Nutrients intake and fiber fraction digestibility of Kacang goats supplemented with different proportions of soybean meal and Calliandra calothyrsus in the diet

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Abstract. This study evaluated the use of Calliandra leaves (Calliandra calothyrsus) as a protein source in substituting soybean meal (SBM) in goat’s diet. Twenty female Kacang goats were used in the study. Goats were randomly plotted into three diets treatments those were T1 = odot grass + 100% SBM; T2 = odot grass + 25% Calliandra + 75% SBM; T3 = odot grass + 50% Calliandra + 50% SBM; T4 = odot grass + 75% Calliandra + 25% SBM; and T5 = odot grass + 100% Calliandra. Grass was offered ad libitum, whereas protein sources supplementation was based on daily protein requirements of animal. Data were collected at last 10 days of experiment, including feed intake, feed refusal, and feces. Sampels were analyzed for crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF), and hemicellulose contents. Data were analyzed using one-way analysis of variance, and furtherly analyzed by Duncan’s multiple range test. Results showed that substituting of SBM with Calliandra did not have a significant effect (P>0.05) on the intakes of fiber fraction, but fiber digestibility was significantly affected (P<0.05) by treatment. The highest digestibilities of CF, NDF, and ADF were found in T1 and T2.

1. Introduction
Ruminants able to utilize fibrous feed due to the presence of rumen function that different from the non-ruminants [1]. The rumen stomach in ruminants has various microflora including bacteria, protozoa, and fungi [2]. Each rumen microbe has diferent role in degrading the fiber fraction of feed, such as cellulolytic and hemicellulolytic bacteria that secreting enzymes for hydrolyzing cellulose and hemicellulose [3]. Many factors influence the life of the rumen microbes so that it can have an effect on the degradation of fibrous feed. Feed components, such as structural and nonstructural carbohydrate, will influence the diversity of microbial in the rumen that have role in feed digestion [4]. If the nutrient for rumen microbes is inadequate, feed has to be supplemented with sources of nutrient, usuallly protein or energy source. Energy or protein supplementation is expected able to increase microbial protein synthesis and optimize fiber degradation in the rumen.

Protein supplement can be derived from proteaceous concentrate and legume plants. However, proteaceous concentrate is fastly degraded in the rumen that result in only few of amino acids from
feed will be available in the intestine for animal metabolism. Moreover, the proteaceous concentrate is relatively expensive for small holder farmer.

Therefore, it is necessary to find an alternative of protein source for ruminant, especially from legume plants. *Calliandra calothyrsus* (Calliandra) is a legume that contains high protein, good palatability, and high digestibility [5]. The use of Calliandra as a substitution for proteaceous concentrate can be evaluated by in vivo experiment in goats. The main objective experiment is to study the substitution of proteaceous concentrate (soybean meal) with Calliandra leaf and its effects on feed intake and fiber digestibility.

2. Material and methods

2.1. Material

The animals used in the research were twenty female Kacang goats with an age average of 3 years old and have body weight ranging from 17-20 kg. The feed stuffs used in the experiment were *Pennisetum purpureum* cv. Mott (odot grass) cultivated in Kalasan region, Sleman; Calliandra leaves harvested from Turi region, Sleman; and soybean meal (SBM).

2.2. Methods

The procedures of animal experiment were based on the guidelines of Livestock Ethics Committee of Faculty of Animal Science, UGM. The Animals were randomized grouped into 5 groups of treatments, thus there were 4 animals in each treatment. The treatments were substitution of SBM with Calliandra, namely T1 = odot grass + 100% SBM; T2 = odot grass + 25% Calliandra + 75% SBM; T3 = odot grass + 50% Calliandra + 50% SBM; T4 = odot grass + 75% Calliandra + 25% SBM; and T5 = odot grass + 100% Calliandra. Odot grass and drinking water were offered *ad libitum*. Supplementation of protein sources (Calliandra or SBM) were calculated based on daily protein requirement (gram/DM/head) [6]. The experimental diet was containing iso crude protein (13 to 14%) and iso energy (56 to 57% of TDN). Animals were kept in individual cages. Feeding was carried out twice a day, namely morning feeding at 08:00-09:00 and afternoon feeding at 15:00-16:00. Trial was conducted for 90 days consisted of adaptation and treatment periods. At the last 10 days of treatment period, feed intake, feed refusal, and total excreted feces were observed.

| Parameters                                  | Treatment |
|---------------------------------------------|-----------|
|                                             | T1       | T2  | T3  | T4  | T5  |
| Composition of diet:                        | as fed (gram) |       |     |     |     |
| Odot grass                                  | 0        | 193 | 290 | 490 | 728 |
| C. calothyrsus                              |          |     |     |     |     |
| SBM                                         | 129      | 104 | 52  | 29  | 0   |
| % DM                                        | 20.9     | 21.0| 21.0| 21.1| 21.3|
| OM (% DM)                                   | 76.4     | 77.3| 78.0| 78.7| 79.6|
| CP (% DM)                                   | 14.2     | 14.1| 13.8| 13.4| 13.2|
| CF (% DM)                                   | 23.5     | 23.5| 23.6| 23.8| 23.8|
| EE (% DM)                                   | 5.2      | 5.0 | 4.8 | 4.6 | 4.4 |
| NFE (% DM)                                  | 34.2     | 35.3| 36.4| 37.5| 38.8|
| NDF (% DM)                                  | 55.4     | 54.6| 54.2| 53.8| 53.1|
| ADF (% DM)                                  | 30.4     | 30.0| 28.8| 29.6| 29.2|
| Total digestible nutrients (TDN)* (% DM)    | 56.2     | 56.7| 57.0| 57.3| 57.8|

*Calculated according to Hartadi et al. [7]
The observed variables were nutrients intake and digestibility those were dry mater (DM), organic matter (OM), crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF), and hemicellulose. Nutrient intake and digestibility were calculated according to these formulas:

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\text{Nutrient intake (g/kgBW0.75/day)} = \frac{\text{feed given nutrient (gram)} - \text{feed residue nutrient (gram)}}{\text{kgBW0.75}}
\]

\[
\text{Digestibility nutrient} \% = \frac{\text{nutrient intake (gram/head)} - \text{nutrient faces (gram/head)}}{\text{Nutrient intake (gram/head)}} \times 100\%
\]

Data were analyzed in one-way analysis of variance, then means differences were analyzed using Duncan's multiple range test [8].

3. Result and discussion

As shown in Table 2, the highest NDF and ADF fractions were found in grass odot, while the highest NFC content was found in Calliandra.

| Feedstuff      | DM   | OM  | CP  | CF  | EE  | NFE | TDN* | NDF | ADF |
|----------------|------|-----|-----|-----|-----|-----|------|-----|-----|
| Odot grass     | 18.9 | 74.4| 9.89| 26.1| 5.42| 33.8| 52.8 | 60.7| 33.1|
| *C. calothyrsus*| 39.5 | 94.9| 22.5| 17.4| 1.52| 52.7| 71.8 | 15.1| 9.4 |
| SBM            | 86.6 | 92.0| 47.3| 3.58| 3.85| 37.3| 82.6 | 31.7| 18.4|

*Calculated according to Hartadi et al. [7]

3.1. Nutrient intake

Results showed that treatments had no significant effect (P>0.05) on nutrients intake (DM, OM, CF, NDF, ADF, and hemicellulose) of Kacang goat as shown in Table 3 below.

| Nutrient intake | Treatment | p-value |
|-----------------|-----------|---------|
| DM              | T1        | 0.157   |
|                 | T2        |         |
|                 | T3        |         |
|                 | T4        |         |
|                 | T5        |         |
| OM              | 0.081     |
|                 | 0.115     |
| CF              | 0.782     |
| NDF             | 0.871     |
| ADF             | 0.930     |
| Hemicellulose   | 0.915     |

Feed intakes were not significantly different among treatments (P>0.05). This indicated that substitution of SBM with Calliandra did not influence the rate of degradation of feed in the rumen, that might affect on feed consumption. The increase of SBM substitution with Calliandra will increase the fiber fraction content in the diet, especially NDF and ADF. However, this study showed that NDF and ADF fractions were still optimally degraded in the rumen. Legume plants, like C. calothyrsus, contain high crude protein, very palatable, have low lignin content compared to grass [5]. Diets in the treatments T2, T3, and T4 presented a combination of proteins sourced from Calliandra and SBM. This protein sources combination might result a better biological value of protein composition in the diet that increased protein synthesis of rumen microbes. Previous research using cassava leaves as a source of protein supplementations had no a significant difference (P>0.05) with diet without supplementation on the intakes of DM, OM, CP, and CF [9].
3.2 Nutrient digestibility

This study showed substitution of SBM with Calliandra had significant effect (P>0.05) on nutrients digestibility (DM, OM, CF, NDF, ADF, and hemicellulose) as presented in the Table 4 below.

| Nutrient digestibility | Treatment | P-value |
|------------------------|-----------|---------|
| DM                     | T1        | 85.88a  |
|                        | T2        | 88.26a  |
|                        | T3        | 81.34b  |
|                        | T4        | 79.39b  |
|                        | T5        | 81.35b  |
| OM                     | T1        | 86.21a  |
|                        | T2        | 88.40a  |
|                        | T3        | 81.14b  |
|                        | T4        | 78.96b  |
|                        | T5        | 81.35b  |
| CF                     | T1        | 77.37a  |
|                        | T2        | 78.14a  |
|                        | T3        | 66.71b  |
|                        | T4        | 59.86c  |
|                        | T5        | 58.21c  |
| NDF                    | T1        | 84.14a  |
|                        | T2        | 86.99a  |
|                        | T3        | 78.11b  |
|                        | T4        | 75.18b  |
|                        | T5        | 76.60b  |
| ADF                    | T1        | 82.91a  |
|                        | T2        | 82.53a  |
|                        | T3        | 74.68b  |
|                        | T4        | 68.77c  |
|                        | T5        | 70.45c  |
| Hemicellulose          | T1        | 85.31ab |
|                        | T2        | 87.14a  |
|                        | T3        | 81.69c  |
|                        | T4        | 82.75bc |
|                        | T5        | 82.90bc |

**Table 4:** Nutrient digestibility of diet containing SBM and C. calothyrsus on Kacang goat (%)

Optimal substitution of SBM with Calliandra reached 25%. At higher proportions of Calliandra (50 to 100%) resulted in the decrease the fiber fractions digestibility. This can be caused by the presence of tannins in Calliandra leaves that reduce nutrient digestibility, especially protein [10]. However, the digestibilities of fiber fractions were high in all of treatments. Fiber fraction of Calliandra is more easily digested than grass, thus amino acids and soluble carbohydrates produced by Calliandra digestion will be combined with biomolecules resulted from SBM digestion that are degraded quickly in the rumen [5]. This combination will synchronize availability of precursors for microbial protein synthesis. The increased of rumen microbial cell synthesis will increased the digestion of the fiber fraction. In a proper protein or energy supplementation, fiber fraction digestibility might be increased that would improve the efficiency of fibrous feed utilization in ruminant diet [11].

4. Conclusion

Substitution of SBM with C. calothyrsus in a diet for Kacang goat did not affect feed and nutrients intakes, but affected on nutrient digestibility. The optimum substitution of SBM with Calliandra was 25%.

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