Butterfly Pea *(Clitoria ternatea)* Plants Nutrient Content and In Vitro Digestibility at Different Harvest Ages at the Second Defoliation

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ABSTRACT
This study aimed to determine the butterfly pea nutrient content and dry matter and organic matter *in vitro* digestibility with different harvest ages, fertilized with NPK at 80 kg/ha dosage. This study used butterfly pea, which was cut at different ages in the second defoliation. There were four treatments, namely the harvest age of 30 days (P1), 40 days (P2), 50 days (P3), and 60 days (P4), to determine the best age to cut the plants properly. Data were analyzed by one-way of variance analysis and were processed using Statistical Package for the Social Sciences (SPSS) version 23. The variables observed were the levels of dry matter, organic matter, crude protein, crude fiber, crude lipid, and the digestibility of the butterfly Pea plant's dry matter and organic matter. The analysis showed that P4 (24.79%) performed the highest dry matter content and was significantly different (P <0.05) with P1 (19.65%), P2 (21.63%), and P3 (23.71%). Treatment P4 (22.2%) had the highest crude fiber content and significantly different (P> 0.05) with P1 (16.78%), P3 (17.68%), and P4 (18.36%). The highest dry matter digestibility of the Butterfly Pea plant was found in P1 (70.09%) and was not significantly different from P2 (69.61%), P3 (68.88%), and different from P4 (65.28%). The content of organic matter, crude protein, crude lipid, and organic matter digestibility in Butterfly Pea plants were not significantly different at P1, P2, and P3 but significantly different at P4. This study concluded that the best age for cutting the butterfly pea plant with 80 kg/ha fertilizer based on its digestibility was 30 to 50 days of harvest age.

Keywords: *Butterfly pea, Harvest age, Nutrient content, In vitro digestibility*

1. INTRODUCTION

Overcoming forage availability during the dry season starts with developing forage plants with high adaptability and are resistant to varied seasons. Legume can provide livestock forage because it has the good nutrient quality and high adaptability to drought [1]. Butterfly pea is one of the legumes which has the potential as a forage source for livestock. Forage production per harvest (harvest age of 42 days) is 25 to 29 ton DM/ha with seed production of 2.2 tonnes/ha [2]. Butterfly pea contains 14 to 20% protein, while the crude fiber content in leaves is 21.5 and 29%, with dry matter digestibility values reaching 70%. Butterfly pea is well adapted to a range of sandy, loamy, and tough clay soils. It is also resistant to drought, resistant to salinity, and able to compete well against weeds [3].

Forage production can be increased by planting density [4]–[7], level defoliation [8], planting space [9], harvesting age [1], [10]–[12] and regrowth management [13]. There are several forage that important in Indonesia such as sorghum and stylosanthes, Puero (*Pueraria javanica*) [14], *Chicoryum intybus* [4], *Brachiria* sp.[7], [15], *Brachiaria brizantha* cv MG 5 [13], *Shorghum* BMR, *Pennisetum purpureum* [5], [16], *Pennisetum purpureum* cv Mott [17], [10].

Harvest age affects the nutrient content of plants, where it can influence material digestibility. The older the plant, the greater the ratio of stems and leaves [18]. In addition, the older the plant, the proportion of non-structural carbohydrates decreases. On the other hand, the proportion of structural carbohydrates increases. NPK fertilizer contains both micro and macro nutrients required by plants that include Nitrogen, Phosphorous and Potassium [4], [9], [11], [19]. It is applicable, easy to absorb by the plant, and more economical. Therefore, it is necessary to test the quality of the butterfly pea by knowing the nutrient content, dry matter, and organic matter in vitro digestibility with different harvest ages [20][21]. This research was expected to determine the best harvest age of butterfly pea, therefore, provided information about the proper harvest of butterfly pea with optimal nutrient quality.

2. MATERIALS AND METHOD

2.1 Research Design

The materials used in this research were butterfly pea which is mirrored in the nursery until 2 weeks old and planted in the field. Plant uniformity was carried out when the plants were 30 days old. The day count for the harvest treatment level was carried out after uniformity. Plants were planted on a 2 x 2 m plot area with 5 replications for each treatment. This research used a planting distance of 75 x 75 cm and fertilizer much as 80 kg/ha given twice. Observations were made at the second defoliation. Research locations were in Malangrejo, Wedomartani, Ngemplak, Sleman Yogyakarta.This study used a completely randomized design one-way ANOVA with 4 harvest ages, namely 30, 40, 50, and 60 days.

2.2 Sample Analysis

The fresh weight of harvested butterfly pea was recorded. The weighed butterfly pea was put in newspapers and then dried in the oven at 55°C for about 3 days to obtain constant dry weight. The dried butterfly pea was then mashed using a Willey mill in a screen diameter of 1 mm. Sample preparation was done in 3 replications. Sample analysis included dry matter, organic matter, crude protein, crude fiber, and crude lipid. After proximate analysis, the digestibility test was followed by Tilley and Terry in vitro method to measure the dry matter and organic matter digestibility [22].

2.3 Data Analysis

Research data obtained were nutrient content, and dry matter and organic matter digestibility were analyzed following a completely randomized design one-way analysis of variance [21]. The differences between treatments were further tested with Duncan Multiple Range Test (DMRT).

3. RESULT AND DISCUSSION

3.1 Nutrient Content of Butterfly Pea Plants

The butterfly pea with harvest age treatment had a very significant effect ($P < 0.05$) on DM content. The increasing harvest age performed higher DM content [6], [11], [23]. The highest DM content was found in the harvest age of 60 days, followed by 50, 40, and 30 days. This was because plant age affects the availability of time spent by plants for photosynthesis, hence affects the accumulation of photosynthetic products in plants. The more photosynthetic time increases, the more the accumulation of photosynthetic plants results. Therefore, it causes a higher plant dry weight. It was known that the more time is available for photosynthesis, the more photosynthetic products accumulated in plant tissue [24]. Harvest age also affects the water content of the plant. Plants cut at a shorter or younger age have a higher water content than older plants. The nitrogen availability affects the plant biomass production[11], [19], [25].

The nutrient content data showed that harvest age had a significant effect ($P < 0.05$) on the butterfly pea OM content. The OM content at different harvest ages was directly proportional to the DM content. Where the older the plant, the organic matter content of the plant will be higher [26]. Plant age is directly proportional to the higher accumulation of plant photosynthesis products. The organic matter content of the plant will continue to increase with the increasing harvest age [27].

The analysis of the nutrient content of the butterfly pea plant showed that the plant harvest age had a non-significant effect ($P > 0.05$). Plant age influenced the leaf to stem ratio. The leaf to stem ratio will affect the nutrient content of plants, such as CP, EE, CF, and other nutrients [28].

The butterfly pea nutrient content showed that the harvest age had a significant effect ($P < 0.05$) on the OM content. This was presumably because the older the plant, the higher crude fiber, thus making it more difficult to digest. CF content will increase following the plant's age. The CF in plants is part of the tissue cell structure, consists of cellulose, hemicellulose, and lignin. The content of CF in plants will reduce the quality of the plants because it is more challenging to digest [8].

Table 1 shows the result of nutrient content analysis. Plants analyzed for nutrient content were butterfly pea that had been cut based on a predetermined age.

Table 1. The results of nutrient content analysis of the butterfly pea based on harvest age.

Nutrient (%)	The harvest age of butterfly pea (days)			
	P1	P2	P3	P4
Dry matter (DM)	19.365 ± 0.43^{a}	21.63 ± 0.26^{b}	23.31 ± 0.36^{c}	24.79 ± 0.35^{d}
Organic matter (OM)	91.64 ± 0.66^{a}	92.49 ± 0.23^{b}	92.99 ± 0.22^{c}	93.29 ± 0.26^{d}
Crude protein (CP) ^{ns}	28.62 ± 2.67	25.11 ± 0.26	25.28 ± 1.26	25.78 ± 2.9`5
Crude fiber (CF)	15.78 ± 0.69^{a}	17.2 ± 0.71^{b}	19.68 ± 0.77^{bc}	19.66 ± 0.59^{c}
Extract ether (EE)^{ns}	3.44 ± 0.56	3.33 ± 0.94	3.54 ± 0.81	3.61 ± 0.86

P1: harvest age of 30 days, P2: harvest age of 40 days, P3: harvest age of 50 days, P4: harvest age of 60 days.
^{ab} different superscriptions on the same line indicate significant differences (P <0.05)

Table 2. Dry matter and organic matter in vitro digestibility of butterfly pea plants with different harvest ages.

Digestibility (%)	Butterfly pea harvest age (days)			
	P1	P2	P3	P4
Dry matter digestibility (DMD)	70.09±1.08^{b}	69.83± 0.69^{b}	67.88± 0.42^{a}	66.28± 3.19^{a}
Organic matter digestibility (OMD) ^{ns}	63.10±2.79	62.86±0.89	59.95± 1.26	58.91± 1.40

P1: harvest age of 30 days, P2: harvest age of 40 days, P3: harvest age of 50 days, P4: harvest age of 60 days.
^{ab} different superscriptions on the same line indicate significant differences (P <0.05)

The butterfly pea nutrient content showed that the harvest age had a non-significant effect (P> 0.05) on the EE content. It was presumable because butterfly pea cut at an older age have a low water content, so they have more chlorophyll and cause a high EE content. The EE content in plants is inversely proportional to the water content of the plants. Therefore, the older the plants are, the lower the water content, but the EE content will increase [29].

3.2. Dry Matter and Organic Matter Digestibility of Butterfly Pea Plants

Digestibility is feed that is consumed by livestock and not excreted in the form of feces. In vitro digestibility is a digestive method carried out in the laboratory by imitating the conditions in the digestive tract of ruminants. DM digestibility is part of the DM in the feed digested by livestock at a certain level of feed consumption. The OM digestibility in the digestive tract of livestock includes the digestibility of feed nutrients in organic material components, namely protein, carbohydrates, fats, and vitamins. Feed digestibility in ruminants is closely related to the activity and the number of microbes in the rumen. Factors that influence microbial growth in the rumen are temperature, pH, DM content, buffer capacity, and osmotic pressure. These factors can affect the digestibility of dry matter in the rumen of ruminants. Table 2 shows the dry matter and organic matter in vitro digestibility test results of butterfly pea with different harvest ages.

Based on the results, the harvest age had a significant effect (P <0.05) on the DMD of butterfly pea. This was presumably because the older the plant will increase its production, but the quality decreases. The crude protein content decreases, and the CF of the plant increases. Therefore, it can affect the DMD of the butterfly pea plant. The CF content influences the increase and decrease in the DMD of the plant. A higher CF content in the butterfly pea plant will lower the DMD. If the CF content in a feed ingredient is highest, the cell wall will be more robust so that it will be more difficult for rumen microbes to degrade the feed material [30].

Cellulose is a component of crude fiber that blocks the process of breaking down the cell walls of feed ingredients by microbes or enzymes that work in the rumen, resulting in low digestibility. Forage plants cut at a more extended age would reduce their digestibility due to increased crude fiber concentration resulting from the plant lignification process [31].

The results of the butterfly pea plant DMD and OMD showed that the harvest age had non-significant effect (P> 0.05) on the OMD. This was presumably because the OMD will tend to decrease as the older the plant age. The older plant has high production, but it is inversely proportional to the quality of their nutrients. It is due to the increasing CF content and the decreasing CP content. The high content of CF and lignin causes cellulose and hemicellulose to be almost entirely bound by lignin to become lignocellulose and lignohemicellulose.

Hence, there is not much cellulose, and hemicellulose can be digested by rumen bacteria and cause a low rumen bacterial population. The increase in CF and lignin content and the decrease in CP content made it difficult for rumen microbes to digest these feed ingredients [32]. High lignin content binds cellulose and hemicellulose, forming lignocellulose and lignohemicellulose, which are difficult to digest by rumen microbes [33].

4. CONCLUSION

Based on the research results, it can be concluded that there was an effect of harvest age on the butterfly pea nutrient content. The harvest age affected the dry matter digestibility.

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