indigofera top leave that ranged between 33.87%-36.62%. These nutritional contents were higher than previously recorded in several studies conducted on the same age of harvest. according to [13], the leaf meals of Indigofera containing a CP at 27.9%. The relatively high amount as compared to several previous research studies with different harvesting ages is the result of the samples were analyzed from top of the leaves which have no branches inside. [5] reported that the crude protein content of Indigofera sp based on cutting intervals of 30 days, 60 days and 80 days ranged from 21.12% - 25.81%. Some researchers reported the CP content of Indigofera as follows; 24.8% (Ngo van Man et al, 1995), 27.9% [13], 23.8% [14], 22-29% [15], 24.17% [3], 27.68% [1] and 24.57% (Hendrawan, 2013).

According to [5] the low protein content at shorter cutting intervals can be caused by high water content. Polakitan and Kairupan (2009) added that the best forage quality is located at the end of the vegetative phase or towards the reproductive phase (generative stage). Indigofera sp starts flowering (generative phase) since the age of 2 months [6] so that if harvested at the age of 60 days it will produce a higher protein content when compared to other cutting ages. Palupi et al [26] used Indigofera shoot leaf flour (ISLF) with a crude protein value of 28.98%, crude fat 3.30%, crude fiber 8.49%, calcium 0.52% and phosphor content 0.34%. ISFL contains complete amino acids and has high vitamin A and ß-carotene, which are 3828.79 IU/100g and 507.6 mg/kg, respectively. ISLF has the potential to be utilized as a protein source feed ingredient. Substitution of 45% soybean meal protein with ISLF protein can improve egg quality and increase yolk color intensity by 55.88%.

3.5 Ether Extract (EE) Content of Indigofera Shoot Leaves

The analysis of variance in Table 2 showed that the time of defoliation had a significant effect (P<0.05) on the content of EE in the leaves of the shoot of indigofera. The results of the DMRT showed that defoliation at the age of 40 days was significantly different from the defoliation of age 60 DAP and 80 DAP, while the harvesting time at the age at 80 DAP were significantly difference to the age at the 60 DAP. The mean of EE content of Indigofera shoot leaf at age 40 DAP is lower than that at the age of the 60 DAP and 80 DAP. The content of Indigofera EE was harvesting at 40 DAP, 60 DAP and 80 DAP indicates a difference between the pruning time that is increasingly high at the age of 60 DAP and decreases at the age of 80 DAP.

[22] recommended that the results of her research on the EE content of Indigofera zollingeriana at the age of 60 days was around 10.86%. Furthermore, [15] reporting that the ether extract of Indigofera is 6.2%. The EE contents of Indigofera at the harvest ages of 2 months, 3 months and 4 months on peatlands range between 2.11% -2.85% (Harmini

et al., 2021). The differences in EE contents of the forages are highly influenced by the type, harvest age and treatment given. However, the results of this study are relatively different from the results obtained by [6] and which report that an increasing harvest age actually improves the forage EE levels. This increase is due to the fact that older crop age, the more energy stores in crude fat are stored on the leaves [6]. The crude fat in feed is used to determine the energy content of feed ingredients that are required by animals to metabolize their body for survival.

3.6 Nitrogen Free Extract (NFE) of Indigofera Shoot Leaves

The variance analyses showed that the harvest time treatments significantly affected (P<0.05) the contents of NFE of the Indigofera leaf shoots (Table 2). DMRT analysis indicated that the NFE contents offshoot leaf was harvested at 40 DAP were not significantly difference with the 80 DAP, but were significantly higher than 60 DAP. The highest NFE contents of Indigofera shoot leaves at 40; it was the highest NFE content at the age at 60 DAP. NFE is easily digested carbohydrate in forage, which is used as an energy resource for the livestock who consume it. Increased contents of crude protein, crude fat, high crude fiber (the longer the harvest time) will result in a decrease in NFE contents. This is consistent with Tilman et al. (1998) that the decrease in the crude protein, ether extract content of the feed ingredient would increase the content of NFE. The NFE is a carbohydrate faction, which is high in sugar and starches, therefore easily digested. Therefore, the NFE content can describe the level of digestible carbohydrates in the forage used as a source of energy for the livestock that consume it. Based on the data in Table 1, it can be seen that the increase in harvest age from 40 to 80 DAP did not give a significant effect on changes in NFE content of Indigofera.

This condition is strongly influenced by the CF content of Indigofera at each harvest age. In this study, the value of Indigofera CF content at harvest age 40, 60 and 80 DAP were not significantly different. When the CF content is relatively the same, the NFE content also shows relatively the same value, because NFE is part or fraction of carbohydrates after deducting the fiber fraction, so the CF value is negatively correlated with the NFE value. Amrullah et al. (2015) reported that high value of CF in feed ingredients would reduce NFE value. NFE content of Indigofera based on the harvest age level of the results of this study is slightly different from the NFE content of legumes from Akpensuen et al. (2018), reported that NFE contents of *Stylosanathes guianensis* increase significantly between 33.55% and 36.82% at harvest age from week 9 to 21 after transplanting. This indicates that NFE content of leguminous plants is affected by type, the climate and soil on which they grow. The averages of NFE content of Indigofera were 46.39% - 51.15% , which harvested at 40, 60 and 80 DAP, based on the results of this study is higher than the NFE value of *Stylosanathes guianensis*. The results of research by Akpensuen et al. (2018) and comparable with NFE value of sorghum research was reported Koten et al. (2014) in ranged from 45.84% - 51.78% at harvest age 50-70 days.

3.7 Neutral Detergent Fiber (NDF) content Indigofera shoot leaves

The result of the analysis shows that time of Harvest had a significant effect (P<0.05) on the content of the NDF Indigofera shoot leaves. Results of DMRT test indicated that harvest time of 60 DAP was significantly difference with the harvest of 80 DAP. NDF content at 60 DAP more higher than at 40 DAP and 80 DAP. This was because plants aged 40 days had shoot leaf, thus lower fraction of fibers. Whereas the plants on 80 DAP experience shade, harvest method (unidentified leaf) because the leaf had fallen off before trimming. Dropping the leaves is common in response of drought stress [27]. According to [25] concentration NDF values were significantly influenced by season and harvest method. State those tree legumes that have NDF in a range of 20-35% usually have high palatability and that species with high levels of lignin are often poorly digested. Report the NDF contents for *Indigofera arrecta* during spring season is 32.80%. Whereas [5] recorded the NDF contents of between 34.74% - 36.83%, with 30 days, 45 days and 90 days of pruning intervals.

However, compared with the results of this research, it is lower, where the research showed that the content of NDF was between 25.34 - 27.28%. The duration of time for harvesting caused an increase in plant age; it is also indicated by an increased NDF level in these plants. Hoffman et al. (2001) suggest that fodder with 40% NDF content has higher value in digestibility as compared with fodder with a 60% NDF content. The NDF makes up the bulk of plant cells walls. The material is composed from cellulose, hemicellulose, lignin, silica, and fibrous proteins [30]. The older Indigofera is harvested, the decrease of NDF contents caused by Indigofera stem hardening and high rough fiber. Polakitan and Kairupan (2009) also explain that the age of forage harvesting for livestock feed is preferably conducted in the period at the end of vegetative stage or prior to the flowering (generative phase) to guarantee the optimal re-growth and high nutrient content.

3.8 Acid Detergent Fiber (ADF) content of the shoot leaves of Indigofera

The variance results indicated that the harvest time was significantly different (P<0.05) on ADF content of the young leaves of Indigofera. The DMRT analysis showed that the time of harvesting at 40 DAP is significantly higher than 60 DAP. ADF contents were lower in the treatment time of 40, and 60 as well as the 80 time of DAP in average values were 21.90% to 23.47%. [5] Reports that the ADF content Indigofera was 24.08, 24.39 and 24.17% in intervals of 30, 60 and 90 consecutive cutting day. [3] Report that the ADF content of Indigofera were 44.69% and 35.24% [1] and 28.83% [16]. According of [5] the increase of the cutting intervals will reduce the content of CF, Ca and P, the higher content for OM, NDF and ADF. The content of ADF in the plant, which is a component that can decrease the content of nutrition in plants. Jung and Allen (1995) state that the contents of the ADF have a higher a positive relationship with digestibility of feed. The content is higher at 60 HSP than 40 ADP OR 80 DAP. This was due to the conditions of the plant in the 80 DAP experienced a shade so that plant height was not optimal, leaves that were produced in plants also decreased their production. The differences in the light intensity will affect the growth. Too little intensity will produce photosynthesis product not maximized and influence the activities of the leaf stomatal cells.

Table 1. Average Nutrient Content of Indigofera Shoot Leaves at Different Harvesting Times

Treatment	DM (%)	OM (%)	CF (%)	CP (%DM)	EE (%DM)	NFE (%DM)
P1	22,66±1,90	91.89 ± 0,15	16.37 ± 0,89	33,87±2,29	7,02±0,93[a]	34,63 ± 1,43[a]
P2	25,75±1,70	92.05 ± 1,14	17.40 ± 1,01	36,62±4,14	10,39±1,07[c]	27,64 ± 5,10 [b]
P3	22,48±4,00	92.49 ± 0,16	17.03 ± 0,67	34,76±2,46	8,75±1,50[b]	31,94 ± 3,45[ab]

Means followed Different superscript letters in the same column indicate significantly different (P<0.05); P1 ; harvesting 40 day; P2; harvesting 60 day; P3; harvesting 80 day after pruning

Table 2. Nutrient contents of NDF, ADF, Cellulosa, Hemicellulosa dan Lignin Indigofera shoot leaf in different harvesting time

Treatment	NDF (%)	ADF (%)	Cellulose (%)	Hemicellulose (%)	Lignin (%)
P1	26,46±1,52[ab]	21,90±1,11[a]	15,52,±2,11	4,56±1,71	6,38±1,38
P2	27,28±1,25[b]	23,47±1,75[b]	14,67±1,54	3,81±0,86	8,79±0,26
P3	25,34±0,98[a]	22,40±0,46[ab]	14,62±1,86	2,94±0,54	7,78±2,03

Means followed Different superscript letters in the same column indicate significantly different (P<0.05); P1; harvesting 40 DAP; P2; harvesting 60 DAP; P3; harvesting 80 DAP (Day after pruning)

Therefore, that it results in inhibited plants growth [17]. The cell walls thickened more intensely during vegetative phases until the plant reaches the physiological maturation, likewise, water-soluble carbohydrates (WSC: Water-soluble carbohydrate) increases until the peak at 6-7 weeks [18]. [6] Describes that forages will continuously experience cells divisions, elongations, and differentiation during the vegetative stage to increase biomass of the leaves and branches.

3.9 The Cellulose contents of the Indigofera shoot leaf

According to the variance results indicated that the value of average cellulose contents of the Indigofera top leaf on each treatment was not significantly difference (P>0.05) respectively 15.52%, 14.67%, and 14.62%. The content was lower than [2], which reported that the content was 22.65% for 60-day cutting intervals. The differences are due to the higher content in water in the shoot leaf due to incompletely developed cells wall, therefore cellulose is low. According to [28] the molecules cellulose are microfibrils from the glucose which are bound to one another forming very long polymers chains. The existence of lignin and hemicellulose surrounding celluloses are the main obstacle to hydrolyzing celluloses.

3.10 Hemicellulose contents of the young leaf of Indigofera

The result of variance analyses indicated that time of harvesting has no significant effect (P>0.05) on hemicellulose contents of the shoot leaf of Indigofera at 40, 60, and on 80 DAP were respectively 4.56%, 3.81%, and 2.94%. The average hemicelluloses contents are low because of the high water contents as well as other compounds that increased. In addition, commonly known as hemicellulose, hemicellulose has a shorter chain than cellulose and is a mixed polymers of various sugars, including xylose, arabinose, and galactose. [19] Also added that hemicelluloses have lower degree for polymerization, which is easier compared to celluloses and do not form into long fiber. Moreover, generally hemicelluloses dissolve in alkali with a low concentrations, whereas the more the branch is the higher its solubility.

3.11 The lignin content of Indigofera shoot leaves

The result of the variance showed that each treatment of the shoot leaf of the Indigofera had no significant effect (P>0.05) on the lignin content. The lignin content was influenced by the plant age where older plant age had thickened the cell walls thus lignin contents increased. Furthermore, the lower lignin contents of forages, higher digestibility level of nutrients and higher opportunity to be used as feed ingredient sources. This is consistent with the opinions of [20], which state that that the age of plants at the time of harvesting has a significant effect on the nutritional contents. Generally, that the older the plant age at the time of the harvest, the decrease in protein levels and the increase of crude fibers. Likewise, according to [21], the protein and moisture contents are high in the young forages, while the fiber contents are lower. Average value of the lignin of the study was quite low and does not exceed from the maximum lignin tolerable by animals is 7% [24].

4. Conclusions

Time of harvest has no significant effects on the contents of organic matters, crude fiber, dry matter; crude protein, crude fiber, cellulose, hemicellulose and lignin shoot leaf of Indigofera, but significantly affects the contents of EE, NFE ADF, and NDF. The nutrient contents in this study qualified as fodder and green concentrate for ruminant and could be substituted to poultry as well. The best harvesting time to produce shoot leaves was 60 DAP in range highest crude protein and ether extract content.

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