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Indigofera zollingerianan Effect as a Subtitute of Concentrate on Growth of Etawa Goats to Digestibility of Fiber Fractions

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ABSTRACT
This study was aimed to determine the effect of giving *Indigofera zollingeriana* as a substitute for concentrate in the diet of Etawa crossbreed goats during growth fed by field grass on fiber fraction digestiility. This study used an experimental method with a Randomized Block Design with 3 treatments and 4 replications. The dietary treatments consisted of (P1) field grass 60% + *Indigofera zollingeriana* 10% + concentrate 30%, (P2) field grass 60% + *Indigofera zollingeriana* 20% + concentrate 20%, (P3) field grass 60% + *Indigofera zollingeriana* 30% + 10% concentrate. The observed variables were the digestibility of the fiber fractions consisting of neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose and hemicellulose. The results showed that the replacement of concentrate with *I. zollingeriana* did not have a significant effect (P>0.05) on the digestibility of NDF, ADF, cellulose and hemicellulose. The results showed that the substitution of concentrate with *I. zollingeriana* up to 30% in the diet had a significantly different effect (P>0.05) on the digestibility of the fiber fraction. The digestibility range of NDF, ADF, cellulose, and hemicellulose were 68.15%-71.55%, 50.59%-56.06%, 72.38%-75.41% and 91.15%-92.57%, respectively. This study concluded that the use of 30% *Indigofera zollingeriana* as a substitute for concentrate in the diet of the Etawa goat showed the highest digestibility value of the fiber fractions. It's composition of the ration was 60% field grass + 30% *Indigofera zollingeriana* + 10% concentrate (P3 ration).

Keywords: *Etawa Goats, Digestibility, Fiber Fractions, Indigofera zollingeriana*

1. BACKGROUND

Goats are small ruminants that are very popular in Indonesia, because they have high economic value and are able to adapt with the Indonesian climate. In general, goats are quite easy to cultivate and do not require large areas of land to maintain. The types of goats that are generally maintained are Kacang goats and Etawa crossbreed (Peranakan Etawa; PE) goats. The PE goat is the result of a cross between the Etawa goat from India and the Kacang goat, which is dual-purpose as a producer of meat and milk.

The ration or feed that is usually given still relies on forage consisted of leaves and grass. Foliage has better nutritional quality than grasses, but leaves are now increasingly difficult to obtain due to limited land available for forage cultivation. This is because some of the land has been converted for settlement and other development. Regarding on this problem, farmers use field grass as the main feed. Field grass as fodder for ruminants is not only easy to obtain because it has high adaptability, especially in the tropics. In addition, field grass has low quality, this is indicated by the crude protein content at 8.82%, total digestible nutrient (TDN) at 53.53%, and crude fiber at 32.59% [1] Dietary single feed such as field grass cannot provide sufficient nutrients to support the productivity of goat, because the nutrients contained in field grass are not able to meet their physiological needs for nutrients, especially protein.

The productivity of goats can be increased by combining field grass with other feed ingredients containing higher nutrients, so that the nutrients content of feed increase. Generally, the feed ingredients used as supplements are concentrates. Concentrates include grain products and their processed wastes as well as types of cakes. Concentrate is a feed ingredient that is rich in energy, protein, minerals, vitamins, low in cassava fiber content and easy to digest, so that it can increase feed

consumption and digestibility. By giving concentrate on grass-based feed, it is expected to increase the digestibility value of the given ration so that it can meet the needs for optimal life, growth, production and reproduction. In general, the price of concentrate feed in the market is relatively expensive which has an impact on large production costs so that it is often not affordable by farmers.

To overcome this problem, the right choice to reduce the use of conventional concentrate is by providing high forage quality through combined field grass with *Indigofera zollingeriana. Indigofera zollingeriana* has been widely developed because it fairly high biomass production, is highly adaptive to low soil fertility, is easy and inexpensive to maintain and has the potential for seed production throughout the season [2]. Previous study [3] reported that the legume *I.zollingeriana* had an average leaf and stem production of 967.75 grams (36.43%) and 1627.25 grams (63.57%) of the total fresh production, respectively. The *I. zollingeriana* can be cultivated in the tropics with leaf production reaching 4096 kg dry matter (DM)/ha [4]. In addition, the legume *I.zollingeriana* has excellent nutrient content, including crude protein (27.9%), crude fiber (15.25%), and fairly high mineral content, consisting of calcium (Ca) 0.22%, phosphorus (P) 0.18% [5] and contains anti-nutrients, such as tannins (0.3-0.4%), saponins (2-4) [4]. The high crude protein, low crude fiber and anti-nutritional content are expected to increase digestibility, so *I.zollingeriana* is very suitable to be used as a substitute for concentrates. Previous study [6] reported that the use of the legume *I. zollingeriana* was able to replace 15% concentrate in complete rations without having a negative impact on livestock consumption and production.

Digestion is a series of processes that occur in the digestive tract until absorption occurs [7]. Measurement of digestibility is needed to determine the potential of the ration that can be utilized by livestock. The higher the digestibility, the better the quality of the ration given. One of the benchmarks to see the digestibility of the ration is the digestibility of the fiber fraction. The digestibility of the fiber fraction was in the form of digestibility of neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose and hemicellulose. Digestibility of the fiber fraction serves to see the digestibility of crude fiber that can be digested in the body of the livestock itself. The higher level of digestibility result in the better the nutritional value of a feed ingredient. Limiting information regarding the data *I. Zollingeriana* for ruminants consumed. Therefore, to see the digestibility quality of the combined ration of field grass with *I. zollingeriana* as a substitute for concentrate in growing PE goats, it is necessary to conduct a study entitled "Use of *I.zollingeriana* as a substitute for concentrate in the diet of growing Etawa goats given field grass on fiber fraction digestibility."

2. MATERIALS AND METHODS

2.1. Research Materials

The livestock used in this study were 12 male of Etawa goats with a body weight of 23-35 kg. The cages used were individual metabolic cages with a size of 1.5 x 0.5 meters each, equipped with a place to eat and a place to drink. The equipment used in this study were a scale to measure the weight of goats, buckets, shovels, feces storage boxes, scales to weigh goat feces, plastic, and laboratory equipment and chemicals used for sample analysis.

2.2. Research ration

The ration used in this study was a mixed ration consisting of *I. zollingeriana* combined with field grass. Concentrate comes from several feed ingredients, namely rice bran, corn, soybean meal, tofu dregs. The composition and chemical composition of the ingredients for the rations and research rations can be seen in the table below.

2.3. Research design

This research was conducted experimentally using a Randomized Block Design (RAK) with 3 treatments and 4 groups as replicates. The grouping was conducted based on the weight of the livestock. The treatment in this study is as follows: (Balance of forage and concentrate = 60:40)

Table 1. The content of nutrients in the feed ingredients that make up the ration

Ingredients	Nutrients (% DM,t)							
	DM	OM	Ash	CP	FC	CF	BETN	TDN
Field grass**	19.29	88.16	11.84	10.05	1.79	27.85	54.18	59.34
*Indigofera zollingeriana****	22.13	83.95	12.72	24.17	2.87	15.25	41.66	75.47
Fine bran*	88.78	91.49	8.51	8.07	8.58	15.05	59.80	71.16
corn*	84.03	97.9	2.1	11.05	4.12	3.3	79.43	86.25
Soybean meal*	87.56	80.81	19.19	49.37	2.83	6.04	22.24	81.71
Dregs tofu*	21.63	91.97	8.03	24.99	5.91	7.73	53.34	83.24

Note:*[8],**[9], ***[10]

Table 2. The content of the fiber fraction of the ration preparation material (% DM)

Feed Ingredients	NDF	ADF	Hemicelulosa	celulosa	Lignin
Field grass**	57.46	32.4	25.06	28.24	4.16
*Indigofera zollingeriana**	35.14	21.54	13.6	17.79	3.75
Fine born***	33.35	18.89	14.50	10.93	5.81
Corn	-	-	-	-	-
Soybean meal	-	-	-	-	-
Dregs tofu	-	-	-	-	-

Note:* [10], **[11], ***[12]

Table 3. Research ration composition (%)

Ration material	Treatment		
	P1	P2	P3
Field grass	60	60	60
Indigofera zollingeriana	10	20	30
Concentrate	30	20	10
Amount	100	100	100

Table 4. Chemical composition of research ration (% DM)

Komponen	Treatments		
	P1	P2	P3
Dry Matter (DM)	39.00	33.94	28.71
Organic matter (OM)	87.00	86.13	85.42
Crude protein (CP)	14.00	14.11	14.35
Crude Fat (CF)	3.24	2.83	2.42
Crude fiber CF)	23.14	23.73	24.33
Nitrogen-Free Extract Ingredients (BETN)	46.61	45.47	44.33
Total Digetible Nutrients (TDN)	64.14	64.06	63.98
Neutral Ditergent Fiber (NDF)	45.44	46.47	47.50
Acid Ditergent Fiber (ADF)	25.50	26.35	27.20
Hemicelulosa	19.94	20.12	20.30
Celulosa	22.03	22.71	23.38
Lignin	3.47	3.65	3.82

Note: Calculated from Table 1, 2 and 3

P1 : 60% field grass + 10% *Indigofera zollingeriana* + 30% concentrate
P2 : 60% field grass + 20% *Indigofera zollingeriana* + 20% concentrate
P3 : 60% field grass + 30% *Indigofera zollingeriana* + 10% concentrate

The mathematical model of the design used in accordance with the design according to Steel and Torrie (1991) is

$Yij = +\tau i+\beta j+\sum ij$

Information :
Yij = The observation value of the experimental unit that received the i-th treatment and the j-th group
= General mean
i = Effect of i-th treatment
j = Effect of the j-th group
ij = Effect of error in the i-th treatment and the j-th group

2.4. Data Analysis

The data obtained from the research would be processed statistically using analysis of variance by Randomized Block Design. Measured Parameter in this study were the digestibility of NDF, ADF, cellulose and hemicellulose.

2.5. Research implementation

2.5.1. Research Feeding

The forage used in the study was field grass, which was given in fresh form, while *I. zollingeriana*, which was used as a substitute for concentrate was dried and given in the form of flour mixed with concentrate. The

concentrate was composed of fine bran, corn, soybean meal, and tofu dregs.

2.5.2. Goat maintenance

Before conducting the research, the cage was cleaned and sanitized with a disinfectant. Livestock to be used are checked for health and given worm medicine.

1) Adaptation
   The adaptation period was carried out before the study was carried out for 7 days. This period was intended, so that livestock could adapt to the environment and the ration given.
2) Introduction
   This preliminary period was carried out for 7 days, which aims to eliminate the influence of the previous ration.
3) Collection Period
   The period was carried out for 5 days, where in this period the ration consumption and feces were measured. The excreted feces were weighed every day and then 10% of the feces samples were taken for each treatment, put in plastic and dried in the sun and then analyzed in the laboratory.

3. RESULTS AND DISCUSSION

3.1. Digestibility Neutral Detergent Fiber (NDF)

Table 5. Average Digestibility of NDF

Treatments	Avarage of NDF(%)
P1	65.70
P2	65.01
P3	69.90
SE	2.81

Note: Values in the same column show no significant difference (P>0,05).

The results of the analysis of variance showed that the use of *I. zollingeriana* up to 30% as a substitute for concentrate in the ration had a significantly different effect (P>0.05) on the digestibility value of NDF. The average digestibility of NDF ranged from 65.01% at P2 (using *I. zollingeriana* at 20%) to 69.90% at P3 (using *I. zollingeriana* at 30%).

As shown in Table 5, the replacement of concentrate with *I. zollingeriana* in the diet showed the highest average NDF digestibility value that was found in the P3 diet (I. *zollingeriana* a 30%), although statistically the effect was not significantly different. This statement was contradictory, because the digestibility at P3 lignin content was relatively the same for each treatment. It was possible that the high digestibility of NDF at P3 was due to the relatively higher crude protein content of the ration compared to P1 and P2. In addition, it was suspected that at P3 the addition of *I.zollingeriana* had a positive effect on rumen microbial activity, so that it was better able to digest fiber. In accordance with the opinion of previous study [2] stated that the digestibility value of *I.zollingeriana* ranged from 78%-82%, the high digestibility indicated that the rumen microbes were able to digest fiber. Supported by previous study [13], the increase in digestibility can be caused by the increase in the protein content of the ration which triggers the activity of rumen microbial fermentation.

The digestibility of NDF is also influenced by the nutrient content and composition of the ration. The protein content of the ration is one of the factors that help in digestibility. With the protein content of 14% in the ration, it could meet the nitrogen requirement for rumen microbial activity in digesting fiber. This is in accordance with the opinion of previous study [14] which states that high microbial activity requires the availability of sufficient food substances, especially energy and protein.

3.2. Digestibility of Acid Detergent Fiber (ADF)

The average ADF digestibility obtained from this study can be seen in the following table:

Table 6. Digestibility average of ADF (%)

Treatments	Avarage of ADF (%)
P1	47.40
P2	46.17
P3	53.69
SE	4.12

Description: Values in the same column show no significant difference (P>0,05).

The results of the analysis of variance showed that the use of *I. zollingeriana* up to 30% as a substitute for concentrate in the ration had a significantly different effect (P>0.05) on the digestibility value of ADF. Table 6 shows that the mean in P2 had decreased, however, when the use of *I. zollingeriana* was added up to 30%, it had increased in P3 although statistically the effect was not significantly different. The high average digestibility at P3 was thought to be due to the relatively higher ADF content in the ratio compared to P1 and P2. In addition, the digestibility of ADF is influenced by the content of the ratio, namely protein and energy that are useful in microbial activity. This is in accordance with the opinion of previous study [15] which states that the balance of protein and energy is considered a strategy to increase the effectiveness of microbial fermentation in the rumen to increase digestibility.

The results of this study indicate that the average digestibility of ADF was lower than the average digestibility of NDF. This is in accordance with the opinion of previous findings [16] that the digestibility of ADF will be lower than the digestibility of NDF, because NDF has a fraction that is easier to digest in the rumen, namely hemicellulose, while ADF is more difficult to digest due to the content of lignin and silica. The opinion of previous study [17] states that the fiber fraction is in

the form of binding to lignin so that it becomes difficult for rumen microbes to digest.

3.3. Cellulose Digestibility

The average digestibility of cellulose obtained from this study can be seen in the following table:

Table 7. Average of Cellulose digestibility (%)

Treatments	Avarage Digestibility of Cellulose (%)
P1	70.08
P2	69.28
P3	73.51
SE	2.47

Description: Values in the same column show no significant difference (P>0,05).

Table 7 shows that with the addition of *I. zollingeriana* as a substitute for concentrate up to 30%, the average value of cellulose digestibility ranges from 69.28%-73.51%. The results of the analysis of variance showed that the use of *I. zollingeriana* as a substitute for concentrate in the ration had no significant effect (P>0.05) on the digestibility of cellulose. Based on the average cellulose digestibility in the table above, the highest percentage of cellulose digestibility was found at P3 (30% use of *I. zollingeriana*) along with the increasing use of *I. zollingeriana* in each treatment. This condition occurred because the digestibility of NDF and ADF is directly proportional to the digestibility of cellulose and hemicellulose, according to the opinion of other study [18] that the digestibility of cellulose and hemicellulose is influenced by the digestibility of NDF and ADF because cellulose and hemicellulose are part of NDF and ADF.

Cellulose is one of the components that make up ADF, according to the opinion of other study [19] which states that cellulose and some lignin are residues from the ADF dissolving process that are not dissolved in an acidic detergent solution. The lignin content in the ration was around 3% (low) indicating a higher average digestibility of cellulose compared to the average digestibility of NDF and ADF. This was because the lignin and cellulose bonds that form lignocellulose are weak. According to the opinion of [20] which states that high cellulose and low lignin content will increase digestibility in the rumen. [21] also stated that different nutrient content in forage feeds will affect feed digestibility, thus giving different digestibility results.

3.4. Hemicellulose Digestibility

The average digestibility of hemicellulose obtained from this study can be seen in Table 8.

Table 8 shows that the average digestibility of hemicellulose ranges from 89.78% at P1 (use of *I. zollingeriana* at 10%) to 91.82% at P3 (use of *I. zollingeriana* at 30%). The hemicellulose content was obtained from the difference between the NDF content and the ADF content. Based on the analysis of variance, it was shown that the use of *I. zollingeriana* as a substitute for concentrate in the ration had an insignificant effect (P>0.05) on the digestibility of hemicellulose. This is because the hemicellulose content in the ration is relatively the same, namely 18.35-19.77%. In addition, the availability of protein in the ration increases, so that it helps the growth and activity of rumen microbes in digesting hemicellulose.

Table 8. Average digestibility of hemicelluloses (%)

Treatments	Avarage of Digestibility (%)
P1	89.78
P2	90.17
P3	91.82
SE	1.62

Description: Values in the same column show no significant difference (P>0,05).

By *in vivo* test results, the digestibility of hemicellulose has a higher value than the digestibility of NDF, ADF and cellulose although the components of hemicellulose and cellulose usually tend to bind to lignin and silica. This is because hemicellulose is the most easily digested fraction [16]. Supported another study [22] stated that hemicellulose can easily be utilized by rumen microbes. Hemicellulolytic bacteria cannot degrade cellulose, on the contrary cellulolytic bacteria can degrade hemicellulose. Therefore, the digestibility value of hemicellulose is higher than that of cellulose.

4. CONCLUSION

From the results of this study, it cloud be concluded that the use of *I. zollingeriana* 30% as a substitute for concentrate in the diet of the Etawa goat gave the best digestibility value of the fiber fraction. The composition of the ration was 60% field grass + 30% *I. zollingeriana* + 10% concentrate.

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