Digestibility of Calliandra, *Indigofera sp.* and the Mixture in the Ration as a Substitute for the Concentrate Given to the Tup Garut

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ABSTRACT
This research aims at figuring out the digestibility value of the weaning tup Garut with rations *Calliandra calothyrsus*, *Indigofera sp.*, and mixture as a concentrate substitution (*in vivo*). Six treatment of experimental rations were tested consisting of P0 (70% *P. purpureum* cv. Mott + 30% Concentrate), P1 (70% *P. purpureum* cv. Mott + 15% Concentrate + 15% *C. calothyrsus*), P2 (70% *P. purpureum* cv. Mott + 15% Concentrate + 15% *Indigofera sp.*), P3 (70% *P. purpureum* cv. Mott + 30% *C. calothyrsus*), P4 (70% *P. purpureum* cv. Mott + 30% *Indigofera sp.*), dan P5 (70% *P. purpureum* cv. Mott + 15% *C. calothyrsus* + 15% *Indigofera sp.*). The method used was Completely Randomized Design (CRD) with four replications, while the observed variables were dry matter digestibility, organic matter digestibility, and crude protein digestibility. The results show that there is an effect of treatment ($P<0.05$) on the ration digestibility value. It can be concluded that the concentrate substitution using 15% *Calliandra calothyrsus* and 15% *Indigofera sp.* results in the best ration digestibility, namely 77.10% dry matter digestibility, 77.65% organic matter digestibility, and 71.48% crude protein digestibility.

Keywords: *Calliandra calothyrsus, Indigofera sp., male garut sheep, digestibility value.*

1. INTRODUCTION

Garut sheep is considered West Java's germplasm asset due to its dual functions, i.e. as meat-type and fighting sheep. Garut sheep population is estimated to reach approximately 947.382 in 2015 [1]. As a meat-type animal, Garut sheep can produce meat equals to 50% of its weight, which is higher than other sheep (45 to 48%) [2]. Among the merit, Garut sheep are high-quality skin and high proliferation ability [3].

Garut sheep's maintenance, production, and reproduction abilities heavily depend on its feed. Feed exhibits the highest proportion compared to seed and care management, as 60-75% of production cost is spent for feed, resulting in high production cost. Therefore it is necessary to find alternative feeds by utilizing legumes.

Leguminosae refers to forage that can increase the nutrition quality and protein supply [4]. Leguminosae is known to have high crude protein (CP) content and anti-nutrition that can benefit the animal at a certain level. Calliandra and *Indigofera sp.* are leguminosae with high CP [5] and productivity that can grow during the dry season. It is estimated that the production of Calliandra planted in wet/dry tropical environment reaches 0.80 - 5.60 tons/ha, which equals to 4.80-33.60 tons/ha/ year of dry matter [6], while *Indigofera sp.* in 60 days of cutting age can produce around 31.20 tons/ha/year of dry matter [7].

Legumes are known to have different levels of tannin. Tannin is polyphenolic compounds that can protect proteins from rumen microbial degradation by protease enzymes. However, it is also a limiting factor for protein absorption because of their ability to bind tannins to form protein-tannin bonds [8]. While

Calliandra contains a high tannin level (up to 11%) [9], Indigofera is known to have a low tannin level (around 0.08-0.61%) in different foliar fertilizer concentrations [10]. A Co-feeding system is a feeding method that combines high and low tannin feeds. This method, according to Herdiawan *et al.* [11], aims to prevent some proteins from being degraded by rumen microbes.

Kaliandra can be used to protect protein [12], to prevent the protein from being degraded by rumen and may serve as the source of protein for the host. Meanwhile, *Indigofera sp.* can be digested in the rumen and act as the source of protein for rumen microbes. Kaliandra and *Indigofera sp.* are expected to meet the animal needs in the rumen and post-rumen, which positively affect the digestibility. Both plants are expected to substitute concentrate feed in order to minimize the production cost.

The present study aimed to figure out the digestibility score of calliandra, *Indigofera sp.* And their mixtures as concentrate substitutions to weaning tup Garut feed ration.

2. MATERIALS AND METHODS

2.1. Materials and Research Design

This study used twenty-four 2-6 months old weaning tup Garut, weighted around 8-12 kilograms (coefficient of variation: 12,05%). They were placed in an individual pen with a raised floor system. The slatted wooden floor allows the sheep manure to fall through the hole. Prior to treatment, animals were given antihelmintic.

This study applied complete randomized design with six ration combinations, including: P0 (70% *Pennisetum purpureum* cv. Mott + 30% concentrate), P1 (70% *Pennisetum purpureum* cv. Mott + 15% concentrate + 15% *Calliandra calothyrsus*, P2 (70% *Pennisetum purpureum* cv. Mott + 15% concentrate + 15% *Indigofera sp.*), P3 (70% *Pennisetum purpureum* cv. Mott + 30% *Calliandra calothyrsus*), P4 (70% *Pennisetum purpureum* cv. Mott + 30% *Indigofera sp.*), and P5 (70% *Pennisetum purpureum* cv. Mott + 15% *Calliandra calothyrsus* + 15% *Indigofera sp.*). Each treatment was repeated for four times.

Feed rations in this study consisted of dwarf elephant grass (*Pennisetum purpureum* cv. Mott), calliandra (*Calliandra calothyrsus*), and *Indigofera sp.* with ±2-3 months defoliation time. The forage included leaves and stalk, which were chopped and aged for ±1 night. The concentrate used in this study was commercial concentrate, consisting of rice bran, pollard, soy sauce pulp, coconut meal, molasses, and mineral mix. The experimental feed rations contained 12-16% crude protein and 57-60% total digestible nutrient, respectively. The feed ingredients and nutritional content used in this study were shown in Table 1.

2.2. Procedures and Observed Variables

The study was conducted for 3.5 months, including the house preparation, animal, ration, equipment, and raising period. The raising period was performed for twelve weeks, consisting of the first two weeks of adaptation period and ten-weeks of the treatment period (*in vivo*).

Rations were given in 3.5 - 4.0% of the animal weight based on dry matter. The administration was adjusted to the changes in animal weight, which was weighted biweekly during the study. Feed ration was given three times a day, in the morning (08.00), noon (10.00), and afternoon (16.00). The drinking water was provided all the time in the house.

Feces were collected twice a day for the last seven consecutive days using a net. 10% of the collected feces were analyzed to examine the digestibility. The observation included dry matter digestibility (DMD,%), Organic matter digestibility (OMD, %), and Crude protein digestibility (CPD, %). The digestibility was measured using the total collecting method [15]. The data were analyzed using ANOVA, followed by Duncan Multiple Range Test [16].

$$DMD = \frac{\text{dry matter intake} - \text{excretion dry matter (feces)}}{\text{dry matter intake}} \times 100\%$$

$$OMD = \frac{\text{organic matter intake} - \text{excretion organic matter (feces)}}{\text{organic matter intake}} \times 100\%$$

$$CMD = \frac{\text{crude protein intake} - \text{excretion crude protein (feces)}}{\text{crude protein intake}} \times 100\%$$

Table 1. Feeding materials and Nutrient Content

Nutrient Content of Feed	Percentage						
	DM	CP	EE	CF	NFE	TDN	Tannin
P. purpureum cv. Mott[1]	24.40	10.04	0.94	30.38	44.09	54.60*	-
C. calothyrsus[1]	31.56	27.31	2.35	23.91	39.29	62.69	11.00[5]
Indigofera sp.[1]	26.67	29.31	2.46	19.86	41.24	62.64	0.08[6]
Rice bran[2]	88.93	9.90	14.10	11.60	48.70	74.00	-
Pollard[3]	88.67	18.72	4.72	6.92	65.88	69.20	-
A. Soysauce pulp[4]	85.43	30.81	8.23	22.77	22.97	66.00	-
B. Coconut meal[2]	88.95	21.60	10.20	12.10	49.70	85.00	-
Molasses[2]	77.00	5.40	0.30	10.00	74.00	70.70	-
Mineral mix[2]	98.00	0	0	0	0	0	-
Treatment**	Nutrient Content of Research Ration (%)						
	DM	CP	EE	CF	NFE	TDN	Tannin
P0	31.16	12.00	3.95	25.31	43.80	60.00	-
P1	28.46	13.06	2.54	26.56	43.79	58.00	1.65
P2	27.77	13.57	2.48	26.02	43.95	58.00	0,012
P3	26.18	15.22	1.36	28.44	42.65	57.03	3.30
P4	25.04	15.82	1.40	27.22	43.24	57.01	0,024
P5	25.60	15.52	1.38	27.83	42.94	57.02	1,662

Description:
[1]Ruminants Nutrition and Food Chemistry Laboratory of Faculty of Animal Science, Universitas Padjajaran (Lab. NTR-KMT) (2017); [2][13]; [3][14]; [4]Ruminants Nutrition and Food Chemistry Laboratory of Faculty of Animal Science, Universitas Padjajaran (2016); [5][9]; [6][10];

*Calculation result of regression equation model:
Formula: -26.685 + 1.334 (CF) + 6.598 (Fat) + 1.423 (NFE) + 0.967 (CP) –0.002 $(CF)^2$ –0.670 $(Fat)^2$ –0.024 (CF) (NFE) –0.055 (Fat) (NFE) –0.146 (Fat) (CP) + 0.039 $(EE)^2$ (CP).
** Trial and eror

3. RESULTS AND DISCUSSIONS

Dry matter digestibility includes many absorbed food substances, while organic matter digestibility includes crude protein, crude fat, crude fiber, and BETN fermented in the rumen. Digestibility represents how much rations are absorbed by animals. A high-quality ration can bring a huge benefit for the animal. Dry and organic matter digestibilities are the main indicator of forage quality [17].

Dry matter, organic matter, and crude protein digestibilities found in this study are 69.95-77.10%, 70.72-77.65%, and 63.60-71.47%, respectively. These scores are higher than those in other studies (DMD 43.6-60.1%, OMD 46.3-62.5% [18], dan CPD 45,1-69,9%) that used *Brachiaria ruziziensis* and *Indigofera sp.* on goat. Meanwhile, the study using calliandra exhibits DMD and OMD scores of 64.74% and 65.39%, respectively [19]. The other study reports DMD score of 59.89% and OMD score of 54.54% with calliandra planted in acid soil [20].

The statistical analysis result indicates that the treatment significantly affects all digestibility parameters. The Duncan test result shows a difference in DMD, OMD, and CPD scores among the treatments given. The DMD and OMD scores of P5 (77.10% and 77.65%) are significantly different ($P<0.05$) from P0 (70.13% and 71.00%) and P2 (69.95% and 70.72%). However, P5 is not significantly different from P1 (72.27% and 74.35%), P3 (71.99% and 72.70%), and P4 (74.92% and 75.51%). Regarding CPD score, P5 is significantly different from ($P<0.5$) P0 (63.60%), P2 (64.95%) and P3 (65.67%) while it is not significantly different from P1 (67.14%) and P3 P4 (67.48%). This result indicates that calliandra and *Indigofera sp.* mixture can substitute the use of concentrate in feed rations with a high digestibility score.

The highest average DMD, OMD, and CPD scores are found in P5 mixture. Ration digestibility refers to the rations absorbed by the animals and are not excreted in feces [21]. The higher the digestibility score, the higher the opportunities the animal benefits from the

Table 2. Dry Matter, Organic Matter, and Crude Protein Digestibility of ration contains dwarf elephant grass, calliandra and *Indigofera sp.*

Treatment	DM±St.Dev	OM±St.Dev	CP±St.Dev
	...% ...	...% ...	...% ...
P0	70.13^{a} ± 2.89	71.00^{a} ± 2.81	63.60^{a} ± 2.63
P1	72.27^{ab} ± 5.28	74.35^{ab} ± 4.96	67.14^{ab} ± 4.45
P2	69.95^{a} ± 3.49	70.72^{a} ± 3.52	64.95^{a} ± 2.93
P3	71.99^{ab} ± 2.96	72.70^{ab} ± 3.00	65.67^{a} ± 3.09
P4	74.92^{ab} ± 3.86	75.51^{ab} ± 3.79	67.48^{ab} ± 3.42
P5	77.10^{b} ± 2.52	77.65^{b} ± 2.39	71.47^{b} ± 1.01

Different superscripted letter in the same column indicate significant difference (P <0.05). DM : dry matter, OM : organic matter, CP : crude protein, St.Dev : standard deviation. P0 (70% *P. purpureum* cv. Mott + 30% Concentrate), P1 (70% *P. purpureum* cv. Mott + 15% Concentrate + 15% *C. calothyrsus*), P2 (70% *P. purpureum* cv. Mott + 15% Concentrate + 15% *Indigofera sp.*), P3 (70% *P. purpureum* cv. Mott + 30% *C. calothyrsus*), P4 (70% *P. purpureum* cv. Mott + 30% *Indigofera sp.*), dan P5 (70% *P. purpureum* cv. Mott + 15% *C. calothyrsus* + 15% *Indigofera sp.*)

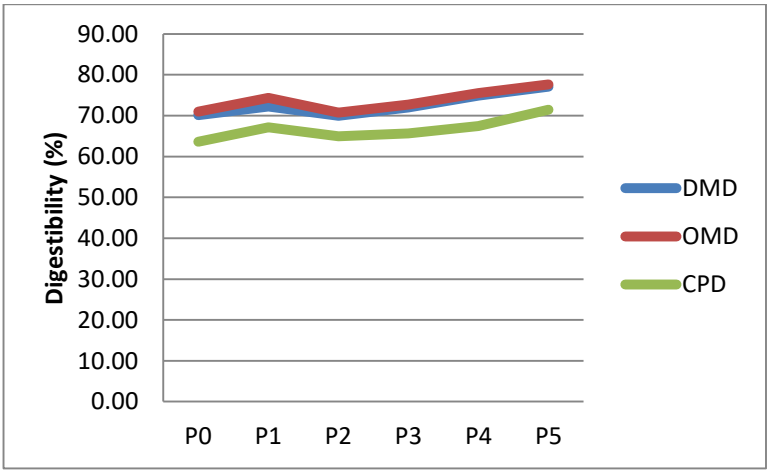

Figure 1. The Average Value of Digestibility

nutrients. Digestibility can be affected by several factors, including composition, physical form, number of consumed feed, and the animal's physiological condition [22].

P1 (15% *C. calothyrsus*), P3 (30% *C. calothyrsus*), and P4 (30% *Indigofera sp.*) are significantly different from P5 (15% *C. calothyrsus* and 15% *Indigofera sp.*). *Indigofera sp.* and calliandra contain tannin (0.08% and 11%). Tannin can protect the ration protein from being degraded in the rumen (protein bypass). A high digestibility score of P5 (15% *C. calothyrsus* and 15% *Indigofera sp.*) may be accounted for by the co-feeding method applied in this study. The purpose of the co-feeding method is to prevent protein from being degraded in the rumen by binding it to the feed that contains a high tannin level [11].

Calliandra is known to have high tannin content, while *Indigofera sp.* is known to have low tannin content. Thus, both can complement each other. *Indigofera sp.* can provide protein for rumen microbes, while calliandra provides protein for the host. The formed tannin-protein bound would be broken down in the abomasum (pH 2,5-3,5) and duodenum (pH 5-9), allowing the protein to be digested and absorbed more by the small intestine [23].

This differs from P0 (without Leguminosae) and P2 (15% *Indigofera sp.*), which exhibit the lowest digestibility score. Grass and concentrate do not contain tannin, while *Indigofera sp.* Contain low tannin level. This causes the feed ration consumed to be degraded in the rumen and used by rumen microbes to form microbial protein, reducing the rations digested or absorbed by the small intestines.

High crude protein content reflects high N in the ration, which positively affects the rumen microbes' development and activities in digesting rations [24]. High protein and TDN consumption may supply the required N and energy for rumen microbes that play

roles in the digestion process their protein [25]. Better rumen microbes' growth may result in better feed ration digestibility [26].

Calliandra and *Indigofera sp.* mixture is proven to improve the digestibility of the ration. The use of both is still within the leguminosae usage limit. The maximum limit for calliandra is 30% [11], while the limit for *Indigofera sp.* is 30-45% [18]. *I. zollingeriana* can be used as a concentrate feed element with a maximum limit of 20% [17].

4. CONCLUSION

The use of 15% *C. calothyrsus* and 15% *Indigofera sp.* exhibit a high digestibility score, indicating that the mixture be used as an alternative feed to substitute concentrate.

AUTHORS' CONTRIBUTIONS

SN designed and conducted the experiment, collected the data and drafted the manuscript. R checked the data analysis and revised the manuscript. RK checked the data analysis, revised the manuscript and paper speaker. All authors read and approved the final manuscript.

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