Research Article

Digestibility and Milk Production of Dairy Goat Fed Concentrate Contain Tree Legumes at Various Levels

Limbang Kustiawan Nuswantara*, Eko Pangestu, Marry Christiyanto, Santoso Dwi Pratomo, Elyza Zahrotul Muhtaromah

Faculty of Animal and Agricultural Sciences, Universitas Diponegoro, Semarang, Indonesia 50275.

Abstract | This study aims to examine the effect of giving different concentrate levels with the addition of tree legume on the digestibility value and total digestible nutrients (TDN) of dairy goats. This study used dairy goats in the lactation phase were 10 of the Etawa Crossbreed and 6 Sapera. The materials used are feed in the form of tofu dregs, elephant grass and concentrate composed of distillers dried grains with soluble (DDGS), corn gluten feed (CGF), coconut cake, soybean meal, wheat bran, molasses, gamal leaf flour, calliandra leaf flour. and indigofera leaf flour and then made in pellets. The experimental design used was a randomized block design (RBD) based on grouping body weights consisting of 4 groups and 4 treatments. The treatment applied was a balance of feed in the form of forage elephant grass with different levels concentrat of 25, 50 and 75%, and control treatment in the form of rations that are usually given by farmers. The parameters observed were Dry Matter digestibility (DMD), Organic Matter digestibility (OMD) and Total Digestible Nutrient (TDN). The results showed that giving treatment feed in the form of the addition of concentrate at different levels containing additional tree legume did not significantly of DMD, OMD and TDN in dairy goats (P>0.05). The conclusion of this research is that feeding treatment in the form of different levels of addition of concentrate with the addition of tree legume does not increase the value of DMD, OMD and TDN in dairy goats.

Keywords | Dairy goat, Digestibility, Concentrate and total digestible nutrients, Antioxidant activity

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***Correspondence** | L.K. Nuswantara, Faculty of Animal and Agricultural Sciences, Universitas Diponegoro, Semarang, Indonesia 50275; **Email:** limbang.kn@gmail.com
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INTRODUCTION

Dairy goats are a type of ruminant livestock that have the ability to produce fresh milk with nutritional value and absorption capacity that can compete with cow's milk to meet national milk needs (Akbar *et al*., 2019). Goat's milk is known to have many benefits, namely being easier to digest, low levels of allergies and containing beneficial chemical compositions that are better than cow's milk (Ratya *et al*., 2017). Livestock farming including dairy goat has provided nutrition and additional income for farmers, along with other agricultural farm in the form of integrated farming system (Mariyono *et al*., 2013; Mariyono, 2018). Dairy goat farming in Indonesia is still mostly small-scale and simple maintenance. Sustainability according to Purbajanti *et al*. (2016) should be provide the good rearing system. The productivity of dairy goats is still low, one of which is due to inadequate feed provision and farmers' lack of knowledge regarding feeding systems. One effort that can be made to overcome this is by improving feeding through the addition of concentrate so that livestock needs can be met. Improvement of feeding materials is expected to enhance the productivity of livestock farming, and thus it will improve the welfare of community (Mariyono *et al*., 2021).

Concentrate or fortifying feed is a mixture of various feed ingredients with a SK content of less than 18% and is easy to digest which is able to meet the necessary nutrient requirements (Nuraini *et al*., 2014). The addition of concentrate to ruminants can be utilized by rumen microbes as energy and allows livestock to consume better nutrients with high palatability (Wati *et al*., 2012). Concentrate feed tends to have a higher digestibility value than forage feed, so the ratio of forage and concentrate feed in the ration needs to be considered to meet the energy needs entering the animal's body (Hamianti *et al*., 2016).

Leguminous plants for goats are potential forage with a fairly high nutrient content compared to grass types. Massive tree legume plants have been developed as a source of feed, especially for ruminants because they contain very high protein and are very popular with livestock (Sutaryono *et al*., 2019). This plant has a high digestibility value and contains protein and minerals that are good for dairy livestock, so it can be used as forage or high quality supplements (Tantalo *et al*., 2019). Leguminose is easier to digest because it contains low SK so it can increase feed flow rate and feed consumption (Marhaeniyanto and Susanti, 2011). Some potential tree legume plants whose availability is quite abundant are gamal (*Gliricidiasepium*), calliandra (*Calliandra calothyrsus*) and indigofera (*Indigofera zollingeriana*). The advantages of legume plants include easy to obtain, economical, high production, able to supply fermentable and by-pass protein, drought resistant, and as an alternative feed for combined concentrate feeds (Nurjannah *et al*., 2019).

The addition of concentrates at higher levels containing tree legumes is expected to increase digestibility and energy consumed by livestock. Feed that is easily degraded and fermented by rumen microbes can be interpreted as having a high total digestible nutrients (TDN) value (Teti *et al*., 2018). Nutrient degradation of feed ingredients is an indicator of the ability of feed degradation by rumen microbes and its utilization by the livestock body (Wati *et al*., 2012). A high digestibility value reflects the amount of nutrients that can be absorbed in the digestive tract which can be used to meet basic living needs and increase livestock production (Hernaman *et al*., 2008). Providing quality feed will be able to provide a higher contribution of nutrients to the blood for the process of milk synthesis in the udder glands so as to increase the quantity and quality of milk (Adriani *et al*., 2004).

The aim of this research was to examine the effect of giving different concentrate levels with the addition of tree legumes on the digestibility and TDN values of dairy goats. The benefit of this research is to find out and provide information regarding the digestibility and TDN values of dairy goats given concentrate at different levels with the addition of tree legumes. The hypothesis in this research is that providing higher concentrate levels with the addition of tree legumes can increase the digestibility and TDN values of dairy goats.

MATERIALS AND METHODS

This research was carried out in October - December 2020. The research location was at the Kuncen Farm Mijen Farmer Group, Semarang. Chemical analysis at the Nutrition and Feed Science Laboratory, Faculty of Animal Husbandry and Agriculture, Diponegoro University, Semarang.

The research material used was 10 dairy goats in the lactation phase of the Etawa (PE) breed and 6 Sapera breeds with an average body weight of 40.38 ± 11.76 kg. The feed ingredients used consist of elephant grass, concentrate and tofu dregs. The concentrate feed ingredients used are DDGS, CGF, coconut meal, soybean meal, wheat bran, molasses, gamal, calliandra and indigofera with the composition which can be seen in Table 1.

Feed ingredients of concentrate.

Ingredient	Percentage (%)
DDGS	8
Corn Gluten Meal	19
Coconut meal	10
Soybean meal	13
Wheat bran	36
Molases	5
Gamal legumes	3
Kaliandra legumes	3
Indigofera legumes	3
Total	100

The equipment used for raising dairy goats is an individual stilt cage with a size of 1 × 1.5 m which is equipped with a feed and drink tray, a sickle for chopping grass, a sack, a hanging scale with a capacity of 50 kg with an accuracy of 10 g, a digital scale with a capacity of 10 kg with accuracy of 1 g, feces collection equipment in the form of plastic covered with netting, sprayer, bucket, plastic bag, scissors, broom stick, tray, label paper and writing utensils. The equipment used for analysis in the laboratory is a grinder, analytical balance with a capacity of 300 g with an accuracy of 0.001 g, electric oven, electric furnace, oil paper, porcelaine crucible, fat filter paper, soxhlet and desiccator.

This research was carried out in several stages, namely the preparation stage, preliminary stage, adaptation stage, data collection stage, chemical analysis stage and data analysis. This research was structured in a randomized block design (RBD) based on body weight grouping consisting of 4

treatments with 4 groups. The treatment applied was a feed balance in the form of the farmer's local forage, namely elephant grass with different levels of concentrate and a control treatment in the form of the ration usually given by the farmer. The following is the treatment applied in the research.

T0 = farmer's forage + tofu dregs
T1 = farmer forage + 25% concentrate
T2 = farmer forage + 50% concentrate
T3 = farmer forage + 75% concentrate

The complete composition of the concentrate feed ingredients used can be seen in Table 1.

Table 2: Feed ingredient content of concentrate.

Nutrient content*	Feed ingredient		
	Elephant grass	Tofu dreg	Concentrate
	%(DM)		
Dry matter (DM)	14.86	8.29	88.12
Ash	15.01	4.21	14.33
Crude protein	19.59	24.18	21.53
Crude fiber	27.27	16.38	7.72
Crude fat	2.58	7.68	3.38
BETN	35.54	47.55	53.03
TDN	56.21**	73.46**	77,92***

Sources: *, Proximate analysis in Faculty of Animal and agricultural sciences; **, Hartadi *et al*. (1993) ***, Sutardi (2001).

The preparation stage includes procurement of feed ingredients, preparation of cages, preparation of research equipment, formulation of feed and manufacture of feed as well as preparation of livestock. The preliminary stage was carried out for 10 days by providing feed from the farmers and drinking water ad libitum, then recording the provision and remaining feed every day to determine the amount of feed consumed. The feed from the farmers in the form of forage and combined feed in the form of tofu dregs were sampled and then carried out proximate analysis to evaluate the consumption and needs of the livestock. The body weight of livestock at the beginning of the rearing period is estimated using the formula in Hidayat (2018) as follows:

$$LW = \frac{(CS^2) \times (BL)}{10^4}$$

Keterangan: LW = Live weight (kg); CS = Chest size(cm); BL = Body length (cm).

The adaptation stage is carried out for 10 days by adapting the dairy goats to the treatment given, until the feed ratio is obtained according to the specified treatment. The data collection stage is carried out by recording the amount of feed given and remaining feed as well as collecting the remaining feed as feed consumption data. The method for measuring feed digestibility is carried out in vivo through total fecal collections carried out during the last 7 days of maintenance. The collected feces are sprayed evenly with 10% H_2SO_4. The remaining feed and feces during data collection were air-dried and 10% of the total sample from each treatment was taken. The chemical analysis stage is carried out through proximate analysis in the form of testing the water, ash and CF content of samples given and leftover feed and feces in the laboratory to determine the dry matter digestibility (DMD), organic matter digestibility (OMD), crude fat digestibility (CFD). The variables observed included DM digestibility, OM digestibility and TDN which were then processed using analysis of variance based on a randomized block design (RBD) at a significance level of 5%. If in the analysis of variance there is a significant effect ($P<0.05$), then proceed with the multiple area test The formula for calculating DM, OM and TDN consumption is as follows:

DM consumption = [Concentrate given (g) × % DM was given] – [remain (g) × % DM remain]
OM consumption = [DM Consumption (g)] × [% OM]
Crude fat consumption = [DM Consumption (g)] × [% crude fat] and Digestibility was compute follow Tillman *et al*. (1991).

RESULT AND DISCUSSION

DM digestibility, OM digestibility and TDN digestibility values in dairy goats are presented in Table 3.

Table 3: Cosumption of DM, OM and energy of dairy goat.

Variable	Treatments			
	T0	T1	T2	T3
DM consumption (g/head/day)	876^{b}	958^{ab}	894^{b}	1.037^{a}
OM consumption (g/head/day)	0.772^{b}	0.795^{ab}	0.762^{b}	0.891^{a}
Energy consumption (kkal/ head/day)	3,717^{b}	4,045^{b}	4,213^{b}	5,326^{a}

*Different superscripts on the same row indicate significant differences ($P<0.05$).

Based on Table 3, it is known that the average consumption of DM feed for lactating goats in treatment T0 is 876 g/head/day, treatment T1 is 958 g/head/day, treatment T2 is 894 g/head/day, treatment T3 is 1,037 g /tail/day. The results of the F test for DM feed consumption from the treatments given to lactating goats showed that they were significantly different ($P<0.05$). Lactating goats that received forage and 75% concentrate treatment showed the highest DM feed consumption value of all treatments.

Differences in DM feed consumption for each animal can be caused by differences in the type of feed, form of feed, amount of feed, ratio of forage and concentrate given to the livestock. The DM consumption value in this study was lower than the study by Sutaryono *et al.* (2019) which has a DM consumption value of 3.62 kg in Etawa cross-breed goats fed forage in the form of calliandra leaves, indigofera, gamal and odot grass as well as concentrates consisting of wheat bran, soybeans, molasses, cumin, salt, vitamins and minerals. Livestock conditions such as age and health can also influence consumption and nutrient requirements. According to Tantalo *et al.* (2019) dry matter consumption for each animal will be different depending on the amount of nutrients needed by each animal.

The average energy consumption at T0 was 3,717 kcal/head/day, treatment T1 was 4,045 kcal/head/day, treatment T2 was 4,213 kcal/head/day, treatment T3 was 5,326 kcal/head/day. The results of the F test for energy consumption from the treatments given showed that they were significantly different ($P<0.05$). The difference in energy consumption values for each treatment can be caused by the consumption of DM feed and the energy content in the feed, the higher the concentrate ratio given, the higher the energy consumed will tend to be. According to Tantalo *et al.* (2019) energy consumption in livestock will be higher as the energy content of feed increases. In this study, livestock with an average body weight of 40.03 kg had an average energy consumption of 4,325 kcal/head/day, this result was higher than research by Sutaryono *et al.* (2019) which had an energy consumption value of 1,508 kcal /head/day with an average body weight of 11.5 kg. The difference in value can be caused by the type of feed given to livestock which has different nutrient content and palatability, apart from that, differences in energy consumption can also be influenced by the level of livestock productivity. According to Nujannah *et al.* (2019) livestock energy requirements can increase along with increases in milk production and body weight.

The average digestible energy in the T0 treatment feed (tofu dregs) was 2,486 kcal/head/day and in the T1, T2 and T3 treatment feed (concentrate) was 3,286 kcal/head/day. The digested energy value at T0 is lower than the research of Nujannah *et al.* (2019), namely 2,656 kcal/head/day, while treatments T1, T2 and T3 had higher digestible energy values than in this study.

The average metabolic energy in treatments T0 (1,988 kcal/head/day), T1 (2,683 kcal/head/day), T2 (3,031 kcal/head/day) and T3 (3,804 kcal/head/day) was higher than the research Sutaryono *et al.* (2019) with the average metabolic energy of livestock fed a variety of forages and different levels of concentrate, namely 895 kcal/head/day.

Table 4: DMD, OMD, TDN, ED, ME and NE of dary goat feed legumes.

Parameter	Treatments			
	T0	T1	T2	T3
	(%)			
DMD	67.15 ± 1.90	64.30 ± 5.56	64.11 ± 4,42	62.20 ± 4.34
OMD	68.80 ± 1.89	66.28 ± 5.52	67.02 ± 4,18	65.46 ± 4.14
TDN	63.42 ± 1.96	57.39 ± 4.90	59.66 ± 4,15	59.64 ± 3.64
Energy disgetibility (ED) (kcal/head/day)	2.486 ± 61.06	2.796 ± 70.10	3.120 ± 77.00	3.942 ± 51.58
Metabolic energy (ME) (kcal/head/day)	1,988 ± 45.36	2,683 ± 69.23	3,031 ± 76.76	3,804 ± 50.92
Nett energy (NE)(kcal/head/day)	1,611 ± 42.82	2,437 ± 69.66	2,808 ± 78.46	3,460 ± 54.41

* Nett energy = Mtabolic energy (ME) – energy contained in milk.

Table 5: Average milk production, milk quality and milk polyphenol content in dairy goats receiving different levels of concentrate treatment containing additional tree legumes.

Parameter	Treatments				p-value
	T0	T1	T2	T3	
Milk production (ml)	794.75	558.75	439.00	742.75	0.080
Fat (%)	6.18	5.74	5.45	5.25	0.496
Lactose (%)	3.92	3.99	3.96	5.59	0.210
Protein (%)	4.14	4.21	4.18	4.32	0.878
Solid Non Fat (SNF) (%)	8.71	8.87	8.80	9.11	0.871
Polyphenol (mg/ml)	2.24	3.13	3.45	3.55	0.040
Antioxidant activity (%)	37.84	36.90	38.65	43.08	0.104

The average percentage of net energy at T0 is 43.11%, T1 is 59.43%, T2 is 66.06% and T3 is 64.89%. The net energy

F test results for the 4 treatments showed that they were significantly different (P<0.05). This difference can be caused by different energy consumption, metabolic energy and energy utilization in milk production for each treated animal. Net energy in this study was obtained from the metabolic energy value minus the energy value contained in the milk produced by livestock, whereas in the research of Nujannah *et al.* (2019) net energy calculations are based on in vitro gas production. Net energy can be used by livestock for basic living needs such as breathing and moving. According to Nujannah *et al.* (2019) net energy in goats can be used for basic living needs.

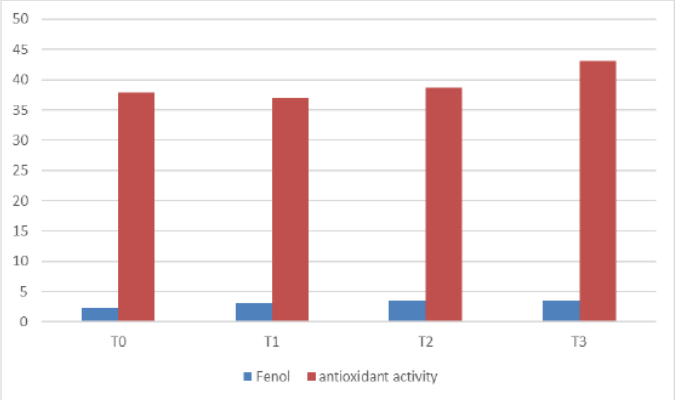

Figure 1: Antioxidant activity of treatments.

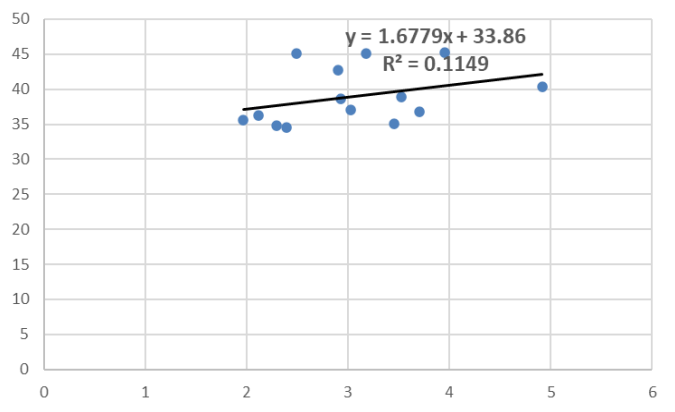

Figure 2: Regression analysis of phenolic and antioxidant activity.

As shown in Figures 1 and 2. Antioxidant activity of dairy goat feed T3 give the best result. The relationship between the content of phenolic compounds in the ration and the antioxidant activity in milk is shown in the Figure 2.

Dry matter digestibility (DMD)

The average DDM value of feed in each treatment was 67.15% ± 1.90 (T0), 64.30% ± 5.56 (T1), 64.11% ± 4.42 (T2) and 62 .20% ± 4.34 (T3). The results of the analysis of variance (Appendix 4) show that there is no significant effect (P>0.05) between the treatment of different concentrate levels and the addition of tree legumes on the DMD value in dairy goats. The DMD value in dairy goats treated with different concentrate levels with the addition of tree legumes produced values ranging between 62.20% - 67.15%. This value is higher compared to research by Cakra *et al.* (2014) in Etawah crossbreed (PE) goats which were given a variety of forages with different levels of concentrate containing molasses and mineral mix had a DMD ranging from 54.25% – 60.53%. Momot *et al.* (2014) stated that local goats fed concentrate feed in Bengal grass rations had a DMD of 57.96% - 73.76%.

The DMD value which has no real influence is thought to be due to the open air drying method of legumes which results in the concentration of the bioactive components contained being still quite high. Bahadoran and Mirmiran (2015) explains that legumes contain bioactive components such as polyphenolic compounds, saponins, isoflavones, linoleic acid, phenolic acids and phytic acid. One class of legume polyphenolic compounds that can reduce feed digestibility is tannin. The tannin content in Gamal, based on research by Faradilla (2019), has a percentage of 11.79%. According to Mannetje and Jones (2000) calliandra can contain tannins up to 11% of the dry matter. Sirait *et al.* (2011) stated that the tannin contained in the Indigofera suffrutiscosa type was 9.35% and Indigofera rahirsufa was 10.43%

It is thought that the presence of tannins in this type of tree legume, which is quite high, can inhibit the digestive process in ruminants. According to Melani *et al.* (2018) an increase in the percentage of tannin results in the carbohydrate and protein of the ration being bound by the presence of tannin, this can inhibit the enzyme activity of rumen microorganisms in degrading carbohydrate and protein components. Zamsari *et al.* (2012) added that the inhibition of protein degradability into ammonia due to the binding of tannin-protein complex compounds can inhibit protein synthesis for rumen microbes. This causes rumen microbial activity to decrease during the fermentation process. Novianti *et al.* (2014) stated that the digestibility of feed in livestock is closely related to the ability of rumen microorganisms in the fermentation process in the rumen.

Organic matter digestibility (OMD)

Calculation results of the average OMD of the feed obtained data as presented in Table 3. The average OMD value of the feed in each treatment was 68.80% ± 1.89 (T0), 66.28% ± 5.52 (T1), 67.02% ± 4.18 (T2) and 65.46% ± 4.14 (T3). The results of the analysis of variance (Appendix 5) show that there is no significant effect (P>0.05) between the treatment of different concentrate levels and the addition of tree legumes on the OMD value in dairy goats. Research by Cakra *et al.* (2014) PE goats that were given various forages with different levels of concentrate containing molasses and mineral mix had OMD values ranging from 69.07% - 80.46%. Momot *et al.* (2014) stated that local goats fed concentrate feed in Bengal grass rations

had a OMD of 60.64% - 77.26%

The influence of tannin polyphenolic compounds in legumes added to concentrate is also thought to cause no real influence on OMD which is interconnected with DMD. According to Fariani and Akhadiarto (2009), the tannin functional group is active in binding proteins and has the ability to inhibit the performance of several enzymes so that it can reduce digestibility. Kusmartono's (2008) research on goats given concentrate with the addition of tannin conden produced DMD and OMD which had no real effect due to the tendency of tannin to bind protein, thereby reducing digestibility. The OMD value also has a relationship with the DMD value of the ration. Suwignyo *et al.* (2016) explained that the OMD and DMD values will correlate with each other and have a very close relationship. The presence of ash is a factor that influences the OM value. It is thought that the ash content in concentrate is higher than tofu dregs, which can influence the OMD value of feed. According to Nugroho *et al.* (2020) high ash content in feed can affect the OMD value and can reduce OM digestibility

Total digestible nutrients (TDN)

Based on the research results, the average TDN value was obtained as presented in Table 3. The TDN value of the ration for each treatment was 63.42% ± 1.96 (T0), 57.39% ± 4.90 (T1), 59.66% ± 4.15 (T2), 59.64% ± 3.64 (T3). The results of the analysis of variance (Appendix 6) show that there is no significant effect (P>0.05) between the treatment of different concentrate levels and the addition of tree legumes on the TDN value in dairy goats. Research by Ratu *et al.* (2020) in the form of giving lemongrass flour to female Kacang goats had a TDN value of 60.41-64.97%. Tfukani *et al.* (2019) in research on feeding concentrate containing fermented corn cob flour to female local goats produced a TDN value of 62.80 - 64.85%.

The TDN value is influenced by the digestibility of feed and the ability to digest microbes in ruminants. According to Pohan (2018) the TDN value is related to the digestibility value and activity of rumen microbes in digesting feed. Rumen microbial activity can be disrupted due to the presence of tannins in feed which are able to bind protein, inhibit the performance of enzymes and disrupt the growth of rumen microbes. According to Muslim *et al.* (2014) tannins which are able to bind protein can have a negative influence on the fermentative ability of rumen microbes. Zahera *et al.* (2020) explained that the availability of protein is needed to maintain the rumen ecosystem which has an important role in supporting microbial activity during the fermentation process.
Tannin in the ration at a certain level can have a positive impact on ruminants, but if the concentration is too high it can reduce the digestibility of the ration. According to Jayanegara *et al.* (2012) to obtain a good impact from tannin, the ration should have a tannin content of >2% of dry matter, but at levels of more than 5% in dry matter, tannin can reduce digestibility and performance. Research by Trisnadewi *et al.* (2014) that the addition of calliandra leaves to the ration by 5 to 20% can reduce the DMD and OMD values *in vitro*. Jena *et al.* (2020) added that concentrate feed containing cherry leaf flour at higher levels tends to reduce DMD and OMD due to the presence of tannins.

The use of a composition of three types of tree legumes with a fairly high tannin content can increase the tannin concentration in the concentrate. This condition will increase the tannin concentration of the ration along with the use of higher levels of concentrate. This is thought to be the cause of the increase in concentrate levels not being followed by an increase in the digestibility of the ration. According to Melani *et al.* (2018) that increasing the percentage of tannin in the diet has a negative correlation with the ability to digest rumen microbes. Abrar and Fariani (2018) added that high tannin concentrations can result in a decrease in rumen microbial activity and are toxic.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research results, it can be concluded that giving treatment feed in the form of different levels of concentrate addition with the addition of tree legumes does not have a significant effect on the DMD, OMD and TDN values in dairy goats. Dairy goat very potencial to develop in Indonesia since the dairy goat milk increase. Government should be improve the skill of the farmer to process feed alternative to develop dairy goat business in Indonesia.

Further research is needed regarding the composition and attention to the level of use of tree legume flour added to concentrate feed to obtain maximum results.

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NOVELTY STATEMENT

Feed is an important component in the development of dairy goats in Indonesia. Legumes are one of the important feeds in dairy goat cultivation. Legumes in dairy goat feed can provide increased antioxidant activity.

AUTHOR'S CONTRIBUTION

All authors contributed to writing this article starting from making proposals, conducting research, data analysis and writing articles.

Conflict of interest

The authors have declared no conflict of interest.

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