**Calliandra calothyrsus** as a protein source in goat's diets: Study of feed intake and ruminal fermentation parameters

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**Abstract.** The study aimed to evaluate the usage of Calliandra leaves as protein source in Kacang goat’s diet at Wonolagi, Gunungkidul. Fifteen female Kacang goats weight 20 to 23 kg were plotted randomly into three diets treatments. The diet consisted of basal diets (local forages provided by farmer’s practices) with three different treatments: 100% Calliandra (T1), 50% Calliandra + 50% Soybean meal (SBM) (T2), and 100% SBM (T3). Parameters observed in this study were: feed intake (Dry matter intake, DMI; Organic matter intake, OMI; Crude protein intake, CPI; and Crude fiber intake, CFI) and ruminal fermentation parameters after 3 hours feeding period (pH value, total volatile fatty acid (VFA), acetate, propionate, butyrate, and A:P ratio). Collected data were analyzed using one-way ANOVA and the difference between means were analyzed using Duncan’s Multiple Range Test. DMI, OMI, and CFI did not differ among treatments, however, greater SBM content in T3 improved CPI 34.21% significantly (P<0.05) compared to T1. Ammonia, total VFA, acetate and propionate profile were greater in T2 diets compared to T1 (P<0.05). In conclusion, the use of Calliandra to substitute SBM should be in the 50 to 50 ratio to optimize the feed intake and ruminal fermentation profile.

**1. Introduction**
Kacang goat is commonly reared in conventional farming system and it is fed with feed from local resources in which the quality and quantity of ration are mainly inadequate. Many local resourced feed had been identified and evaluated for its quality; however, the balanced ration to optimize the Goats productivity has not been justified. Providing high protein feed like legumes in animal ration with poor quality feed would improve the nutritional value. *Calliandra calothyrsus* (CC) is legume found abundantly in tropics that has great crude protein content (± 22%) and has high palatability [1]. Although CC has great protein content, proportion in the ration should be maintained as it has bioactive compound namely tannin as much as 1.2%. Previous studies showed that supplementing legumes with high tannin content reduced nutrient digestibility [2]. For local farmers to utilize Calliandra leaves effectively, justification on the proper proportion of the legume for example varying the supplementation level is necessary to overcome or reduce the presence of bioactive compound, thus it can be safely mixed into the ruminant feed as well as can be easily practiced by farmers. This study investigated the usage of Calliandra and its effect on feed intake and ruminal fermentation parameters in Kacang goats.
2. Material and methods

2.1. General

The procedure of animal experiment was conducted based on the guidelines of the Faculty’s Livestock Ethics Committee. It was conducted in a traditional farm in Wonolagi District, Gunungkidul, Yogyakarta, Indonesia. Fifteen Kacang goats weight 20 to 23 kg were arranged using completely randomized design. Each goat were penned individually and provided with ad libitum water but with different feeding treatments. All Kacang goats were fed with similar local forages provided by local farmers and supplemented with three different protein feed. Protein feed consisted of soy bean meal (SBM) and Calliandra calothyrsus leaves (CC). Total collection was conducted for 14 days followed with rumen collection for 3 days. Nutrient intake was observed by subtracting nutrient in provided feed with nutrient in feed residue and Ph value was recorded with pH meter after 3 hours of intake. Ruminal fermentation parameters were observed 3 hours after feeding. Measurement of volatile fatty acid (VFA) was conducted using Gas-Chromatography (GC) method [3] and ammonia was measured with methods described by Chaney and Marbach [4].

Nutrient intake\( (g/kgBW^{0.75}/day) = \frac{\text{nutrient in provided feed (gram)} - \text{nutrient in feed residue (gram)}}{kgBW^{0.75}} \)

Table 1. Feed composition and nutrient contents of the protein diet treatment

| Parameters                                      | T1            | T2            | T3            |
|------------------------------------------------|---------------|---------------|---------------|
| Feed composition:                               |               |               |               |
| a. Local forages                               | Adlibitum     | Adlibitum     | Adlibitum     |
| b. Protein diet treatment (% DM):               |               |               |               |
| Calliandra calothyrsus                         | 320.00        | 145.00        | -             |
| Soybean meal                                   | -             | 74.76         | 150.50        |
| Nutrient content of the protein diet            |               |               |               |
| Dry matter (DM)*                                | 39.5          | 63.3          | 86.7          |
| Organic matter (OM) (% DM)*                     | 94.9          | 93.5          | 92.1          |
| Crude protein (CP) (% DM)*                      | 22.5          | 23.6          | 47.3          |
| Crude fiber (CF) (% DM)*                        | 17.4          | 10.5          | 3.6           |
| Total digestible nutrients (TDN) (%DM)**        | 71.8          | 75.4          | 82.6          |

* The proximate analysis was carried out at the Animal Feed Science Laboratory, Faculty of Animal Science, Universitas Gadjah Mada [5]
** Obtained by the regression formula [6]

2.2. Statistics

Collected data was analyzed using one-way analysis of variance, then if the results show a significant difference, further analysis will be conducted with the Duncan's new multiple range test [7].

3. Results and Discussion

3.1. Nutrient intake

Dry matter intake, organic matter intake and crude fiber intake did not significantly differed among treatments, however, greater SBM content in T3 improved crude protein intake (CPI) 34.21% significantly (P<0.05) compared to T1 diet (Table 2).

DMI, OMI and CFI did not different among treatments which are likely due to the three supplemented protein diet treatments have similar nutrient quality (DM, OM and CF). This result is in accordance with previous studies where the supplementation of cassava leaves as protein feed did not give different result on DMI, OMI and CFI [8]. Meanwhile, due to greater protein availability in T3,
there was higher protein intake in T3. However greater protein intake does not mean greater protein digestibility, thus, this research should be followed with protein digestibility study. The study in protein content in the forage should be followed with protein availability of the forage because of the protein availability might be affected by anti-nutritional content such as phenol and tannin. Tannin is commonly bound to protein thus made the protein unavailable to be digested [1].

Table 2. Diets effects on nutrient intake of Kacang goats

| Parameters       | 100% Calliandra (T₁) | 50% Calliandra + 50% SBM (T₂) | 100% SBM (T₃) | SEM  | p-value |
|------------------|----------------------|-------------------------------|---------------|------|---------|
| DMI⁹⁶              | 115.96               | 116.36                        | 112.13        | 1.04 | 0.384   |
| OMI⁹⁶             | 104.37               | 97.24                         | 103.60        | 0.72 | 0.508   |
| CPI               | 25.78⁺               | 31.23ᵇ                        | 38.17ᵃ         | 0.97 | 0.001   |
| CFI               | 53.39                | 52.56                         | 51.72         | 1.69 | 0.226   |

DMI= Dry matter intake; OMI = Organic matter intake; CPI = Crude protein intake; CFI = Crude fiber intake
⁺ Different superscript in the same row show significant difference (P<0.05)
⁻ Non-significant (P>0.05)

3.2. Ruminal fermentation parameters

Ammonia, total VFA, acetate and propionate profile were greater in T2 diets compared to T1 diet (P<0.05) with value 11.42%; 39.61%; 46.48% and 34.12% respectively. Meanwhile, the pH value, butyrate profile, and A:P ratio had no significant difference between treatments.

Table 3. Diets effects on in vivo ruminal pH, rumen NH₃-N, and VFA concentration of the Kacang goats

| Parameters       | 100% Calliandra (T₁) | 50% Calliandra + 50% SBM (T₂) | 100% SBM (T₃) | SEM  | p-value |
|------------------|----------------------|-------------------------------|---------------|------|---------|
| pH value³ᵃ       | 6.96                 | 6.76                          | 6.67          | 2.62 | 0.152   |
| NH₃-N            | 30.99ᵇ               | 32.97ᵃ                        | 34.15ᵃ        | 1.75 | 0.001   |
| Total VFA        | 44.68ᵇ               | 73.55ᵃ                        | 69.91ᵃ        | 2.85 | 0.001   |
| Acetic acid      | 36.49ᵇ               | 49.56ᵃ                        | 42.82ᵃ        | 2.26 | 0.001   |
| Propionic acid   | 13.79ᵇ               | 18.33ᵃ                        | 21.03ᵃ        | 1.93 | 0.035   |
| Butyric acid²ᵃ   | 4.44                 | 5.67                          | 6.06          | 2.24 | 0.111   |
| A:P              | 2.01                 | 2.71                          | 2.04          | 2.84 | 0.070   |

VFA= Volatile fatty acid; A:P= Ratio of Acetic Acid and Propionic Acid
³ Different superscript in the same row show significant difference (P<0.05)
⁻ Non-significant (P>0.05)

Greater total VFA and VFA profile in T2 was probably due to high fermentation intensity as a result of greater uptake of nitrogen for microbial synthesis [9,10]. The greater uptake of nitrogen was in accordance with higher ammonia produced during nutrient degradation [11], therefore, greater VFA and ammonia profile was observed in T2 compared to T1. The rate of VFA’s production is closely related to the rate of substrate fermentation, whereas the molar proportion is associated with existed microbial species in the rumen [9]. An increase in the population of cellulolytic bacteria can be also one of the reasons why acetic acid and propionic acid production increases in T2 and T3 [10,11]. Greater propionic acid observed in T2 and T3 could also be attributed to high solubility of nitrogen and high carbon present for VFA production, this was in agreement with the study [11] that indicated the greater nitrogen availability in the rumen increased greater VFA production especially propionic acid. Greater nitrogen availability was shown through ammonia-N production that increased along with greater nitrogen content. Greater nitrogen content in T3 had higher ammonia production compared to T1, indicating that nitrogen availability from SBM was greater compared to Calliandra. However, nitrogen availability in T2 was likely similar to T3, thus Calliandra leaves can substitute nitrogen availability from SBM up to
50%. There was likely anti-nutritional quality in Calliandra leaves that hinders nitrogen availability to be degraded in the rumen. Meanwhile pH value remained stable and were within the range (6.8-7.2) similar to previous studies [12].

4. Conclusion
It can be concluded that in local farmers practice the use of Calliandra calothyrsus to substitute SBM should be in the 50:50 ratio to optimize the intake and ruminal fermentation profile. Further studies related to digestibility of Calliandra leaves should be conducted to provide further information related to the usage of Calliandra leaves as protein source in Goats diets.

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