Milk quality of Etawa crossbred dairy goat fed combination of fermented oil palm fronds, Tithonia (Tithonia diversifolia) and Elephant Grass (Pennisetum Purpureum)

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Abstract. The aim of this research was to determine the influence of Fermented Oil Palm Fronds (FOPF) by Phanerochaete chrysosporium with Tithonia (T) and Elephant Grass (EG) as roughage on milk quality of Etawa Crossbred Dairy Goats (ECDG). This study used a randomized complete design consisting of four treatment groups that is: T1 = 20% FOPF+16% T+64% EG, T2 = 20% FOPF+32% T+48% EG, T3 = 20% FOPF+48%T+32% EG and T4 = 20% FOPF+64% T+16% EG. Four replicates were used per treatment. The data were analysed using Analysis of Variance (ANOVA) and differences among the treatment means were tested using Duncan’s Multiple Range Tests (DMRT) with 5 replications and 1% confidence intervals. Parameters measured were quality of milk, i.e. protein, fat, lactose and mineral (Ca and P) content. Results showed using combination FOPF by phanerochaete chrysosporium with T and EG can significantly increase milk mineral concentration (Ca and P) (p<0.01), but there was no effect on milk content of protein, fat and lactose (p>0.05). The combination FOPF by Phanerochaete chrysosporium with Tithonia (T) and Elephant Grass (EG) can be used as an alternative feed for goats. The best feed for dairy goats was 20% FOPF + 64 % T+ 16 % EG (Treatment D).

1. Introduction
Goat milk is quite popular with Indonesian people because of its many health benefits. According to Affandi goat milk has been tested with various diseases, especially tuberculosis, asthma, anemia, hepatitis, muscle cramps and stomach ulcers [1]. Goat milk is also able to neutralize stomach acid, increase vitality and endurance, overcome impotence and optimize child growth. Goat milk is a good source of amino acids and nutrients, can be consumed by individuals who are not tolerant of cow's milk, because of several types of milk protein that produce milk that is not found in Cow milk [2]. Goat's milk is easier to digest than cow's milk because of its smaller fat size and in a more homogeneous state [3]. Fluorine content in goat milk is quite high. Fluorine is useful as a natural antiseptic that can produce pathogenic bacteria in the body [4].

Etawa crossbreed dairy goat have been maintained for a long time, so that they are considered to be local goats with better genetic quality than other local goats. Etawa cross bred Dairy Goat (ECDG) is a dual-purpose goat that can produce milk such as Etawa goat and produce meat such as Kacang goats [5]. Milk production of ECDG can reach 1.5-3 liters per day [6]. Goat's milk fat and protein is quite high at 6.08% and 4.48% [7].
The use of alternative feed in improving the quality of goat milk needs to be studied. This is due to the limited availability of forage and the quality of goat milk depends on the quality of the feed given. Oil palm fronds (OPF) is an oil palm plantation waste that is available all the time in large quantities [8,9]. The area of oil palm plantations in Indonesia in 2015 reached ± 11,300,370 Ha and continued to increase with an increase in area per year [10]. The use of palm fronds as animal feed is still very limited because the OPF contain high lignin which causes low digestibility [11-13]. The use of Phanerochaete chrysosporium fungus supplemented with minerals Ca, Mn and P in the OPF fermentation has been proven to reduce lignin content so that the cellulose and hemicellulose components can be used optimally for feed [14-15]. Digestibility values and VFA concentrations of OPF also increased significantly [16-17].

Tithonia (T) plants also have potential as an alternative feed. T cultivated in West Sumatra can produce as much as 30 t of fresh material or 6 t of dry matter per year on a land area of approximately 1/5 ha. When grown as a hedge, it can produce 27 kg of dry weight from three harvests in 1 year [18]. Jamarun et al. reported the following nutritional contents of T [19]: DM (25.57%), OM (84.01%), CP (22.98%), CF (18.17%), NDF (61.12%), ADF (40.15%), cellulose (34.59%) and lignin (4.57%). Jama et al. reported that the green leaves of T contained high levels of N (3.5-4.0%), P (0.35-0.38%), K (3.5-4.1%), Ca (0.59%) and Mg (0.27%) [20]. Research on T as a ruminant feed material is limited because its leaves contain many antinutritional substances that endanger livestock, such as phytic acid, tannins, saponins, oxalates, alkaloids and flavonoids [21]. The combination of T and elephant grass (EG) can improve the digestibility and fermentability of the rumen fluid. Jamarun et al. reported a combination of 20% T and 80% EG in vitro resulting in the dry matter and organic matter digestibilities of 58.30 and 57.85%, respectively, pH 6.68, ammonia (NH3) concentration of 16.89 mg/100 mL and volatile fatty acid (VFA) content of 127.50 mM [22]. The provision of diets with varying forage will increase VFA production and MPS in Etawa goat crossbreeds [23]. The forage composition of the feed greatly affects the response of livestock growth and production. Based on the description, research was conducted on milk quality ECDG feeding by rations FOPF, Tithonian and elephant grass.

2. Materials and methods
For this study, the in vivo treatments was conducted at the Company of Etawa Crossbred Dairy Goat (ECDG), Rantiang Ameh Agam Regency west Sumatra on January until Mei, 2018. The livestock used is the second lactation ECDG weighing 75-80 kg. Analysis of milk Quality was conducted in the Laboratory of Dairy Nutrition and Laboratory Dairy Cattle Production of the Bogor Agricultural Institute. The parameters measured in this study were quality of milk: protein, fat, lactose and mineral (Ca and P).

2.1. Fermented Oil Palm Fronds (FOPF)
The Oil Palm Fronds (OPF) materials used as the raw material in this study were taken from the distal two-thirds of the OPF. The OPF substrates were cut, dried and finely milled. The OPF were then fermented using phanerochaete chrysosporium, supplemented with 2000 ppm of Ca, 2000 ppm of P and 150 ppm of Mn. Fermentations were made for 20 days.

2.2. Rations of ECDG
FOPF are stirred with concentrate consisting of rice bran, soybean meal waste, corn, palm kernel cake, salt and minerals. Elephant grass and Titonia grasses are mixed according to treatment. Feeding is done twice a day, which is at 08.00 and 17.00, feed was given according to NRC which is 4% body weight in the form of dry matter [24]. Drinking water was given ad libitum. The composition of the ingredients in the treatments ration in this experiment can be seen in tables 1,2 and 3.
Table 1. Nutritional content of raw materials.

| Nutritional content (%) | Raw materials | FOPF | EG | T | Rice bran | Soybean meal waste | Palm kernel cake | Corn |
|-------------------------|---------------|------|----|---|-----------|-------------------|-----------------|------|
| Dry Matter              |               | 72.01 | 21.23 | 25.57 | 87.80 | 28.40 | 91.83 | 85.80 |
| Organic matter          |               | 91.34 | 89.46 | 84.01 | 90.80 | 97.67 | 91.41 | 99.10 |
| Crude protein           |               | 08.89 | 10.88 | 22.98 | 10.72 | 20.11 | 12.36 | 07.70 |
| Crude fiber             |               | 38.59 | 32.77 | 18.17 | 11.60 | 19.00 | 26.68 | 02.44 |
| Extract ether           |               | 01.27 | 02.48 | 04.71 | 08.73 | 01.25 | 08.23 | 03.50 |
| NDF                     |               | 66.52 | 66.57 | 61.12 | 55.13 | 59.28 | 66.70 | 49.96 |
| ADF                     |               | 57.85 | 41.71 | 40.15 | 29.35 | 26.65 | 46.10 | 36.76 |
| Cellulose               |               | 37.50 | 34.18 | 34.59 | 15.52 | 22.93 | 43.25 | 29.52 |
| Hemicellulose           |               | 08.67 | 24.86 | 20.97 | 25.78 | 32.63 | 20.60 | 13.20 |
| Lignin                  |               | 18.35 | 06.29 | 04.57 | 06.90 | 02.20 | 17.29 | 07.50 |
| TDN                     |               | 61.90 | 63.48 | 62.60 | 66.63 | 74.61 | 65.40 | 81.90 |

Description: a. Laboratory of Dairy Animal Nutrition Faculty of Animal Husbandry IPB (2016)
               b. Laboratory of Ruminant Nutrition Faculty of Animal Husbandry Andalas University (2017)

Table 2. Ration composition %.

| Raw Materials       | treatments | A   | B   | C   | D   |
|---------------------|------------|-----|-----|-----|-----|
| FOPF                |            | 12  | 12  | 12  | 12  |
| Elephant Grasa      |            | 38.4| 28.8| 19.2| 9.2 |
| Tithonia            |            | 9.6 | 19.2| 28.8| 38.4|
| Rice bran           |            | 12  | 12  | 12  | 12  |
| Soybean meal waste  |            | 10  | 10  | 10  | 10  |
| Palm Kernel cake    |            | 9   | 9   | 9   | 9   |
| Corn                |            | 8   | 8   | 8   | 8   |
| Salts+Mineral       |            | 1   | 1   | 1   | 1   |
| Total               | 100,0      | 100,0| 100,0| 100,0| 100,0|

Table 3. Composition of experimental food ingredients.

| food ingredients     | Treatments (%) | A   | B   | C   | D   |
|----------------------|----------------|-----|-----|-----|-----|
| Dry Matter           |                | 47.75| 48.17| 48.58| 49.00|
| Organic matter       |                | 90.20| 89.67| 89.14| 88.62|
| Crude protein        |                | 12.48| 13.64| 14.79| 15.96|
| Crude fiber          |                | 24.84| 23.44| 22.04| 20.68|
| Extract ether        |                | 03.75| 03.96| 04.17| 04.39|
| NDF                  |                | 61.95| 61.43| 60.90| 60.38|
| ADF                  |                | 40.08| 39.94| 39.79| 39.64|
| Cellulose            |                | 31.35| 31.39| 31.43| 31.47|
| Hemicellulose        |                | 21.86| 21.49| 21.11| 20.74|
| Lignin               |                | 08.18| 08.02| 07.85| 07.69|
| Total Digestible Nutrient |           | 65.71| 65.62| 65.53| 65.45|
| Ca                   |                | 00.71| 00.72| 00.85| 00.94|
| P                    |                | 01.87| 01.90| 02.07| 02.44|
2.3. Milk collection and measurement of milk quality
Livestock maintenance during the study period was carried out in three periods, namely the period of adaptation, introduction and collection. The adaptation period lasts for 15 days aimed at adjusting livestock to the experimental ration. The preliminary period lasts for 25 days, aiming to eliminate the influence of the previous ration. Collecting period is a data collection period lasting 5 days for fecal sampling and calculation of feed consumption. Collective milk production begins after the end of the 30-day adaptation period. Sampling for milk quality testing was carried out for 2 times in the study in 2 different milking times, namely morning and evening. Determination of the levels of protein, fat, milk lactose using the Milkotester Master Pro 10211 tool. Phosphorus mineral levels were measured based on Taussky and Shorr [25].

2.4. Experimental design and statistical analysis
This research was conducted using a completely randomized design (4x4) with 5 replications (levels of FOPF, T and EG as the treatments). The differences between the treatment means were analyzed using Duncan’s multiple range tests (DMRT) with confidence intervals of 5% and 1% Steel and Torrie [26]. The treatments were as follows:

A = 20% FOPF + 16% T + 64% RG
B = 20% FOPF + 32% T + 48% RG
C = 20% FOPF + 48% T + 32% RG
D = 20% FOPF + 64% T + 16% RG

3. Results and discussion
Data analysis of the milk quality of ECDG fed with FOPF combined with different levels of Titonia and elephant grass are presented in table 4. Table 4 shows that the treatments had not significant effect (P> 0.05) on the levels of protein, fat, Lactose but highly significant effect (P <0.01) on the levels mineral of Ca and P. This shows that the response of ECDG to forage rations consisting of a combination of FOPF, titonia and elephant grass is good, there is no difference in the quality of milk (Protein, fat and Lactose) despite an increase in titonia levels to 64%.

Table 4. The milk quality of ECDG fed with FOPF combined with different levels of titonia and elephant grass.

| Parameters | Treatment |
|------------|-----------|
| Protein (%) | A | B | C | D |
| 4.03 | 4.08 | 4.14 | 4.39 |
| Fat (%) | 7.29 | 7.61 | 8.23 | 8.23 |
| Laktose (%) | 4.10 | 4.15 | 4.24 | 4.46 |
| Ca (%) | 0.21<sup>a</sup> | 0.23<sup>b</sup> | 0.24<sup>b</sup> | 0.25<sup>c</sup> |
| P (%) | 0.08<sup>a</sup> | 0.09<sup>b</sup> | 0.09<sup>bc</sup> | 0.10<sup>c</sup> |

<sup>a-c</sup>Means in the same row with different letters are significantly different (P<0.01)

3.1. Milk protein
Judging from protein content, milk protein content of ECDG varied from 4.17-4.56% [27]. Sunarlim et al. stated that the analysis of ECDG milk protein content was relatively higher at 4.3% for goat milk and 3.8% for cow’s milk [28]. According to Afandi the protein content of goat milk ranged from 4.1% to 4.5% [1]. Chaniago and Hartono obtained goat milk protein content of 3.3-4.9% [29], while Adriani obtained a range of goat milk, the results of which were 3.00-6.90% [30]. These results indicate the protein content of milk obtained is still within the normal range of goat milk protein. Protein content of
ECDG milk obtained in this study is higher when compared to the results of Ardiansyah [31] and Rizqan [32] research which obtained milk protein levels by feeding concentrate based on palm oil waste was 2.95% and 3.68%. Milk protein in this study included the category of premium or best milk protein based on Thai Agricultural Standards due to > 4% milk protein value [33].

Not different effect (P > 0.05) of treatments A, B, C, and D on milk protein levels caused by crude protein in all treatments consumed by livestock can still be digested by livestock so that the need for crude protein to form proteins in milk is still can be fulfilled. The value of crude protein digestibility in all treatments also differed not significantly (P > 0.05) and the protein quality of the ration given was also high. Like the opinion raised by Smith et al. which states that high quality protein can be protected from degradation of rumen microorganisms so that it is more available in the pasca rumen [34]. Then the protein rations consumed will condense and enter the bloodstream to be converted into blood amino acids with carbon precursors from non-essential amino acids. Furthermore, amino acids from the blood will be converted into amino acid deposits and will enter the udder secretory cells and be synthesized into milk proteins. This is explained by Collier which states that milk protein synthesis comes from amino acids circulating into the blood as a result of absorption of the digestive tract, body protein changes and amino acids synthesized epithelial cells gland milk into milk protein [35]. Akers adds that when there is an increase in milk production, most of the protein or amino acid feed is focused on milk synthesis so that the milk protein content does not increase [36].

Different types of milk protein treatments A, B, C and D are also caused by genetic factors that ECDG are used uniformly. The effect of feed on milk protein is relatively small, even though the feed protein of each treatment is different and increases from treatment A to D. This is in accordance with the opinion of Le Jaouen which states that variation in milk protein content is relatively small compared to milk fat content because Milk protein is more influenced by genetic factors than environmental factors [37].

3.2. Milk fat
The difference in titonia and elephant grass combination levels in each treatment did not affect (P <0.05) the fat content of goat milk produced. The average fat content of goat milk was 7.84%, with a range of 7.29 - 8.23%. This result is higher than other studies in lactating ECDG which are 6 ± 0.05% Budi [38] and Arief [39], with palm oil industry based byproducts of food which is 5.24%. Milk fat content obtained in this study is almost the same as Chania goat and Hartono which is 7.3% [29]. This difference is caused by differences in the crude fiber content in the ration. Sutardi states that milk fat content is the most volatile component and is very dependent on the crude fiber content of food [40]. Low coarse food fiber will produce low acetate, whereas acetate is the main ingredient in the formation of milk fat [41]. The fat content value in this study is quite high due to the high contribution of crude fiber content and digestibility of crude fiber so that the need for crude fiber to form fat in milk can still be fulfilled and is able to maintain milk fat. In dairy cattle consumption of crude fiber found in animal feed is very important and affects the quality of milk, especially milk fat. As explained by Wikantadi the level of milk fat is strongly influenced by the consumption of crude fiber in the feed given [42].

In addition, consumption of livestock for carbohydrates obtained from the combination of forage combination FOPF, titonia and elephant grass is still sufficient so that acetic acid produced as a precursor to form milk fat content is available in large quantities so that it can meet the needs in the formation of milk fat content. This is supported by Arief explanation that milk fat content is affected by acetic acid from forage [39]. Forage eaten by livestock, then undergoes a fermentative process in the rumen by rumen microbes. The results of the fermentative process are VFA. VFA consists of propionate, acetate and butyrate. Acetate enters the blood and is converted into fatty acids, then it will enter the secretion cells of the udder and become milk fat. Milk fat content is influenced by feed because most of the milk components are synthesized in the udder of a simple substrate derived from feed [39].
3.3. Milk Lactose

The difference between titonia and elephant grass levels does not affect the lactose content of ECDG milk. The average lactose of the study milk was 4.34%, with a range of 4.10 to 4.46%. This result is almost close to some previous researchers, namely goat milk lactose is 5.0% [43] and 4.84% [39]. Lactose content of PE goat milk obtained in this study is still included in the standard levels of goat milk lactose in the tropics in the opinion of Davendra and Burn which ranges from 3.52% - 6.30% [44]. Lactose milk is one indicator to increase the amount of milk produced, the higher the lactose content in milk, the higher the absorption capacity of water for milk formation, resulting in increased production of milk without changing the lactose content in milk [41].

It was not different in fact (P> 0.05) treatments A, B, C, and D due to the digestibility of the fiber fraction also did not differ significantly, but an increase in titonia levels up to 64% showed the highest levels of milk lactose. Fiber fraction is a source of carbohydrates. The carbohydrates found in these feeds will be overhauled by microorganisms into VFA, one of which is propionic acid which is a precursor in the formation of blood sugar which as the raw material for forming lactose and amino acids absorbed in the intestine is converted into glucose in the liver through gluconeogenesis, so blood glucose levels can be maintained. The availability of a substrate in the form of glucose can help in the process of lactose milk synthesis. This is supported by the opinion of Schmidt also stated that glucose is the main precursor to the formation of lactose milk. In addition, it was added by Leng et al. which states that 54% of body glucose comes from propionic acid [45]. Concentrate on the four treatments was also not different in type and number.

3.4. Milk Minerals (Ca and P)

The mean of Ca and P of this experimental goat milk was 0.23% and 0.09%. This result is lower than Arief which is 2.84% and 0.56% [39]. The combination of titonia and elephant grass levels were very significantly different (P> 0.01) affecting the levels of Ca da P milk. The highest levels of Ca and P were obtained at Treatment D (Combination of 64% T + 16% RG) and the lowest in treatment A (16% T + 64% RG). This difference is due to the mineral content of the ration. The content of Ca and P rations increased from A to D along with the addition of titonia levels. Ration D gets the highest titonia portion so that it contributes high minerals Ca and P as well. This is consistent with Jama et al. statement that titonia is rich in minerals such as Ca and P [20].

4. Conclusion

The combination of 20% fermented oil palm fronds + 64% titonia + 16% elephant grass (Treatment D) yielded the best quality of milk.

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