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Chemical Composition and Relative Feed Value of Tree Legume Leaves as a Feed Source for Ruminants

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ABSTRACT

Background: Tree legumes are a pivotal to meet the nutritional needs to support the productivity of ruminants. The aim of this study was to evaluate the chemical composition and relative feed value of various types of tropical tree legumes as a potential feed source for ruminants.

Methods: The study was designed using a completely randomized design (CRD) with four treatments for legume tree species and three replications. A1 (*Sesbania grandiflora*), A2 (*Leucaena leucocephala*), A3 (*Calliandra calothyrsus*) and A4 (*Moringa oleifera*).

Result: Variance analysis showed that the species of tree legume had a significant effect (P<0.05) on the content of crude protein (CP), crude fibre (CF), nitrogen-free extract (NFE), digestibility of dry matters (DMD), dry matter intake (DMI), relative feed value (RFV) and not significantly different (P>0.05) on EE (EE). The four tree legumes had protein content above 20.20%, CF below 21.58%, EE below 7.88% and NFE above 33.48%, DMD above 65.00%, DMI above 3.4% of body weight, RFV above 182.74 including good quality feed ingredients. The four tree legumes are potential ruminant feed in the tropics.

Key words: Chemical composition, Feed sources, Relative feed value, Ruminants, Tree legumes.

INTRODUCTION

Ruminant livestock production in the tropics faces significant constraints, especially during the dry season when the availability and quality of forage decrease dramatically. These constraints arise due to fluctuations in pasture area and feed availability, conversion of grazing land into residential areas and high population growth (Giridhar *et al.,* 2021). To address these constraints, alternative sources of animal feed other than forages are needed.

Tree legumes have always played an important role in livestock production systems (Jayaprakash *et al.,* 2016). They have the potential to serve as a source of supplementary feed that can be utilized bysmall, medium and large-scale farmers to improve the nutritional value of feed and livestock productivity (Gebreyowhans and Zegeye, 2019). Tree legumes exhibit high protein content, digestibility and palatability and they are resistant to changes in weather and climate conditions (Simbaya *et al.,* 2020). Tree legumes are also widely regarded as easy to cultivate and deep-rooted; therefore, they are commonly used as live fences, conservation crops and erosion preventers (Sawen and Abdullah, 2020).

As tree legumes are crucial for maintaining ruminant productivity throughout the year, it is necessary to examine the nutritional value of potential tree legumes for ruminants. Variations in tree legumes nutritional value arise due to plant species, environmental conditions, soil types and rainfall differences (Darma *et al.,* 2023). Tree legumes, such as *sesbania, leucaena, calliandra* and *moringa*, are generally of prime quality. Therefore, it is vital to assess their nutritional value and quality. This study aims to determine the chemical composition of selected tree legumes growing in Makassar, Indonesia.

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MATERIALS AND METHODS

Time and area of leaves sampling study

This study was conducted in the tropical zone at the Faculty of Animal Science, Hasanuddin University, Makassar, South Sulawesi, Indonesia (5°07′383 S; 119° 29′E), at an average altitude of 20 meters above sea level. The research was carried out from April to September 2022.

Research methods

The research materials were tree legumes, namely *sesbania, leucaena, calliandra and moringa*, as shown in Fig 1. which were obtained from the pasture of the Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia. The age of the plants is approximately one year and they were grown on dusty clay soil with an average

rainfall of 55 to 200 mm³/day (Indonesian Central Statistics Agency, 2021).

Tree legumes werse obtained from several plants pruned at a height of two to three meters from the ground, totaling 10 kg. Twigs were separated from the plant branches and stalks and leaves suitable for livestock consumption were collected as one-kilogram samples. These samples were then dried in an oven at 65°C for three days. After drying, they were finely ground using a B-One Disintegration Machine Model DM-120 M with a sieve size of 40 mesh and analyzed for proximate composition in the laboratory (AOAC, 2019) and fiber fraction (Van Soest, 1994).

The experimental used was a completely randomized design (CRD) with 4 treatment and 3 replications of tree legumes. The types of tree legumes studied were:

A1: Sesbania leaves (*Sesbania grandiflora*)
A2: Leucaena leaves (*Leucaena leucocephala*)
A3: *Calliandra* leaves (*Calliandra calothyrsus*)
A4: *Moringa* leaves (*Moringa oleifera*)

Data processed with SPSS Statistics software version 26. If the treatment had a significant effect, it was followed by the Duncan multiple range test (Gaspersz, 1994). DMD, DMI and RFV of selected tropical tree legumes were estimated using the equations proposed by Horrocks and Vallentine (1999):

$$DMI = 120/\%NDF \text{ on dry matter basis}$$

$$DMD = 88.9 - (0.779 \times ADF)$$

$$RFV = (DMD \times DMI)/1.29$$

If the RFV value is greater than 151, then the tree legume is considered the best or prime feedstuff.

RESULTS AND DISCUSSION

The effect of species differences on chemical composition

Table 1 presents the nutrient content of different types of legumes. Variance analysis showed that the type of tree legume had a significant effect ($P<0.05$) on the content of CP, CF, EE and NFE. As shown in Table 1, the A4 treatment had the highest CP content, while the A1 treatment had the lowest. The CP content obtained in this study for the four types of legumes, namely *sesbania*, *leucaena, calliandra* and *moringa*, was above 20.20%. The CP content, in general, was almost the same and even higher than that obtained in several studies, except for *sesbania* and *moringa*.

The protein content in *sesbania* in this study is comparable to the findings reported by Bayissa *et al.* (2022) at 20.30% but lower than the results of the studies conducted by Islam *et al.* (2021) at 21.13%. according to Hameed and Priya, (2022) the nutritional value of *Sesbania grandiflora* includes protein (30-45%) and CF (7.75-11.75%). *Sesbania aculeata* contain a high amount of nutrients and it is a potential ingredient in feed preparation (Raman *et al.,* 2024). The protein content in *leucaena* in this study was higher than the research of Olomonchi *et al.* (2022) at 19.78% and lower than Simbaya *et al.* (2020) that reported at 24.5%. The CP content of *calliandra* obtained in this study was higher than Adrizal *et al.* (2021) which was 19.93%. The CP of *moringa* in this study was 26.57%, higher than the findings of Singh *et al.* (2019) at 23.95% but lower than the findings of Simbaya *et al.* (2020) which reached 28.63%. according to Meel *et al.* (2021) nutrient values in *Moringa* leaf are CP: 24.56%, EE: 7.10%, C. Fiber: 7.82%, NFE: 51.32%, NDF: 11.30%, ADF: 8.39%, Ca: 1.58% and P: 0.30%, while Raju *et al.,* (2024) reported that the nutrient content of *Moringa* is 18.35% CP, 8,56% EE, 6.71%



Fig 1: (a) *Sesbania grandiflora*, (b) *Leucaena leucocephala*, (c) *Calliandra calothyrsus*, (d) *Moringa oleifera*.

Table 1: Chemical composition of tree-forage legume leaves.

Parameters	A1	A2	A3	A4
CP (%)	20.20^{a}	22.73^{b}	23.73^{c}	26.57^{d}
CF (%)	14.96^{a}	15.09^{a}	14.69^{a}	21.58^{b}
EE (%)	7.62^{a}	7.88^{a}	7.18^{a}	7.61^{a}
Nitrogen-free extract (NFE) (%)	46.60^{b}	45.51^{b}	48.99^{c}	33.48^{a}

Note: A1: sesbania, A2: leucaena, A3: calliandra, A4: moringa.

CF and 54.84% NFE. Boulal *et al.,* (2021) also reported that *Moringa oleivira* has a high antioxidant power. *Leucaena* has high nutrient content, bypass protein and can reduce gas production. According to Indonesian National Standard (2022), concentrate needs for fattening cattle require a minimum CP of 14% and for dairy goat kids, a minimum CP of 16% is required. The replacement of concentrates as green fodder can be accomplished by these four tree legumes.

The CF content of *leucaena* in this study was lower than the results reported by Marhaeniyanto *et al.* (2019) amounting to 21.51%. The CF content of *calliandra* in this study was lower than the results reported in the studies of Adrizal *et al.* (2021) which were 32.43%. The CF content of *moringa* in this study was lower than the 23.09% found in Mahima *et al.* (2014) research. The CF content of *sesbania* and *leucaena* in this study was smaller than Agustono *et al.* (2017) findings of 33.13%. and 20.10%. CF content increases with longer cutting age, while protein content conversely decreases (Abqoriyah *et al.,* 2015). CF in this study has sufficient value as a source of fibre. Suharti *et al.* (2019) report that CF content of 12.74% can provide a body weight gain of local male sheep.

The EE content ranged from 7.18% (*calliandra*) to 7.88% (*leucaena*). The EE content of *sesbania* in this study was higher than that of Bayissa *et al.* (2022) at 2.76% and Olomonchi *et al.* (2022) findings of 2.95%. The EE content of calliandra in this study was higher than the results of Adrizal *et al.* (2021) findings of 2.83%. However, it was lower than the result of Nyakira *et al.* (2015) which reached 12.69%. The EE content of *moringa* in this study is higher than the results of Simbaya *et al.* (2020) which only amounted to 6.8%. According to Indonesian National Standard (2022), the EE requirement for fattening sheep is a maximum of 7.00%. The results obtained in this study ranged around 7.00%, meaning it meets the needs of ruminants.

The NFE in *calliandra* in this study amounted to 48.99%, which is higher than the results of Nyakira *et al.* (2015) which is 45.54%. However, this result is lower than Jayaprakash *et al.* (2016) research findings of 54.86%. The NFE content of *moringa* in this study was lower than Mahima *et al.* (2014) at 51.11%. The NFE content of *sesbania and leucaena* in this study is higher than Agustono *et al.* (2017) which only reached 25.65% and 30.48%. Sutaryono *et al.* (2019) stated that *sesbania, leucaena* and *indigofera* are tree legumes favored by cattle, but *calliandra* and *moringa* are less preferred. NFE generally contains starch, which has the potential to serve as an energy source. The four tree legumes had NFE contents ranging from 33.48% to 48.99%, making them sufficient as a source of digestible energy.

DMD was highest at 74.32% in *sesbania* and lowest at 65.00% in *calliandra*. Duncan's multiple range test showed that the dry matter digestibility of *calliandra* was lower than that of *leucaena*, *moringa* and *sesbania*. The DMD of *sesbania* was the same as that of *moringa*.

The dry matter digestibility of leucaena in this study was higher than Olomonchi *et al.* (2022b) findings of 57.7% but lower than Kökten *et al.* (2012) research, which reached 76.8%. Similarly, the DMD result of *moringa* in this study, at 74.10%, was lower than Arif *et al.* (2020) findings of 76.61%. Moreover, the DMD in this study surpassed the *in vitro* dry matter digestibility of Despal *et al.* (2023) research, that is *moringa* 66.31%, *leucaena* 46.35% and *calliandra* 28.54%.

The higher the DMD of a feed ingredient, the better the quality of the feed ingredient. DMD digestibility above 65.00% indicates prime quality standards, as observed in *sesbania, moringa* and *leucaena*. Physically, the texture of *calliandra* is stiffer, closely related to the relatively high lignin content of *calliandra*, which is 12.76% compared to other legume (Islamiyati *et al.,* 2022). The tannin content in *calliandra* is 3.2%, which causes low DMD. The DMD value of *calliandra* in this study is in the grade 1 category, while *sesbania*, *leucaena* and *moringa* fall into the prime category (Horrocks and Vallentine, 1999). The highest DMI was 5.22% of body weight in *sesbania* and the lowest was 3.40% of body weight in *leucaena*. According to Duncan's multiple range test, DMI was lower in compared to, *moringa* and *sesbania*.

The DMI of the four legume observed was above 3, indicating prime quality (Horrocks and Valentine, 1999). The DMI result for leucaena in this study was lower than Kökten *et al.* (2012) study, which reached 6.8% of body weight but higher than Fekadu *et al.* (2018) finding of 2.22%. The DMI of this study is higher than Olomonchi *et al.* (2022) finding of only 1.90% of body weight. Arif *et al.* (2020) obtained DMI results for *moringa* of 4.85, while in this study is to 4.26, which was lower than Fekadu *et al.* (2018) that is 2.81. The result of DMI analysis of *sesbania* in this study was 5.22, higher than Fekadu *et al.* (2018) that of 2.88. The DMI results of this study mean that they have met these requirements. The DMI value is included in the prime

Table 2: Relative feed value of Tree-forage legume leaves.

Tree legume	ADF (% of DM)	NDF (% of DM)	DMD (% of DM)	DMI (% of BW)	RFV	Quality of RFV
A1	18.72^{a}	23.01^{a}	74.32^{a}	5.22^{a}	300.72^{c}	Prime
A4	19.00^{a}	28.17^{b}	74.10^{a}	4.26^{a}	244.26^{b}	Prime
A2	24.77^{b}	35.33^{d}	69.61^{b}	3.40^{b}	183.28^{a}	Prime
A3	30.70^{c}	33.08^{c}	65.00^{c}	3.63^{b}	182.74^{a}	Prime

Note: A1: sesbania, A2: leucaena, A3: calliandra, A4: moringa.

category if it has a value > 3 (Horrocks and Valentine, 1999). In this study, the DMI values for selected legume were > 3.4, so they are included in the prime category.

The effect of species differences on RFV

Table 2 presents the highest RFV was 300.72 in *sesbania* and the lowest was 182.74 in *calliandra*. Duncan's multiple range test showed that the RFV of *calliandra* was the same as that of *leucaena*, lower than that of *sesbania* and *moringa*. The RFV results of leucaena in this study are lower than the findings of Kokten *et al.* (2012) which reached 403.7, but higher than Olomonchi *et al.* (2022) findings of 85.4. Similarly, the RFV value of *moringa* in this study is higher than the findings of Arif *et al.* (2020) which only amounted to 299.13. The assumption is that all parts of *moringa* can be used as high-value feed.

The average RFV of *sesbania* , leucaena , *calliandra* and *moringa* with CP content greater than 19%, ADF less than 31%, NDF less than 40% and DMD greater than 65% and DMI higher than 3.0% of BW, indicate that these legumes are prime quality feedstuffs. The RFV values of the four selected tree legumes observed were more than 151 in the prime category (Horrocks and Valentine, 1999).

CONCLUSION

The four tree legumes are *sesbania*, leucaena, *calliandra* and *moringa*, with protein content above 20.20%, CF below 21.58%, EE below 7.88%, NFE above 33.48%, DMD above 65.00%, DMI above 3.4% of body weight, RFV above 182.74 and RFQ above 223.85, including superior-quality feed ingredients. The four-tree legume are potential ruminant feed in the tropics.

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Conflict of interest

All authors declared that there is no conflict of interest.

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