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Research Article
Milk Quality of ETAWA Crossbred Dairy Goat Fed by Product of Palm Oil Industry

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Abstract

Background and Objective: The utilization of by-products of palm oil industry consists of palm kernel cake (PKC), palm oil sludge (POS) as feed is limited duo to their high lignin content. Probiotics are able to create a balance of microbes in the digestive tract thus creating optimum conditions for digestion of fibrous feed and improving feed conversion efficiency, which in turn can increase the production of livestock. The objective of this research was to determine the level of replacement concentrate ration of Etawa Crossbred dairy goat (ECDG) with concentrates formulated by various of by product of palm oil industry (palm kernel cake (PKC) and palm oil sludge (POS)) that have supplemented with probiotics. **Materials and Methods:** Research was conducted using completely randomized design (CRD) with 5 treatments concentrate ration replacement and 4 replications (Treatment A: about 100% concentrate standard (CS) and 0% concentrate of by products of palm oil industry (CBPO), B: 75% CS+25% CBPO, C: 50% CS+50% CBPO, D: 25% CS+75% CBPO and Treatment E). 0% CS+100% CBPO. Parameters measured were quality of milk, ie protein, fat, solid non fat (SNF), density and mineral (Ca and P). **Results:** The results showed that protein, fat, SNF, density and mineral (Ca and P) was not significant ($p>0.05$). **Conclusion:** From the overall parameters it can be concluded that the use of a byproduct of palm oil industry until 100% for ECDG ration does not affect the quality of milk in terms of protein, fat, minerals and density of milk.

Key words: Ration, ETAWA crossbred dairy goat, milk quality, palm oil sludge, by product of palm oil, palm industry

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

One of the source for very potential alternative non conventional feed ingredients unconventional potential used as animal feed is a by-product of palm oil industry. In 2012, Indonesia is the largest palm oil producer in the world with a total production of crude palm oil (CPO) as much as 27 million t year^{-1}, far above Malaysia, as the second largest producer, with 16.9 million t[1]. With a total area of oil palm plantations in 2012 reaching 11.5 million ha[2], the amount of by-products of palm oil industries to be produced as the source of an animal feed ingredient is very large with as much as 60% of it is a byproduct. Thus, the amount of by-products of palm oil industries to be produced is very large and will be problems in the future if not handled properly.

By-products of palm oil industry consists of palm kernel cake (PKC), palm oil sludge (POS) and palm fibers (PF) that can potentially be used as animal feed because it has a fairly good nutrient content[3,4]. The PKC feed substances are as follows: Dry matter (DM) 91.83%, Crude protein (CP) 12.36%, Crude fiber (CF) 26.68%, Neutral detergent fiber (NDF) 66.70%, Acid detergent fiber (ADF) 46.10%, Cellulosa 43.25%, Hemicellulose 24.94%, Lignin 17.29% and Total digestible nutrient (TDN) 65.40%. The content of the palm oil sludge feed substances (POS) are as follows: DM 90.35%, CP 10.89%, CF 20.31%, NDF 45.91%, ADF 38.64%, Cellulose 20.19%, hemicellulose 7,27%, Lignin 14.21% and TDN 58.60%. Meanwhile, palm fibers (PF) contains the following: CF 93.11%, CP 6.20%, CF 48.10%, NDF 77.65%, ADF 53.57%, Cellulose 32.75%, Hemicellulose 24, 94%, lignin 21.25%, TDN 51.00%[5].

As seen from the content of nutrients, the three industrial byproducts of palm oil industry is quite high but the amount of benefit as animal feed are very low. This is because of the high content of crude fiber and lignin, especially in palm fiber which causes low palatability[6]. In Africa, PKC has been used in sheep rations and can make efficient use of concentrates around 20-30%[7]. Palm oil sludge can replace 60% of bran in the diet of sheep[8]. Palm fiber can be used in cattle rations as replacement of forage as much as of 25% dry matter. If the reimbursement exceeds 25% will reduce feed intake.

Efforts that have been made to improve the nutritional value byproducts of the palm oil industry by applying a processing technology has yet to deliver optimal results in favor of livestock productivity[9,10]. Therefore, an increase in the digestibility of fibrous feed needs to be combined with efforts to optimize biological process in the rumen by rumen microbial population increase by feeding affixes (supplementation) of probiotics.

Probiotics are life microbial feed additive which is profitable for cattle. Probiotics are able to create a balance of microbes in the digestive tract thus creating optimum conditions for digestion of fibrous feed and improving feed conversion efficiency, which in turn can increase the production of livestock[11]. Then added that, if on right target, probiotics are very economical because aside from increasing the production, probiotics can also increase better feed conversion and improve the[12,13].

Etawa cross bred dairy goat rearing is one alternative livestock for dairy cattle diversification aside from dairy cows. Various studies indicated that goat milk is quite popular like cow's milk[14]. Goat milk has the advantage that is easier to digest than cow's milk because of the smaller size of the fat and in a more homogeneous state[15]. The use of non-conventional feed with probiotic supplementation is expected to meet the needs of livestock in terms of protein and energy to support the productivity of dairy goats.

Based on the description, research was conducted on milk quality Etawa goat feeding by rations the palm oil industry by products supplemented probiotics with the aim of studying the effect of the replacement of conventional feed rations formulated from various byproducts of oil processing industry which has been supplemented with probiotics on milk quality of ECDG.

MATERIALS AND METHODS

For this study, the *in vivo* treatments was conducted at the Company of Etawa Crossbred Dairy Goat, Rantiang Ameh Padang Panjang west sumatera on June until August, 2016. The livestock used is the first lactation ECDG weighing 75-80 kg. Analysis of milk Quality was conducted in the Laboratory of Biotechnology of the Animal Sciences Faculty, Andalas University. The parameters measured in this study were quality of milk : protein, fat, solid non fat, density and mineral (Ca and P). Standard concentrate was used is Soybean Meal Waste compositions.

This research consists of 3 stages of research as follows:

Research phase I: *In vitro* studies (Phase I) of the concentrate ration of by product of palm oil industry (CBPO).

Research using completely randomized design (CRD) with 4 kinds of concentrate ration formulation treatment consisting of a mixture of various byproducts of palm oil industry (PKC and POS) with 5 treatment and 4 replications. Ration treatments are as follows: A ration (10% PKC+50% POS), B ration (20% PKC+40% POS), C ration (30% PKC+30% POS), D

Table 1: Formulation and nutrient content of ration (%)

	Ration formulation (%)				
Feed stuff	A	B	C	D	E
Palm kernel cake	10.00	20.00	30.00	40.00	50.00
Palm oil sludge	50.00	40.00	30.00	20.00	10.00
Corn	15.00	15.00	15.00	15.00	15.00
Rice bran	20.00	20.00	20.00	20.00	20.00
Coconut meal	4.00	4.00	4.00	4.00	4.00
Mineral	1.00	1.00	1.00	1.00	1.00
Percentage (%)	100.00	100.00	100.00	100.00	100.00
Nutrient content (%)					
Protein	12.03	11.98	12.38	12.50	12.56
TDN	68.98	69.98	69.90	69.87	70.08

ration (40% PKC+20% POS) and E Ration (50% PKC+10% POS). Other materials used in the ration is corn, rice bran, coconut meal and mineral. The Ration formulation and nutrient content can be seen in Table 1.

Implementation of *in vitro* study refers to methods of Tilley and Terry[16] with the preparation of the solution medium mimicking the conditions in the rumen of ruminant true. The materials used in the manufacture of medium solution is a solution macromineral, micromineral and resazurin. The solution was made to determine the level of reduction of the oxygen contained in the solution medium. The CO_2 gas is required to condition the medium becomes anaerobic solution and keep the oxygen does not enter into the bottle of *in vitro* which has been in a state of aneorob when inserting material or when taking samples of rumen fluid. Rumen fluid that has been taken directly inserted into the flask so that the temperature can be maintained 39°C under anaerobic conditions. Rumen fluid is filtered using a 4-layer chesscloth for digestibility.

Research phase II: *In vitro* study consist of Supplementation of Probiotics "Bioplus" on Rations Concentrate of by Product Palm Oil Industry (CPalm) The Best In Phase I.

The aims of study were to determine the influence of supplementation of bioplus on the quality and digestibility of the ration concentrate based on byproducts of palm oil industry (CBPO) which is the best result of phase 1 (D rations measured by pH, VFA and NH3-N rumen fluid) by *in vitro*. The research used a completely randomized design (CRD) with 5 treatments and 4 replications. The treatment is a dose of probiotic supplementation in the ration of concentrate which were A) 100 g, B) 125 g, C) and D 150 g) 175 g and E. 200 g. Probiotics was given once one time at the beginning of the experiment based on Winugroho and Widiawati[17], Prihandono[18] and Ngadiyono *et al.*[12].

Phase III studies: Biological test of ration of concentrate formulation of by product palm oil (CBPO) Best results of a Phase II research as Substitute Concentrate Ettawa CrossBred Dairy goats.

The objective of the research was to determine the effect of concentrate rations containing PKC and POS (D ration in Phase 1) as a substitute of concentrate standard of dairy goat that has been supplemented with probiotics "bioplus"(200 g) on the quality of milk.

Animals used are lactation ECDG (lactation 1). Research used completely randomized design (CRD) with 5 treatments and 4 replications. The treatment is replacement of the standard concentrate ration of dairy goats with the best research results of Phase II concentrate ration as follow:

Treatment A = 100% standard concentrate (CS)+0% ration concentrate by product palm oil industry (CBPO)
Treatment B = 75% (CS)+25% (CBPO)
Treatment C = 50% (CS)+50% (CBPO)
Treatment D = 25% (CS)+75% (CBPO)
Treatment E = 0% (CS)+100% (CBPO)

Parameters: The parameters measured in this study was the quality of the milk which is protein, fat, solid non fat (SNF), density and mineral (Ca and P). Milk quality was measured 3 times then average of taken.

Statistical analysis: Differences between treatments were tested using analysis of variance (ANOVA) according to Steel and Torrie[19], while the difference between treatments was tested by Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The research result of ECDG milk availability in Table 2.

The nutrient content of milk is a key factor that affects the quality of the milk. Milk quality is quite good if the nutrients contained in milk meets the quality standards of milk.

Statistical analysis showed that the treatment did not affect the quality of goat milk ($p>0.05$), the results of research and quality of goat milk goats above is within the quality standards of milk goats. This suggested that the response of goats to concentrate rations based palm oil industry byproducts is good, no differences in the quality of milk although the base material ration has been replaced by palm oil industry byproducts.

Some of the factors that led to no differences in the quality of the milk is the same feed quality as well as the ration and the same maintenance of system. Bruhn[20] reinforce the above results stating that the kind of feed affects the quality of milk and feed quality will affect the body's metabolism in animals that affect the availability of energy and nutrients for the synthesis of the components of milk. Added by Haenlein[21] that 50% nutritional components of milk is determined by feeding and management factors, if the feed and livestock management is good nutritional composition of milk would be good too.

In addition, the intake of dry matter ration was also relatively similar, causing no difference to the quality of the milk produced. The relatively similar composition and nutrient content of ration will not affect the end product of fermentation in the rumen because milk and milk fat synthesis is the main raw material of milk in lactating dairy cattle. This is supported by the opinion of Sukarini[22] which stated that the feed is the determining factor of the final product of feed fermentation in the rumen, the increased production of VFA will provide enough energy for microbes to thrive and availability of raw materials for the synthesis of milk[23].

Protein and fat of milk: Judging from the content of protein and fat, according to Damayanti[24] and Afandi[25] the protein and milk fat content ranged between 4.1 and 4.5%. Subagiana[26] and Chaniago and Hartono[27] got the goat milk protein content ranging between 3.3-4.9%, while Adriani[28] got the range of goat milk research results are 3:00-6.90%.

The results of the above study showed that the protein content of milk obtained from this research is still in the normal range of protein and fat goat's milk. The similar content protein and fat of milk is caused by the same proportion of forage and concentrate, where such of the forage and concentrates is a source of acetic and propionic acid affecting levels of fat and milk protein. According to Tilman *et al.*[29] acetic acid formed in the rumen is the main raw material forming fat milk, reduced the amount of acetic acid resulted in reduced milk fat synthesis so that the fat content of milk decreases. In addition, the influence of feed to milk proteins are relatively small, feed was affecting more of the fat milk. Le Jaouen[30] explained that the variation in the protein content of milk is less compared to the fat content of milk because milk protein is more influenced by genetic factors than environmental factors.

Density and mineral (Ca and P) of milk: The research density of dairy goat also did not differ much from those obtained by Adriani[28], who got an average weight of 1,029. Meanwhile, Budi[31] got the density of milk ranges between 1.027-1.035. No difference in the quality of milk above was because of the similar composition of ration, stage of lactation, age and breeds of cattle in accordance with the opinion of Fox and McSweeney[32] that the quality of the milk produced by an animal depends on the individual animal, nation, health, nutritional status, stage lactation, age and milking interval. Added by Breemel[33] that a variation in the composition of milk can occur among individuals of one species of animal, age, body weight, feed, environmental and animal health. The

Table2: Milk quality of etawa crossbred dairy goat fed various rations formulated by product palm oil industry and probiotics supplementation (%)

	Milk quality (%)					
Treatments	Protein	Fat	SNF	Density	Ca	P
A	4.48	6.08	15.66	1.028	2.96	0.58
B	4.35	5.44	15.15	1.028	2.78	0.62
C	4.31	5.28	14.9	1.028	2.82	0.56
D	4.18	5.23	14.48	1.027	2.87	0.61
E	3.98	5.22	14.43	1.027	2.78	0.57
Average	4.26	5.45	14.92	1.028	2.84	0.58

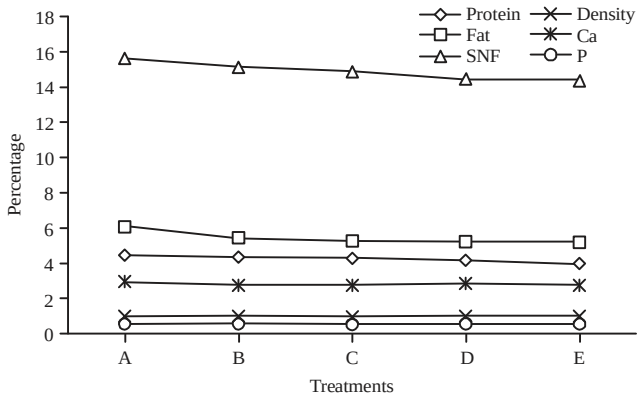

Fig. 1: Milk quality of etawa crossbred dairy goat fed various rations formulated by product palm oil industry and probiotics supplementation (%)

density of milk in this study is still on the weight limit of milk in accordance with the National Standardization Board 1998 in the Indonesian National Standard number 01-3141-1998, the minimum density is 1.0280.

Ca and P content of milk is high enough with 2.84 and 0.58%. Goat milk is a great source of Ca, P and nutrients. In addition, goat milk is consumed by people who are intolerant to cow's milk because some protein in cow's milk could cause allergies, which was not found in goat's milk and goat's milk also contained some anti-inflammatory agents like oligosacharida[34]. Effects of ration treatments on milk quality can be seen in Fig. 1.

SNF of milk: Average Non-Fat Solid Content of ECDG using CBPO can be seen in Table 1. Table 1 showed that levels of non-fat solid milk of ECDG with CBPO treatment ranged between (14.43-15.66%). The results of the diversity analysis showed that the application of CBPO as feed concentrate of ECDG was not significantly different ($p>0.05$) solid milk non fat content. A, B, C, D and E treatment with CBPO as ECDG feed caused by CBPO has high nutrient content ($p>0.05$), especially the crude protein content that can still be digested by livestock so that the need for crude protein to form proteins in milk can still be fulfilled. This greatly affects the solid non fat content in milk. According to Zurriyanti *et al.*[35] stated that solid non fat may be affected by milk proteins and lactose. If the protein and lactose levels of milk increase, it will be followed by increasing the solid non fat content of milk. Where the milk protein is formed from the concentrate feed consumed by the livestock will then be synthesized by rumen microbes into amino acids and the amino acids will be absorbed in the small intestine and fed into the blood and into the cells of udder secretion which will later become milk proteins[36]. The addition of protein source feed can increase the non-fat solid milk content[37]. In this study obtained levels of protein and lactose in milk showed no significant differences that affect the non-fat content of milk produced.

The solid fat non fat content found in this study is still within the minimum limit of solid non fat content according to SNI of 8.00% and also the result of this study is still within the range of solid non fat content according to Thai Agricultural Standard i.e., 8.25%.

CONCLUSION

It can be concluded that the byproduct of palm oil industry, name as palm kernel cake, palm oil sludge and can be used as a feed ingredient ECDG and use of a byproduct of palm oil industry for goat lactation ration does not affect the quality of milk in terms of protein, fat, SNF, lactose, minerals and density of milk.

SIGNIFICANCE STATEMENT

This study demonstrated that use of palm oil industry waste could be beneficial for ruminants that consume concentrate-based waste from oil palm plantations. This study will help researchers to uncover the critical functions of the palm oil industry waste in the rations of Etawa goats, resulting in full utilization of the nutrients in the palm oil by the rumen microbes. Thus, this study may lead to a new hypothesis for the optimal combinations of palm oil industry by-product and concentrate standard and their effects on the quality of milk.

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