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Full Length Research

Nutrients using in goats fed concentrate consist of vary levels of *Muntingia calabura L* leaves as maize substitution

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ABSTRACT: The research was carried out to measure nutrients utilize by goats fed concentrate containig varying levels of *Muntingia clabura* L. as maize substitute. This research was conducted based on Double Latin Square 4 x 4 eight female *Kacang* goats. Four treatments and four periods used as replications. The treatments are MC_0 = concentrate 100% of maize mills without the flour of *Muntingia calabura L.* leaves; MC_{20} = concentrate with 20% *Muntingia calabura L.* leaves flour as maize substitute; MC_{40} = concentrate with 40% of *Muntingia calabura L.* leaves flour as maize substitute and MC_{60} = concentrate with 60% of *Muntingia calabura L.* leaves flour as maize substitute. All data are tabulated and analyzed using Analysis of Variance (ANOVA) and where the influence of the treatments was recorded, Least Quare was utilized using SPSS software, version 23 for windows. The result shows that the average dry matter consumption increases with an increase in the levels of *Muntingia calabura L.* leaves as maize substitute but the treatments have no significant influence ($p>0.05$). On the contrary, the value of NFE consumption tends to decrease, but it has no significant influence. However, the consumption of other nutrients, mainly crude protein, crude fiber, and crude fat increases significantly. The increasing of these nutrients is not followed by the increasing of digestibility values, since values of dry matter, crude protein, and crude fat decreases. Actually, there is an increase of rumen fermentation condition as indicated by concentrations of total VFA, rumen NH3, and propionate acid although it has no significant influence, statistically. In conclusion, the leaves of *Muntingia calabura L*. can be used as a component of concentrate formulation as maize substitute up to 40% inclusion level.

Keywords: *Muntingia calabura L*, local goat, maize, concentrate, nutrient.

INTRODUCTION

The increasing production and livestock quality can not be separated from a continual effort of quality feed preparation. The effort can be done by applying vary technologies that can increase and or can maintain feed quality for the livestock. Besides, the feed preparation effort can be done by utilizing alternative feed sources that have a high quality in the form of land cover plants, shrubs, and trees.

Commonly, the productivity of ruminants depends on the grazing method on the pasture areas. In addition, forages on the pasture is also very dependent on the interaction of various external components, mainly land and water in an area. Technology application that can support feed availability continually is the main thing to be done in tropical areas, particularly in East Nusa Tenggara (NTT) since the area has low rainfall and the rainy season occurs in a short period of time. The existing conditions have a direct impact on feed availability, both qualitatively and quantitatively.

The shortage of feed in NTT can be overcome by applying a technology namely feed supplementation in the form of concentrate with a high content of nutrients and relatively complete. Most utilizing of concentrate for livestock based on the mixture of various kinds of local feed available in a site. In NTT, particularly, there are some

concentrate formula sources which relatively adaptive to its climate condition. One of the materials used is maize mills.

Nevertheless, maize is one of the main food sources in NTT. Moreover, maize is used as the main component in livestock industries and as well as livestock ration formulation. Actually, maize production in NTT is 685,081 tones in 2015. Furthermore, level of maize consumption is 0.02 kg/capita/week, and the price of maize in 2019 is IDR 7,500 (BPS, 2015). These facts show that the utilizing of maize as the main source of livestock ration formulation will not be optimally fulfilled since the maize still used as food. Therefore, it needed a depth study focused on alternative feed as maize substitute which is not relatively competing with human needs. One of the feed sources with a high content of carbohydrate is *Muntingia calabura L.* leaves.

Muntingia calabura L. plant is a wild plant and relatively adaptive to NTT climate. The plant form as a tree with red, sweet and tiny fruits. The plant is categorised as a shrub, commonly it can reach 7 m height, and nearly horizontal branches (Patel et al., 2016). Sometimes this plant can reach 7.5 to 12 m height and their leaves are evergreen approximately 5 to 12.5 cm (Mahmood et al., 2014). The leaves also used as a natural antioxidant with antioxidant activities can reach 80.50% (Triswaningsih et al*.,* 2017). Furthermore, it has been stated that the volatile compound such geraniol, citronellol α amirin, etc., while phenol in its leaves and also fruit is *gallic acid, catechin, gelacic acid* (Triswaningsih et al*.,* 2017; Pereira et al., 2018).

Besides antioxidant compound content, the *Muntingia calabura L* leave has the content of nutrient mainly crude protein is 2.99 % while carbohydrate content is 28.76 % (Laswati et al., 2017). On the other hand, the content of carbohydrate in maize is 18.7 g in each 100 g of maize seed and energy content is 360 kj or 86 kcal (Anonymous, 2019a). Although the plant is adaptive and evergreen, it has not been utilized as feed. The reason is farmers have no information about nutrients content of the plant.

In view of the nutrients content, the effort of utilizing the *Muntingia calabura L* leaves as maize substitute can be applied in order to realize the efficiency of maize using as feed. The utilization can be observed based on the variables of nutrients used by the livestock. The using of *Muntingia calabura L* leaves as a source of feed is rare, therefore the information of this research can be used as a reference in ruminant development, goats in particular. Thus, the objective of this research is to evaluate the influence of using *Muntingia calabura L.* leaves in concentrate as maize substitute towards the utilizing of nutrients and physiological status of local goats.

MATERIALS AND METHOD

The research materials are 8 to 12 months of eight (8) female goats with body weight average of 9.46±1.59 kg. Feed used is native grass and concentrate comprise various local feed as shown in Table 1. Concentrate quantity fed is 30% of dry matter total need of the animal.

The method applied is an experimental method using Latin Square Design 4 x 4 replicated in twice (Double Latin Square) comprises 4 treatments and 4 periods as replicates. The treatments are as follow: MC_0 = base feed + concentrate contains 100% of maize mills; MC_{20} = base feed + concentrate with 20% *Muntingia calabura L* leaves flour as maize substitute; MC_{40} = base feed + concentrate with 40% of *Muntingia calabura L* leaves flour as maize substitute; and MC_{60} = base feed + concentrate with 60% of *Muntingia calabura L* leaves flour as maize substitute. The formulation of feed content refers to the research of Hartati et al. (2009) with crude protein content is 17% and TDN 78.16%, and the proportion of each treatment is as indicated in Table 1.

All of those feed sources are processed as flour and homogenous mixed. The mixture process started with the smallest proportion material and followed by the others, respectively. Quantity of the concentrate fed is 120 g/head/day, while the forage is fed *ad libitum*.

Research procedure

All of the concentrate formulation sources are made in the form of flours, weigh according to their proportion of each treatment, and mixed. The mixture is fed to the goats. Every research period in 15 days with a preliminary period of 10 days and data collection for 5 days. The proximate component analysis is taken based on AOAC procedure (1990).

Variables measured

The research variables measured are:

1. Quality of *Muntingia calabura L* forage, concentrate and base feed of available native grass were determined. Samples are analyzed in a laboratory in order to evaluate the nutrients content (DM, crude protein, crude fat, crude fiber, NFE, ash) according to the procedure of AOAC (1990).
2. Nutrients consumption: dry matter, crude protein, organic matter, crude fiber, and energy measured by the consumption of dry matter times content of each nutrients (Tillman et al., 1991).
3. Nutrients digestion: feed quantity consumed times to the nutrient content reduced nutrient quantity excreted times 100 according to the method of Chedda and Crowder (1982).
4. Fermentation condition of rumen gained by measuring partition portion of VFA and VFA total, NH_3 using spectrophotometer according to the procedure of Supelco (1982) and pH of rumen liquid by HANNA instrumen pHep HI 98107 pocket size pH meter.

Table 1. Proportion of feed sources as concentrate formulation based on the treatments.

Feed Sources	Proportion of materials (%)/Treatments			
	MC_0	MC_{20}	MC_{40}	MC_{60}
Maize mills	46.25	37	27.75	18.5
Muntingia calabura L leaves flour	0	9.25	18.5	27.75
Rice bran	20.5	20.5	20.5	20.5
Coconut meal	23	23	23	23
Fish mill	8	8	8	8
Oil	1.5	1.5	1.5	1.5
Salt	0.25	0.25	0.25	0.25
Premix	0.5	0.5	0.5	0.5
Total	100	100	100	100

Data analysis

Research data are tabulated and analyzed using Analysis of Variance (ANOVA) and where the influence of the treatments was recorded, Least Quare was utilized using SPSS software, version 23 for windows.

RESULT AND DISCUSSION

Influence of treatments towards ration chemical composition

Data related to the chemical composition of feed materials are shown in Table 2. Data concerning consumption variables and nutrients digested are shown in Table 3, while data focused on the variables of rumen fermentation are described in Table 4.

Data from Table 2 show that the content of crude protein of *Muntingia calabura L* leaves is 20.91%. These data are different from the one reported by Silivong et al. (2012) who stated that the crude protein content of *Muntingia calabura L* leaves is 16.6%. The difference occurs might be caused by the difference in soil fertile and ratio of branches: leaves during sample analysis. In common, the content of crude protein in the leaf is higher than that of the branch, therefore the more branches in analysis, the more different content is gained.

The higher the using of *Muntingia calabura L* leaves in the formulation of concentrate as maize substitute, the higher the protein content produced. The concentrate with a high protein content is hoped will influence microbes activities during rumen fermentation, therefore, it can produce higher digest value. However, it can be seen that the higher the level of *Muntingia calabura L* leaves flour in concentrate as maize substitute, the lower the NFE content produced. The low content of NFE shows that the lower the carbohydrate availability that is easy to be fermented in rumen, the lower the VFA concentration produced.

Equalisation between the contents of protein and carbohydrate, particularly NFE, will commonly influence rumen fermentation. Rumen fermentation mechanism needs the availability of N source with a final product such as amino acid and NH_3. Besides, it also needed the carbon source for microbes protein synthesize. The microbe's synthesize protein will influence the increase of microbes mass which have a role in fermenting the other fibrous feed.

Influence of the treatments towards variables of consumption and nutrients digestibility

Variables of consumption and nutrients digestion are indicator variables of feed utilizing by an animal. The using of *Muntingia calabura L* leaves flour as maize substitute in concentrate wether will influence total consumption and the value of nutrient digestion can be seen in Table 3.

Data from Table 3 shows that increasing the level of *Muntingia calabura L* leaves flour in concentrate fed, increasing the value of dry matter consumption. A high value of dry matter consumption relates to the quality of concentrate used. The higher the concentrate quality, the higher the crude protein content. This fact affected by the crude protein content in *Muntingia calabura L* leaves is higher than that of maize mill. The higher the content of crude protein in concentrate influences the activities of the microbes during the fermentation process, the higher the movement of feed. A high movement of feed will influence the increase in the consumption value of dry matter ration.

Although the consumption value of ration dry matter tends to increase as a cause of the increasing level of *Muntingia calabura L* leaves flour in concentrate, but statistically result from analysis figures an insignificant effect. This condition occurs due to the carrying capacity of rumen goats' is optimum. The dry matter needed by a goat is 3 to 3.5% of body weight (Rashid., 2008). Commonly, the research result is 3.73 % of the goats' weight. Actually, the value gained in this research is higher but it still in a normal range or 3.5 to 4% of the body weight (Anonymous, 2019b). The result of this study was

Table 2. Chemical composition of feed materials and concentrate.

Items	Feed materials/Treatments						
	Flour of *Muntingia calabura L* leaves	Native grass	Maize mill	MC_0	MC_{20}	MC_{40}	MC_{60}
DM (%)	89.25	30.55	87.2	89.2	89.52	89.26	89.37
CP (% DM)	20.91	13.69	10.32	17.19	17.66	19.40	20.69
CL (% DM)	11.52	5.26	4.26	9.29	9.72	10.86	12.20
CF (% DM)	18.52	28.67	2.44	11.0	10.59	12.59	12.63
NFE (% DM)	40.61	41.34	81.66	54.09	52.49	47.36	44.88
Ash (% DM)	8.44	11.04	1.33	8.44	9.54	9.79	9.89
GE (Kcal/kg DM)	4801	3706	5770	5127	5111	5040	5094

Table 3. Influence of using *Muntingia calabura L* leaves flour as maize substitute towards the variables of consumption and nutrient digestiblity.

Variables nutrient consumption and digestibility	Treatments				P-value
	MC_0	MC_{20}	MC_{40}	MC_{60}	
DM consumption (g/day)	393.04±56.21	397.18±32.09	403.86±42.79	405.72±35.21	0.269
CP Consumption (g/day)	57.74±7.69^a	58.85±4.39^a	61.71±5.86^b	63.43±4.82^b	0.000
CL Consumption (g/day)	25.2±2.96^a	25.92±1.69^a	27.54±2.25^b	29.16±1.85^c	0.000
CF Consumption (g/day)	92.82±16.12^a	93.48±9.2^a	97.70±12.69^b	98.26±10.09^b	0.025
NFE Consumption (g/day)	176.81±23.24	176.77±13.27	173.73±17.69	171.71±14.55	0.251
DM Digestibility (%)	59.92±7.91	61.84±8.52	59.11±8.68	58.39±10.59	0.158
CP Digestibility (%)	74.07±5,28	74.09±5.04	71,95±4.76	71.96±5,93	0.068
CL Digestibility (%)	80.49±3.57^a	81.48±4.70^a	79.03±5.25^b	76.87±3,87^b	0.002
CF Digestation (%)	45.97±9.73	48.20±12.26	47.26±10.45	46.28±15,17	0.664
NFE Digestibility (%)	63.71±7.58^b	65.73±9.12^{ab}	61.95±9.46^b	60.46±11,49^b	0.020

Table 4. Influence of using *Muntingia calabura L* leaves flour as a substitute of maize towards variable of rumen fermentation.

Variables	Treatments				P-value
	MC0	MC20	MC40	MC60	
VFA (mM)	95.04±8.93	101.43±18.53	111.37±13.61	110.36±18.88	0.067
NH3 (mM)	8.62±1.4	9.08±1.78	9.8±2.19	10.2±2.8	0.065
pH	6.34±0.39	6.5±2.4	6.51±0.31	6.48±0.29	0.490
Asetat (mM)	35.39±7.29	36.63±9.86	35.46±12.25	36.42±6.03	0.978
Propionat (mM)	14.96±5.63	16.21±6.75	17.19±7.48	15.16±6.14	0.749
Butirat (mM)	8.95±3.03	7.64±2.59	8.12±3.69	6,87±2.56	0.476
iso-Butirat (mM)	4.26±0.83	3.52±1.14	4.89±1.93	3,55±1.35	0.111
Valerat (mM)	2.79±0.82	2.09±0.79	2.92±1.07	1,84±0.49	0.013
iso-Valerat (mM)	5.13±0.09	4.33±2.33	5.39±2.14	4,28±2.16	0.185

different and higher than a report by Samkol (2003) who reported that dry matter consumption of *Muntingia calabura* L. foliage hanging was higher than foliage in a trough. The results of the study showed that concentrate provides has an effect on the rate of fermentation which has an effect on the increase of dry matter consumption.

The increasing consumption value of the ration dry matter is followed by the increasing of crude protein consumption. This condition affected by a high content of ration crude protein. The increasing of crude protein consumption has an important role in preparing protein sources for the development and activities of rumen microbes. The increasing of rumen microbes activities has a direct relation to energy availability for the host. The ration protein content has a direct influence on the increase of dry matter consumption, but it will decrease

when the density of ration energy increases. There are many factors participate in influencing the amount of dry matter needed on goats such as breed, age, lactation, mating season and environment temperature (Anonymous, 2019b).

Influence of the treatments towards variables of rumen fermentation

Variables of rumen fermentation can be seen in Table 4. pH value of rumen was important as indicator fibre digestion in the rumen (Tellier et al., 2004). Normal pH rumen is range 6-7 if less than 6 has the implication of reducing fibre digestibility (Van soest, 1994) and there is no digestion of fibre if pH rumen less than 5.7 according to the National Research Council (1996). In this study, pH rumen is in the normal range. It is seen that when *Muntingia calabura L* leaves flour as a substitute to maize flour in concentrate, the rumen pH tends to increase but not statistically significant different. These results are different and lower than the Tellier et al. (2004) who reported the pH value of the rumen as 6.88 and 6.86 when steers are fed with low and high protein. pH rumen is relative constant although the ration protein content increases (Xia et al. 2018).

The higher the level of *Muntingia calabura L* leaves in concentrate, the higher the protein content as well as the protein consumption value. The analysis of variance result shows that the *Muntingia calabura L* treatments recorded a very significant influence ($p<0.01$) towards increasing crude protein consumption. It means the using of *Muntingia calabura L* leaves flour as a substitute to maize flour in concentrate is able to prepare and to increase protein for rumen microbes as well as to increase the protein for the animal. Protein intake then changed to amino acid and then convert to ammonia (Satter and Rofler., 1975). Ammonia has an important role to supply N for microbe protein synthesize in the rumen (Wang et al. 2012).

The content of crude lipid in *Muntingia calabura L* leaves is relatively high and it reaches 11.4 %. Actually, the high content of lipid in *Muntingia calabura L* leaves shows that the increasing of *Muntingia calabura L* leaves flour level in concentrate, increasing the amount of crude lipid consumption. Commonly, lipid in feed material will be used as a source of VFA synthesize and at once it is a source of energy for the animal (Fiorentini et al., 2015). A high-value consumption of ration crude lipid is followed by the declining of crude lipid digest value. The analysis of variance result shows that the treatment of using *Muntingia calabura L* leaves declines the digest value of crude lipids significantly ($p<0.05$). Commonly, it can be seen that although the dry matter consumption and other nutrients tend to increase as well as the increasing of *Muntingia calabura L* leaves, the nutrient digest value shows a different result by the decreasing of digest value. The declining of digest value occurs due to the substitute of maize mill with *Muntingia calabura L* leaves has a positive correlation to the increasing of crude fiber content and the declining of ration NFE content. There is a close relationship between the ration protein digest and the increasing in nutrient consumption (Sampelayo, 1995).

There are many factors that take part in influencing the nutrient digest value of feed materials namely factors of animal, feed, and feed preparation. The feed factor mainly it is chemical composition mostly influence by land fertile, fertilizer, water availability, physiological age phase of the plant, trimming frequency, and species (Sufyan, 2018). Commonly, the higher the tannin content in feed materials, the higher the Nitrogen excretion in faeces; and the higher the ration crude protein content will follow by the increasing of N content both in urine and in faeces (Decandia et al. 2014).

Mechanism of fermentation in the rumen will produce a various product with any indicator which can be used as feed quality description. The using of feed with a high content of crude protein will produce a higher concentration of NH_3. The increasing the using of *Muntingia calabura L* leaves, increasing the concentration of NH_3 produced. The high concentration of NH_3 is in relation to the protein breaking in the rumen during microbes fermentation (Baumgard and Rhoads., 2011). Ammonia concentration in this study was 8.62 to 10.2 mM. This value was lower than reported by Ahmed et al. (2017) but higher than reported by Gumilar et al. (2012). The optimum concentration of rumen fluid ammonia range between 8.5 and 30.0 mg/100 ml (McDonald et al., 2012).

The concentration of rumen VFA in this study was 95,04-111,37 mM and relative similar to reported by Ahmed et al. (2017) who reported that rumen VFA was 111 mM when goats fed Leucaena leaf. The VFA play a vital role in the development and growth of rumen papillae, leading to increase papillae capacity for nutrient absorption and metabolism (Lane and Jesse, 1997). This study result was higher than reported by Gumilar et al. (2012) who reported that the concentration of rumen VFA was 49.69 mM. This different may due to different types and quality of feed. In general, this result study was still in normal range of rumen fluid VFA products that support microbial growth is 75 to150 mM according to McDonald et al. (2012).

The result shows that the satisfaction value of NH_3 and VFA used in synthesize of rumen protein microbes. This condition impacts to the increasing of fiberous feed fermentation which produce various kind of short-chain lipid acid. Propionate acid value in our study was lower compared to Wang et al. (2016) who reported that concentration of propionate acid was 48.06 mol/100 mol when goats fed normal amylose starch and decrease when high amylose starch was given. Propionate acid gained in this research tends to increase as the increasing of *Muntingia calabura L* leaves level until 40%. One function of propionate acid is glucose synthesize precursor so it can help in preparing to satisfy glucose for the animal.

Synthesize of propionate showed that better utilization of the dietary energy for the formation of propionate and reduce the amount of hydrogen for methane synthesize (Ahmed et al., 2017).

In our research, concentration of propionate acid range from 14.96 to 17.19 mM. Increase of protein content of concentrate, followed by increase of propionate concentration. Similar result was obtained by Davies et al. (1956) who stated that the increasing of ration protein is followed by the decreasing of total VFA concentration mainly acetate acid, however, the concentration of propionate acid increases. The increasing of VFA concentration occurs due to the fermentation mechanism of rumen microbes that changes feed materials into VFA and microbes protein (Loor et al. 2016).

Besides, the other variable of rumen fermentation that enhance fermentation speed indicates that *Muntingia calabura L* leaves used as a maize substitute produces a fluctuating concentration. The fluctuation occurs due to the existence of bioactive compounds in the *Muntingia calabura L* leaves that influence the rumen microbes activities. However, the animal response occurs in normal condition. This fact describes that the *Muntingia calabura L* leaves can be used as a maize substitute in concentrate. The increasing level of maize substitutes will be an advantage since maize still remains the main food of humans.

Conclusion and recommendation

In conclusion, *Muntingia calabura L* leaves can be used as concentrate formulation material for substitute the maize up to 40% level without influence consumption and digest of nutrients include rumen fermentation. Based on the finding, the following recommendation were made: It is needed to utilize the muntinga leaves flour in order to decrease the utilisation of maise.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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