Chemical Composition of *Pennisetum purpureum* and *Panicum maximum* on Silvopastoral System in Jambula, Ternate, Indonesia

B Suwignyo\(^1\)*, A Guntur\(^1\), N Umami\(^1\), R Utomo\(^1\), P Suryanto\(^2\) and G Pawening\(^1\)

\(^1\)Faculty of Animal Science, Universitas Gadjah Mada
\(^2\)Faculty of Forestry, Universitas Gadjah Mada

E-mail: *bsuwignyo@ugm.ac.id*

**Abstract.** The experiment was conducted to investigate the adaptive grasses *Pennisetum purpureum* and *Panicum maximum* growing under shading coconut (*Cocos nucifera L*), nutmeg (*Myristica fragrans*) and clove (*Eugenia aromatic*) plantation canopy. Two species of tropical grasses *Pennisetum purpureum* and *Panicum maximum* were cultivated for 40 days at Jambula, Ternate, Maluku Utara, Indonesia. The parameters of research were nutrient quality and *in vitro* digestible of each grass. Data were analyzed using factorial and for the significant differences were further tested by Least Significant Different (LSD). Shade from control, coconut, nutmeg and clove plantation canopy each of which is 0, 38, 78, and 83%. The result showed that *Panicum maximum* chemical composition and *in vitro* digestible was better than *Pennisetum purpureum*. It can be recommended that *Panicum maximum* is persistent species, and has a good productivity for a long period of time under shading in plantation.

1. Introduction

The availability of feed, especially forage feed both in quality, quantity and continuity is an important factor in determining the success of ruminants. This is because nearly 90% of ruminant feed comes from forage with fresh consumption per day 10-15% of body weight, while the rest is concentrated and supplementary feed (feed supplement) [1]. Feed production not only considers quantity and quality, but also feeds that are economical, affordable and continuously. Based on data from the Ternate City Central Statistics Agency, there were 1581 cattle population [2]. This Ternate Island Sub district is because this area is a plantation area that has greater potential so that vacant land is only used for plantations and agriculture alone while for the use of forage land for animal feed has not been developed. Jambula Village is a village in Pulau Ternate Sub district, where some of the livelihoods of its residents are in the sectors of livestock, agriculture, plantations and fishermen. Problems in the field of animal husbandry, namely feed plants will die in the dry season and some land is used for plantation crops, so that livelihoods focused on the livestock sector will be very difficult in finding feed ingredients. The limited supply of forage has resulted in low livestock production, especially during the dry season. In general, these conditions can hamper the development opportunities of the cattle population.

The main problem faced in the development of forage is limited land. Farmers in Ternate, especially Jambula, generally use productive land for the cultivation of food crops, horticulture and...
plantations that are considered to have higher economic value than feed crops. The shade under the land is 38%, and the land under the shade of plantation crops has not been used to its full potential.

The above problems need to find a solution so that livestock remains a livelihood, food remains available and plantation or forestry land remains a long-term source of income. In solving this problem it is necessary to conduct research in which the community can still carry out forage for animal feed from land that has been planted with plantation or forestry crops.

2. Materials and Methods
The research has been carried out in Jambula, Ternate, Indonesia start from May to September 2014. The materials used are stek \textit{P. purpureum} (\textit{Pennisetumpurpureum}), and \textit{P. maxicum} (\textit{Panicum maximum}), urea fertilizer (45% N), plastic and paper. Cultivation grass under coconut, nutmeg, and clove plantation. Shade from control, coconut, nutmeg and clove plantation canopy each of which is 0, 38, 78, and 83%. Grass cultivated 40 days. The samples that have been cut are weighed, then chopped and put in a newspaper bag (already in the 55°C oven for 1 day). Newspaper bags contain samples then 55°C for 3 days. The next stage was weighed and milled using a willey mill equipped with a filter with 1 mm porosity. Samples that have been prepared later in the proximate analysis include dry matter (DM), organic material (OM), crude fiber (CF), crude protein (CP), and extract ether (EE) [3]. In vitro digestion test method is 2 stage [4]. The fermentation process is complete, the in vitro fermented feed ingredients are used to test nutrient digestibility which includes dry matter digestibility (IVDMD), organic matter (IVOMD) [3]. The study was conducted using a completely randomized design (CRD) factorial pattern (2 grass and 3 canopy) and if significant continued Least Significant Different (LSD). Proximate analysis is a chemical to determine the nutrient content of feed or feed raw materials. [5] explained that the proximate analysis was divided into six nutrient fractions namely air content, ash, crude protein, crude fat, crude fibre and non-fat extract (NFE). There are several nutritional contents of \textit{P. purpureum} and \textit{P. maxicum} which can be seen in:

3. Results and Discussion

3.1. Dry matter
Based on the results of statistical analysis there were differences in the average dry matter of \textit{P. purpureum} and \textit{P. maxicum} plants harvested at 40 days. At the age of 40 days \textit{P. maxicum} for each treatment gave an average value of higher dry matter or dry matter continued to increase along with the shade with an average of 19.11%. When viewed in terms of the silvopastoral system the average dry matter of \textit{P. purpureum} and \textit{P. maxicum} harvested at 40 days was highest in the treatment under nutmeg tree shade of 20.31% and then followed by treatment under the shade of a clove tree which was 20.12% and the last in the treatment under the shade of coconut trees is 18.55%.

Table 1. Dry matter of \textit{P. purpureum} dan \textit{P. Maxicum}

| Defoliation | Grass          | Plantation (canopy) | average   |
|-------------|----------------|---------------------|-----------|
|             |                | Control (0%) | Coconut (38%) | Nutmeg (78%) | Clove (82%) |         |
| 40 days     | \textit{P. purpureum} | 14.42±0.27 | 18.34±3.11 | 19.84±3.32 | 19.10±2.48 | 17.92±3.11 |
|             | \textit{P. maxicum}   | 15.78±0.64 | 22.28±8.93 | 20.39±1.86 | 18.01±0.68 | 19.11±4.67 |
| Average     |                | 15.09±0.86a | 20.31±6.36b | 20.12±2.43b | 18.55±1.73ab | - |

Number which followed by different letter on same parameters show significant different (P<0.05)

Table 1 also shows that the average percentage of dry matter of \textit{P. purpureum} and \textit{P. maxicum} plants harvested at the age of 40 days between the treatment under the nutmeg tree is 20.31% and the treatment under the clove tree is 20.12% not significantly different (P <0.05) with treatment under the
shade of coconut trees at 18.55%, but significantly different (P <0.05) with no shade treatment of 15.09%. The difference in dry matter in the treatment under the shade of nutmeg trees, under the shade of the clove tree and under the shade of coconut trees with no shade treatment is assumed to be caused by several possibilities including the genetic factors of the plant species and the low light intensity in the shade treatment described by [6] stated that shade affected plant growth and morphology, namely reducing the production of tillers, leaves, stems, fine roots and the production of thin leaf roots with high water content and broader leaves.

3.2. Organic matter

P. purpureum and P. maxicum plants harvested at 40 days. At 40 days, P. purpureum for each treatment gave an average value of higher ash content or the organic matter content continued to increase along with the shade. When viewed in terms of the silvopastoral system, the highest organic matter content of P. purpureum and P. maxicum harvested at 40 days was 88.00% in the shade of the clove tree, 85.69% in the shade of nutmeg trees. And the last in the treatment under the shade of coconut trees is 87.12%.

Table 2. Organic matter of P. purpureum dan P. Maxicum

| Defoliation | Grass    | Control (0%) | Coconut (38%) | Nutmeg (78%) | Clove (82%) | average     |
|-------------|----------|--------------|---------------|--------------|-------------|-------------|
| 40 days     | P. purpureum | 83.18±3.74   | 85.54±0.33    | 85.32±2.61   | 85.92±0.83  | 84.99±2.27  |
|             | P. maxicum | 86.98±1.11   | 88.70±2.25    | 86.06±0.09   | 90.09±0.18  | 87.96±1.94  |
| Average     |           | 85.08±3.23b  | 87.12±2.25ab  | 85.69±1.70ab | 88.00±2.34a |             |

Number which followed by different letter on same parameters show significant different (P<0.05)

Nutmeg trees and treatment under the shade of clove trees were 85.69 and 87.12% respectively, but significantly different (P <0.05) with treatment under the shade of coconut trees at 88.00%. The difference between treatment without shade, treatment in the shade of nutmeg trees, treatment in the shade of a clove tree with treatment under the shade of a coconut tree is assumed to be caused by several possibilities including genetic variation between the two species.

3.3. Crude protein

Based on Table 3 it can be seen that there is a difference in the average crude protein content of P. purpureum and P. maxicum plants harvested at 40 days. At the age of 40 days P. maxicum for each treatment gave an average value of higher crude protein content or crude protein content continued to increase along with shade with an average of 15.46%. When viewed in terms of the silvopastoral system the average crude protein content of P. purpureum and P. maxicum harvested at 40 days was highest in the treatment under nutmeg tree shade of 16.50%, followed by treatment under the shade of a clove tree of 14.70% and the last in the treatment under the shade of coconut trees is 13.76%.

Table 3 also shows that the average percentage of crude protein content of P. purpureum and P. maxicum plants harvested at 40 days between treatments without shade of 16.73% was significantly different (P <0.05) with the treatment in the shade of trees coconut was 13.76% and the treatment under the shade of clove tree was 14.70%, but not significantly different from the treatment under nutmeg tree shade of 16.50%. Treatment under the shade of coconut trees produces a lower crude protein content of 13.76% when compared to other treatments. This is assumed to be caused by several possibilities including the amount of irradiation intensity received by plants, as explained by [7] that shade can reduce forage production, but can increase plant nitrogen content.
Table 3. Crude Protein of \textit{P. purpureum} dan \textit{P. Maxicum}

| Defoliation | Grass | Plantation (canopy) | Average |
|-------------|-------|---------------------|---------|
|             |       | Control (0%) | Coconut (38%) | Nutmeg (78%) | Clove (82%) |
| 40 days     | \textit{P. purpureum} | 16.65±1.63 | 16.42±1.10 | 15.24±1.86 | 13.23±0.77 | 15.39±1.85 |
|             | \textit{P. maxicum}    | 16.80±2.28 | 16.59±0.85 | 14.16±2.09 | 14.30±0.16 | 15.46±1.88 |
|             | Average                   | 16.73±1.77 | 16.50±0.88 | 14.70±1.87 | 13.76±0.76 |

Number which followed by different letter on same parameters show significant different (P<0.05)

This is also likely due to the genetic factors of the plant as explained by Bogdan (1977) that each variety and species that is different in genetic traits will influence their response to crude protein formation. In addition to genetic factors, the content of crude protein, crude fiber, and HCN of a plant is also affected by the climate and fertility of the soil where it grows, as well as the age of the plant [8].

3.4 Crude Fiber

Based on Table 4 it can be seen that there is a difference in the average crude fiber content of \textit{P. purpureum} and \textit{P. maxicum} plants harvested at 40 days. At the age of 40 days, \textit{P. maxicum} for each treatment gave an average value of higher crude fiber content or crude fiber content continued to increase along with the shade with an average of 33.82%. If viewed in terms silvopastoral system average crude fiber content of \textit{P. purpureum} and \textit{P. maxicum} harvested 40 days of age is highest in treatment under the nutmeg tree shade of 34.21%, followed by treatment in the shade of coconut trees at 32.94% and the last one in the treatment under the shade of the clove tree was 32.64%.

Table 4. Crude Fiber of \textit{P. purpureum} dan \textit{P. Maxicum}

| Defoliation | grass | Plantation (canopy) | Average |
|-------------|-------|---------------------|---------|
|             |       | Control (0%) | Coconut (38%) | Nutmeg (78%) | Clove (82%) |
| 40 days     | \textit{P. purpureum} | 32.37±0.93 | 32.37±0.93 | 33.87±3.14 | 31.54±0.76 | 32.54±1.72 |
|             | \textit{P. maxicum}    | 33.50±3.98 | 33.51±3.98 | 34.54±1.46 | 33.74±0.43 | 33.82±2.52 |
|             | Average                   | 32.94±2.66 | 32.94±2.66 | 34.21±2.22 | 32.64±1.32 |

Number which followed by different letter on same parameters show significant different (P<0.05)

Table 4 also shows that the average percentage of crude fiber content of plant \textit{P. purpureum} and \textit{P. maxicum} harvested at 40 days between treatments without shade and treatment in the shade showed differences not significant, i.e. treatment without shade at 32.94 %, treatment under the shade of coconut trees amounted to 32.94%, the treatment in the shade of nutmeg by 34.21%, and treatment in the shade of clove of 32.94%.

3.5. Extract ether

Based on Table 5 it can be seen that there is a difference in the average crude fat content of \textit{P. purpureum} and \textit{P. maxicum} plants harvested at 40 days. At the age of 40 days \textit{P. maxicum} for each treatment gave an average value of higher crude fat content or crude fat content continued to increase along with the shade with an average of 4.68%. When viewed in terms of the silvopastoral system the average crude fat content of \textit{P. purpureum} and \textit{P. maxicum} harvested at the highest 40 days of age was found in the treatment under the shade of clove trees of 5.05%, followed by treatment in the shade of nutmeg trees of 4.77% and the last one in the treatment under the shade of coconut trees was 3.20%.
Table 5. Extract Ether of \(P.\) purpureum dan \(P.\) Maxicum

| Defoliation | Plantation (canopy) | Average |
|-------------|---------------------|---------|
|            | Control (0%) | Coconut (38%) | Nutmeg (78%) | Clove (82%) |
| 40 days P. purpureum | 1.99±0.54 | 2.47±0.27 | 4.12±5.41 | 5.38±0.45 | 3.49±1.45 |
| P. maxicum | 4.67±1.29 | 3.93±0.71 | 5.41±0.96 | 4.72±0.71 | 4.68±1.00 |
| Average | 3.33±1.71a | 3.20±0.99a | 4.77±0.96b | 5.05±0.64b |

Number which followed by different letter on same parameters show significant different (P<0.05)

Table 5 also shows that the average percentage of crude fat content of \(P.\) purpureum and \(P.\) maxicum plants harvested at 40 days between the treatments under the clove tree and the treatment under nutmeg trees showed differences that were not significantly different, namely in a row Shade poho clove was 5.05% and nutmeg tree shade was 4.77%, but it was significantly different (P <0.05) with no shade treatment and treatment under the shade of coconut trees which were 3.33% without shade. And the shade of coconut trees is 3.20%.

3.6. In vitro digestible dry matter

Based on Table 6 it can be seen that there are differences in the average dry matter digestibility of \(P.\) purpureum and \(P.\) maxicum plants harvested at 40 days. At the age of 40 days \(P.\) maxicum for each treatment gave an average value of higher dry matter digestibility or dry matter digestibility continued to increase along with the presence of shade with an average of 55.39%. When viewed in terms of the silvopastoral system the average dry matter of \(P.\) purpureum and \(P.\) maxicum harvested at 40 days was highest in the treatment under nutmeg trees of 57.56%, followed by treatment in the shade of clove trees of 57.54% and the last one in the treatment under the shade of coconut trees was 44.26%.

Table 6. In Vitro Digestible dry matter of \(P.\) purpureum dan \(P.\) Maxicum

| Defoliation | Grass | Plantation (canopy) | Average |
|-------------|-------|---------------------|---------|
|            |       | Control (0%) | Coconut (38%) | Nutmeg (78%) | Clove (82%) |
| 40 days P. purpureum | 57.78±0.53 | 39.05±28.74 | 58.77±1.83 | 56.48±1.00 | 53.02±14.92 |
| P. maxicum | 57.16±0.53 | 49.48±0.45 | 56.34±1.46 | 58.60±2.10 | 55.39±3.83 |
| Average | 57.47±0.59 | 44.26±19.05 | 57.56±1.99a | 57.54±1.87 |

Number which followed by different letter on same parameters show significant different (P<0.05)

Table 6 also shows that the average percentage of dry matter digestibility of \(P.\) purpureum and \(P.\) maxicum plants harvested at 40 days between shade and control (control) and treatment under shade showed differences that were not significantly different, ie treatment without shade of 57.47%, the treatment under the shade of coconut trees was 44.26%, the treatment under the shade of nutmeg trees was 57.56% and the treatment under the shade of clove trees was 57.54%.

3.7. In vitro digestible organic matter

Based on Table 7 it can be seen that there are differences in the average digestibility of organic matter of \(P.\) purpureum and \(P.\) maxicum plants harvested at 40 days. At the age of 40 days \(P.\) purpureum for each treatment gave a higher average digestibility value of organic matter or the digestibility of organic matter continued to increase along with the presence of shade with an average of 55.22%. When viewed in terms of the silvopastoral system the average organic digestibility of \(P.\) purpureum
and P. maxicum harvested at the highest 40 days was found in the shade of coconut trees at 57.30%, followed by 55 clove trees, 53% and the last one in the treatment under nutmeg trees was 50.86%.

Table 7. In Vitro Digestible Organic Matter of P. purpureum dan P. Maxicum

| Defoliation Grass | Plantation (canopy) | Average |
|-------------------|---------------------|---------|
|                   | Control (0%)        | Coconut (38%) | Nutmeg (78%) | Clove (82%) |
| 40 day P. purpureum | 54.31±1.24          | 56.00±1.00 | 54.16±1.98  | 56.42±1.43  | 55.22±1.62  |
| P. maxicum        | 54.37±0.95          | 58.60±2.10 | 47.55±0.72  | 54.64±2.05  | 53.79±4.36  |
| Average           | 54.34±0.99          | 57.30±2.05 | 50.86±3.86  | 55.53±1.86  |

Number which followed by different letter on same parameters show significant different (P<0.05)

Table 7 also shows that the average percentage of organic matter digestibility of P. purpureum and P. maxicum plants harvested at 40 days between treatments in the shade of coconut trees was significantly different (P <0.05) with the treatment under nutmeg trees and treatment without shade, i.e. without shade of 54.43% and nutmeg tree shade of 50.86%, but not significantly different from the treatment in the shade of the clove tree of 55.53%. The high percentage of digestibility of organic matter of P. purpureum and P. maxicum plants in each treatment under the shade is thought to be due to the high effect of N availability in the soil in each treatment, N is the most accumulated element in the organic matter because it is the most important element in microbial cells involved in the soil organic matter reshuffle process. Further said that organic matter is produced by plants through photosynthesis process so that the carbon element is the main constituent of the organic matter.

4. Conclusions

The percentage of shade of coconut, nutmeg and clove plantations is 38%, 78% and 82%, respectively. The chemical composition of Pennisetum purpureum and Panicum maximum is influenced by the percentage of shade and plantation environment. Land under the shade of plantations has the potential to produce forage with the silvopastoral system. Grass that has the potential to be developed on land under plantation shade is Panicum maximum.

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