



The Effect of Palm Oil Waste Based Rations Enriched with Cassava Leaves Silage and Organic Micro Minerals on Growth and Nutrients Digestibility of Goat

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Abstract | Fermentation palm oil waste that can break down fiber content, supplementation of cassava leaves silage and addition of organic micro minerals are also efforts to increase the nutritional content that it can meet the needs of animal feed. The effect of fermented palm oil fronds, supplementation of cassava leaves and organic micro minerals on growth and digestibility nutrients of goat. This study used 12 Ettawa Grade goats, used a Randomized Block Design (RBD) method which was and based on body weight. Feed materials used in this study were fermented palm oil waste (palm fronds and fronds), cassava leaves silage, and organic micro minerals. The treatments consisted of R1: control ration; R2: ration waste based on fermented palm oil; R3: R2 + cassava leaves silage; and R4: R3 + organic micro minerals. Supplementation of cassava leaves silage and organic micro minerals in palm oil waste based rations significantly affected ($P < 0.1$) on body weight gain and feed efficiency. Supplementation of cassava leaves silage and organic micro minerals in palm oil waste based rations did not significantly affect ($P > 0.1$) on crude fiber digestibility, digestibility of crude protein, crude fat digestibility, and TDN in goats. Supplementation of cassava leaves silage and organic micro minerals in palm oil waste based rations with different treatment on goats had improved on body weight gain and feed efficiency but not affect on digestibility of crude fiber, crude protein, crude fat, and TDN in goats.

Keywords | Palm oil waste, Enriched ration, Growth, Nutrient digestibility, Goat

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INTRODUCTION

The main feed of goats are forage, forage is a good source of energy and vitamins, but the crude protein content is relatively low compared to grain feed. The productivity of goats can be increased with a good management system, through the provision of quality feed, that has sufficient nutritional value for basic living needs and production.

Utilization of plantation industrial waste is an alternative that needs to be done so that it can meet the needs of animal feed with high nutrient content and digestibility. One of the plantation industry wastes is palm oil waste,

palm oil waste has many types of diversity such as leaf waste with or without palm oil sticks, palm frond waste and palm oil mill by products waste such as palm kernel cake which is often used as feed material for fattening ruminants. Efforts to improve ruminant animal feed based on palm oil waste that are considered quite effective are by conducting fermentation technology.

This fermentation technology can increase the structural digestibility of carbohydrates and increase the amount of protein by chemical, physical, and biological fermentation. It is expected that palm oil-based waste can be used as an alternative to goat feed, with high feed intake, can

optimize the goat's body weight gain. However, if only use palm kernel cake with palm fronds, the nutritional needs have not been fully met. Limitations of quality feed sources require nutritional supplementation, especially protein and energy sources.

Cassava leaves silage is a source of protein that can be supplementary feed to meet the protein needs of goats. In addition, minerals also need to be added to the ration to meet all the chemical elements of feed to optimize the productivity of goats (Adhianto et al., 2019).

According to Mathius et al. (2003) note that the majority of palm oil waste contains high crude fiber. Furthermore, if the oil palm waste product is used for livestock, it can cause nutrient deficiencies, thereby reducing productivity. High fiber content will reduce the value of TDN (Total Digestible Nutrients) from feed ingredients.

According to Sudaryanto (1999) there are four kinds of treatments that can be done to improve the quality of palm oil waste, namely physical, chemical and biological treatments, one of which is fermentation. Palm oil waste-based feed fermentation can break down cellulose, hemicellulose and lignin into simple forms so that feed ingredients are easily digested by rumen microbes. The process will also include microbial body cells and enzymes that contain proteins and other metabolites, thus resulting in better quality feed products, especially their nutritional content. Supplementation of cassava leaves silage and addition of organic micro minerals are also efforts to increase the nutritional content of the ration and the digestibility of the ration so that it can affect production (Muhtarudin et al., 2016, 2018).

MATERIALS AND METHODS

This study used 12 young male goats. This study uses a Randomized Block Design (RBD) method, which was based on body weight. In this study the goat were grouped into 3 group and each group consist of 4 goats as a replication. Group division was based on body weight as follows: Group I: 12.0-21.0 kg, Group II: 23.0-31.5 kg, and Group III: 32.5-44.0 kg

Feed materials used in this study were fermented palm oil waste (palm fronds), cassava leaves, and organic micro minerals. Feed giving 2 times, in the morning and evening with the number of giving in an *ad libitum*. Basal ration consists of cassava by product, Palm kernel cake, elephant grass, palm fronds, rice bran, urea and premix. The ration formulation used in the study can be seen in Table 1 and the treatment are:

R1: control ration (15% palm oil fronds, 15% elephant

grass, 39% casava byproduct, 10% rice bran, 18% palm kernel cake, 2% urea, 1% premix)

R2: ration waste based on fermented palm oil (15% fermented palm oil fronds, elephant grass 15%, casava byproduct 39%, 10% rice bran, 18% fermented palm kernel cake, urea 2%, premix 1%)

R3: ration waste based on fermented palm oil (15% fermented palm oil fronds, 15% cassava leaves silage, 39% casava byproduct, 10% rice bran, 18% fermented palm kernel cake, 2% urea, 1% premix)

R4: ration waste based on fermented palm oil (15% fermented palm oil fronds, 15% cassava leaves silage, 39% casava byproduct, 10% rice bran, 18% fermented palm kernel cake, 2% urea, 1% premix, organic micro minerals (Zn 40 ppm, Cu 10 ppm, Se 0,10 ppm, Cr 0.30 ppm)

Table 1: Ration treatment.

Feed ingredients	Balance %			
	R1	R2	R3	R4
Cassava by product	39	39	39	39
Palm kernel cake	18	–	–	–
Fermented palm kernel cake	–	18	18	18
Palm oil fronds	15	–	–	–
Fermented palm oil fronds	–	15	15	15
Elephant grass	15	15	–	–
Cassava leaves silage	–	–	15	15
Rice bran	10	10	10	10
Urea	2	2	2	2
Premix	1	1	1	1
Organic micro minerals				0,001
Total	100	100	100	100

Description: R1: control ration (15% palm oil fronds, 15% elephant grass, 39% casava byproduct, 10% rice bran, 18% palm kernel cake, 2% urea, 1% premix); R2: ration waste based on fermented palm oil (15% fermented palm oil fronds, elephant grass 15%, casava byproduct 39%, 10% rice bran, 18% fermented palm kernel cake, urea 2%, premix 1%); R3: ration waste based on fermented palm oil (15% fermented palm oil fronds, 15% cassava leaves silage, 39% casava byproduct, 10% rice bran, 18% fermented Palm kernel cake, 2% urea, 1% premix); R4: ration waste based on fermented palm oil (15% fermented palm oil fronds, 15% cassava leaves silage, 39% casava byproduct, 10% rice bran, 18% fermented Palm kernel cake, 2% urea, 1% premix, organic micro minerals (Zn 40 ppm, Cu 10 ppm, Se 0,10 ppm, Cr 0.30 ppm).

Observed variables: Body weight gain, feed intake, feed efficiency, and feed digestibility (dry matter, organic matter, protein, and crude fiber digestibility). Data obtained from the results of the study were analyzed using analysis of variance (ANOVA) and the least significant difference test (LSD) would be carried out if the ANOVA was significant (Steel and Torrie, 1991).

EFFECT OF TREATMENT RATION ON PRODUCTION PARAMETERS IN GOAT

FEED INTAKE

The results of the analysis of variance (Table 2) showed that the supplementation of fermented cassava leaves and organic micro minerals in rations based on palm oil waste did not have a significant effect ($P > 0,05$) on feed intake. Based on the LSD test showed that feed intake of R3 and R4 were higher than that of R1 and R2. The high feed intake in treatments R3 and R4 was accompanied by increased body weight of goat. Treatment of R3 and R4 resulted in higher intake by the goat when compared to R1 and R2, it due to the addition of fermented cassava leaves in the ration. In addition, this is due to the higher protein content of rations in R3 and R4 compared to R1 and R2 in line with Wallace and Newbold (1992); Muhtarudin et al. (2017) that feed intake is influenced by protein quality. The large amount of feed intake by goat can illustrate the palatability of the ration.

Table 2: Feed intake, body weight gain, feed efficiency and digestibility.

Parameters	Treatment			
	R1	R2	R3	R4
Feed intake (g/day)	982 ^a	897 ^a	1,336 ^b	1,263 ^b
Body weight gain (g/day)	55.57 ^a	61.13 ^a	133.33 ^b	144.47 ^b
Efficiency ration	0,06 ^a	0.08 ^a	0.12 ^b	0.13 ^b
Crude fiber digestibility (%)	72.92	65.82	58.98	59.28
Crude protein digestibility (%)	85.64 ^a	81.31 ^b	85.43 ^a	86,88 ^a
Crude fat digestibility (%)	92.79	90.39	89.92	93.94
Total digestible nutrients / TDN (%)	72.26	69.62	75.49	74.34

Description: R1: control ration (15% palm oil fronds, 15% elephant grass, 39% casava byproduct, 10% rice bran, 18% palm kernel cake, 2% urea, 1% premix); R2: ration waste based on fermented palm oil (15% fermented palm oil fronds, elephant grass 15%, casava byproduct 39%, 10% rice bran, 18% fermented palm kernel cake, urea 2%, premix 1%); R3: ration waste based on fermented palm oil (15% fermented palm oil fronds, 15% cassava leaves silage, 39% casava byproduct, 10% rice bran, 18% fermented palm kernel cake, 2% urea, 1% premix); R4: ration waste based on fermented palm oil (15% fermented palm oil fronds, 15% cassava leaves silage, 39% casava byproduct, 10% rice bran, 18% fermented palm kernel cake, 2% urea, 1% premix, organic micro minerals (Zn 40 ppm, Cu 10 ppm, Se 0,10 ppm, Cr 0.30 ppm).

According to Kartadisastra (1997), body weight of livestock is always directly proportional to the feed intake, the higher the body weight, the higher the level of feed intake. In addition, the maximum feed intake is highly dependent on the balance of nutrients in digestion. According to Church

and Pond (1988), the amount of feed intake is influenced by several factors, including palatability, feed digestibility, feed flow rate, and protein content. Parakkasi (1991) stated that feed intake is influenced by several factors, including livestock (body weight and age), feed digestibility, feed quality, and feed palatability.

BODY WEIGHT GAIN

The results of the analysis of variance (Table 2) showed that supplementation of cassava leaves silage and addition of organic micro minerals significantly affected ($P < 0.01$) on body weight gain. Growth rate of animal is influenced by age, environment and genetics, where the body weight of the initial phase of fattening is related to adult weight (Tomaszewska, et al., 1993). Body weight gain is influenced by environmental factors, one of which is feed. Feed is material that is eaten and digested by an animal that is able to provide nutrients that are important for body maintenance, growth, fattening, reproduction and production (Hartadi et al., 1986; Muhtarudin et al., 2017).

Based on the Table 2, the highest body weight gain was 144.47 g/day that was at R4 treatment and the lowest was 55.57 g/day that was at treatment R1. All treatment was an increase in body weight of goats, from 55.57 g/day to 144.47 g/day. Kartadisastra (1997), stated that the body weight of livestock is always directly proportional to the consumption of rations, the higher the body weight, the higher the level of consumption of the ration. In addition, the maximum consumption of feed is highly dependent on the balance of nutrients in digestion. This is because nutritional needs are the main stimulant to be conveyed by the hypothalamus as a hunger center (Wilson and Kennedy, 1996).

This increase in body weight is closely related to the digestibility of dry matter, digestibility of organic matter and N retention. In this study R3 and R4 had high intake with protein content of the ration so that weight gains also increased. This was related to the level of palatability of ration for livestock. R3 and R4 contained fermented cassava leaves silage in the ration witch contain lots of protein and amino acids. Fermented cassava leaves can be used as a source of branched chain amino acid (BCAA). Protein synthesis by microbes requires BCFA (branched chain fatty acids) which includes isobutyric acid, 2 methyl butyrate and isovalerate. The rumen BCFA is the result of BCAA decarboxylation and deamination, namely valine, isoleucine and leucine (Muhtarudin et al., 2017; Adhianto et al., 2018).

According to Zain (1999), BCAA supplementation stimulates bacterial growth so that feed digestion and livestock growth increase. It was further explained that the best ratio of BCAAs used in increasing feed digestibility

was 0.1% valine, 0.2% isoleucine and 0.15% leucine. Rumen microbes degrade cassava leaves into ammonia and the ammonia can be partially converted back into microbial protein which is then used by host animals (Leng et al., 1984).

Ruminant body weight gain is strongly influenced by the quality and quantity of feed, this is meant by an assessment of ruminant body weight gain in proportion to the ration consumed (Nursasih, 2005). Parakkasi (1991) added that, one of the factors that influence body weight gain is feed intake, the higher the amount of feed intake, the rate of livestock growth is higher too.

FEED EFFICIENCY

The results of the analysis of variance (Table 2) showed that the highest average efficiency in feed use was R4 (0.13) and the lowest was in treatment R1 (0.06). The results of the analysis of variance showed that the treatments of R1, R2, R3, and R4 had a significant effect ($P < 0.1$) on feed efficiency. Card and Nesheim (1972) stated that the value of efficient use of feed shows how much weight gain is generated from one kilogram of feed.

Feed efficiency is the opposite of feed conversion, the higher the value of feed efficiency, the amount of feed needed to produce one kilogram of meat is less. Fat and energy in the ration can improve feed efficiency because the higher levels of fat and energy in the ration causes cattle to consume less feed but results in high body weight gain. Feed efficiency can be improved by adding fat to the ration but it will result in reduced feed intake. The addition of fat in the ration can increase efficiency because the fat in the ration will be deposited in the body so that it will increase body weight.

Based on Table 2 shows the response efficiency of the use of feed treatments R3 and R4 better than R1 and R2 treatments. This is due to the fact that feed intake and body weight gain in treatments R3 and R4 are higher than R1 and R2. The treatments R3 and R4 are higher ration efficiency when compared to R1 and R2. When compared with the results of other studies, the average value of the feed efficiency of this study is better than the results of the research of Kaunang (2004) on ruminants fed with sulfur water fertilized forage (0.08); also better than the results of Kardaya's Research (2000) on the provision of organic mineral supplementation (Zn-protein and Cu-protein) and ammonium molybdate on local goat performance (0.12).

NUTRIENTS DIGESTIBILITY

CRUDE PROTEIN DIGESTIBILITY

The treatment of ration did not affect protein digestibility ($P > 0.05$). Average results of crude protein digestibility can be seen in Table 2. The treatment did not affect the

digestibility of crude protein due to the protein content of each treatment being relatively the same. The protein content in the ration will affect the level of consumption and palatability of the ration. The crude protein content of rations R1, R2, R3, and R4 were 14.95%, 15.89%, 17.03%, and R4 17.35%, respectively. According to Kears (1982) protein needs in goats range from 12-14% so that the protein content of rations is relatively high. According to Parakkasi (1991) good quality feed was higher in consumption than low quality feed. In ruminant protein digestibility occurs in the reticulum, rumen, and omasum which are carried out by rumen microbes. The results of digestion protein in this section are high quality microbial body proteins (microbial proteins) that will be utilized by the host. Digestibility of proteins occurs also in the abomasum (enzymatic digestion) whose role is enzyme pepsinogen and renin that breaks down proteins into simpler pieces. Protein digestion is continued in the small intestine which digests protein enzymatically into amino acids which are then absorbed through the intestinal wall to further undergo metabolic processes.

CRUDE FIBER DIGESTIBILITY

From the results of the proximate analysis of crude fiber content of rations R1, R2, R3, and R4 each of 18.49%; 17.78%; 16.08%; 16.34%. The relatively low crude fiber content in the range of 16.08-18.49% can still be tolerated by fiber-digesting rumen microbes so as to produce the same digestibility of crude fiber. Cellulolytic microbes secrete enzymes cellulitis which will degrade cellulose and hemicellulose to become volatile fatty acids (VFA). VFA will be absorbed through the rumen wall into the blood of the host, transported through the blood into the cell and will be metabolized into glucose and eventually become energy. In ruminants, fiber digestion is carried out by microbes in the reticulum, rumen and omasum. Degradation of crude fiber also takes place before the digestion, namely in the cecum and colon because in this section there are fiber-digesting microbes although in terms of the number and types of less than the reticulum, rumen, and omasum.

CRUDE FAT DIGESTIBILITY

The digestibility of crude fat produced in each treatment is very high. This may be influenced by the use of rations in every treatment which has very good quality. The highest fat digestibility of the average yield was in the R4 93.94% treatment ration, however the high and low digestibility is not only influenced by the ration of treatment given to an animal. There are other factors such as age, consumption and type of livestock which is very influential on digestion. In addition, digestion is also related to consumption of rations. The greater the consumption of rations, the digestibility will also increase. This is in line with Pond et al. (2005) stated that the true digestibility of fat exceeds 80%.

The results are also higher than the research conducted by Suprpto et al. (2013) which obtained the average digestibility of fat in weaning Etawah goats reached \pm 86%.

Based on the analysis of variance in Table 2, it was found that the digestibility of crude fat in goat ration was not significantly different ($P > 0.05$). This shows that there is an equal substitution between the silage of cassava leaves and micro organic minerals on a palm oil-based ration. The feed material used is also an important factor in the digestibility of crude fat, one of which was palm kernel cake. Palm kernel cake is a source of protein feed with crude fat content reaching 15.53%. The digestibility of palm kernel cake is also quite high. According to Devendra (1980) palm kernel cake has a digestibility rate of around 70%. Parakkasi (1991) states that the more feed that can be digested through the digestive tract, the flow speed causes more space available for feed addition so that consumption increases. The treatment rations given to goats have very good quality so that each treatment goat has a high enough digestibility of fat.

The treatment ration used had a large enough fat content (R1= 7.25%, R2= 7.94%, R3= 9.45%, R4= 9.68%). Thus, treatment rations are high-energy rations because ruminant animal fat requirements are generally less than 5%. The amount of digestibility of each treatment is quite high because the digestibility of each feed ingredient is also quite large. In rations R3 and R4 are quite large values of fat content with an average of 90% fat digestibility. Fat also functions as a vitamin solvent, but will cause diarrhea if excessive.

The condition of a healthy goat with a large consumption can also be a factor in the value of crude fat digestibility is quite large. The higher the consumption, the greater the feed that enters the rumen. According to Doreau and Chilliard (1997), that fat entering the rumen will undergo hydrolysis by rumen bacteria such as Anaerovibrio lipolytica and Butyrivibrio fibrisolvens which will release lipase enzymes, galactosidase and phospholipase.

TOTAL DIGESTIBLE NUTRIENT (TDN)

TDN is the total energy of feed substances in livestock that is equated with energy from carbohydrates, and can be obtained by biological tests or calculations using proximate analysis data. TDN is used to measure the energy content of feed ingredients. TDN is an energy unit based on all digestible feed nutrients, so that the TDN value is almost the same as digestible energy (DE) the difference lies in the measurement method, where the DE value of feed ingredients is determined by way of burning samples of feed ingredients and faeces in calorimeter bombs (Sutardi, 1980).

Based on the results of the analysis of variance in Table 2 shows that TDN goat ration was not significantly different ($P > 0.05$) for all treatment. This showed that the digestibility of each treatment ration is high enough so that the total nutrients that can be absorbed were also quite large. TDN produced in each treatment with an average of 72.26% (R1), 69.62% (R2), 75.49% (R3), and 74.34% (R4) which each treatment has a fairly high TDN value.

TDN in each treatment was very high, probably due to the value of protein ration. The digestibility of crude protein in each treatment was also quite good so it can affect the value of TDN. The result of current study was reinforced by Siregar (1994) which stated that all feed contains feed substances that can be a source of energy, crude protein, crude fiber, fat and extract ether without nitrogen. So with the increase in crude protein content it is possible that TDN content also increases.

The treatment rations on R3 and R4 showed an increase in R1 and R2. Even though the analysis of variance had no significant effect, it can be said that the supplementation of fermented cassava leaves and minerals organic micro can improve the digestibility of ration nutrition even though the value is not so high. The reason was that control ration in this study has a high enough protein content (14.95%). If seen from the research of Purbowati et al. (2007) who obtained the results that the most efficient use of rations was crude protein level 15.09% with TDN 58.60%. Diets with higher protein and TDN are inefficient so that the use of rations at TDN level $>70\%$ with protein level $>15\%$ will have no effect even though the treatment was carried out in this study. This is also in line with research Nugroho et al. (2013) which reported that there was a negative correlation between crude protein and TDN.

Crude fat digestibility also affects TDN. According to Gatenby (1986) that, livestock absorb energy in the feed mainly for basic living, and if there is still excess energy will be used for production, but some of the energy absorbed in the body will be converted to body heat. Fat digestibility reaches more than 90% so that the TDN is quite large.

Total Digestible Nutrient is the total amount of feed needed by livestock. Excess energy will be stored in body fat and vice versa if the feed consumed does not meet energy needs then the body fat will be overhauled to meet the energy needs for livestock staples that are not sufficient from the feed. The amount of TDN shown in Table 2 can mean that the digestibility of the ration is very good.

Treatment ration using palm oil waste-based ration is able to provide high TDN values. The statement is in accordance with Sembiring (2006) reported that palm kernel cake

fermentation technology increases energy content and digestibility of feed ingredients. This is evidenced by the use of oil palm cake at each treatment ration giving a high TDN yield, as indicated at each treatment ration.

High of dry matter intake (DMI) can also affect TDN. DMI in each treatment is quite large in the range of 60-80%. The statement was reinforced by [Zulbadri et al. \(1995\)](#) which states that an increase in DMI will be followed by an increase in TDN ration, on the contrary there is a decrease in DMI, TDN will also decrease.

The treatment ration had good nutritional quality, with a high enough DMI so that the TDN was also quite large. Body weight gain per treatment is also good. Although there are significant differences between each group, it does not affect the treatment.

CONCLUSION

1. Supplementation of fermented cassava leaves silage and organic micro minerals in palm oil waste based rations increased goat body weight gain and feed efficiency.
2. Supplementation of fermented cassava leaves silage and organic micro minerals in palm oil waste based rations did not affect on digestibility of crude fiber, crude protein, crude fat, and TDN in goats.

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AUTHORS CONTRIBUTION

All authors contributed equally.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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