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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Research Article

Production and Quality of Etawa Raw Milk Using Palm Oil Industry Waste and Paitan Plants as an Early Feed

Arief, Elihasridas, Simel Somen, Elly Roza, Roni Pazla and Rizqan

Faculty of Animal Science, Andalas University, Padang, West Sumatera, Indonesia

Abstract

Objective: The aim of this research was to determine the influence of palm oil industry by-products (palm kernel cake and palm oil sludge) and Paitan (*Tithonia diversifolia,* TD) as roughage on the production and quality of Etawa crossbreed (EC) goat milk. **Materials and Methods:** Eighteen EC dairy goats on their second lactation month were used in this study. This study utilized a Completely Randomized Design (CRD) that consisted of 6 treatments and 3 replicates. The treatments were as follows: (A) 50% roughage+50% soybean meal waste (SMW)+0% palm oil concentrate (POC), (B) 50% TD+50% SMW+0% POC, (C) 50% TD+37.5% SMW+12.5% POC, (D) 50% TD+25% SMW+25% POC, (E) 50% TD+12.5% SMW+37.5% POC and (F) 50% TD+0% SMW+50% POC. The variables observed in this study were the production and quality of Etawa crossbreed milk (protein and lactose). **Results:** Results showed a milk production rate (1.44-1.85 kg/head/day) with a milk protein concentration (3.48-3.76%) and a lactose concentration (4.01- 4.16%). Using palm oil industry by-products and TD as an early feed can significantly increase milk production ($p<0.01$), but there was no effect on milk quality ($p<0.05$). **Conclusion:** The TD and palm oil industry by-products can be used as an alternative feed for animals. The optimal feed for dairy goats was 50% TD+25% SMW+25% POS (treatment D).

Key words: Palm oil industry by-products, paitan, Etawa crossbreed, milk production, milk quality

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Corresponding Author: Arief, Faculty of Animal Science, Andalas University, Padang, West Sumatera, Indonesia

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

Goats are one of the small ruminant livestock that produce meat and milk. Goat milk has comparable nutritional value to cow milk. Goat milk has been shown to reduce respiratory problems (such as asthma), control body fat and smooth the skin. In addition to having an advantage in protein content, goat milk also contains an abundance of vitamin A and vitamin B (especially riboflavin and niacin). One breed of goat that is widely cultivated by breeders and used as a source of animal protein (meat and milk) is the Etawa crossbreed (EC). The potential of EC goats as milk producers has been reported by many researchers. However, EC milk production is still very diverse, ranging from 0.45-2.2 kg/head/day[1].

One problem in goat rearing is that the food rations provided to the ECs does not contain enough nutrients (protein content) to meet the needs of the livestock. Since good quality foodstuff is expensive, breeders cannot afford the good quality feedstuff and therefore, resort to rough feeding. It is required for feed ingredients to be used as a substitution for forage or concentrate for livestock with the goal of increasing the quality and amount of milk production and livestock productivity at low cost. Foodstuffs that can be used as alternative feed include palm oil industry by-products [palm kernel cake (PKC), palm oil sludge (POS)] and paitan (*Tithonia diversifolia,* TD), all of which can be used as a roughage for dairy goat[1].

Palm oil by-products (PKC and POS) are non-conventional feedstuffs that have the potential to feed livestock, especially ruminants. Palm kernel cake (PKC) is a by-product of the palm kernel extraction process. Every 1 t of fresh fruit produces 5% palm kernel meal, which then produces 45-46% of palm kernel cake. Palm oil sludge (POS) is a solid waste solution produced during the process of extortion and extraction of palm oil. Palm kernel meal is derived from the palm kernel and has the highest nutritional value for animal feed. Protein from palm kernel cake can be categorized as "medium degradability" and is known to be deficient in the amino acids lysine, methionine, leucine and isoleucine[2]. POS has a protein content similar to rice bran (approximately 12%)[3]. The relatively high protein contents of PKC and POS make them good substrates for the growth of microorganisms in rumen.

Arief[1] stated that PKC is the by-product of the palm oil industry with the highest nutritional value, with a high crude protein content (12.36%) and an energy content (4361 kal g^{-1}). Hanafi[4] stated that the addition of palm kernel cake in livestock feed will improve the quality of milk, especially milk fat content and cheese viscosity. Molasses-coated PKC can increase milk production of dairy cows from 8.92-9.08 L/day[5]. In addition to PKC, the use of POS can replace 60% of bran in sheep rations[6]. The protein content of POS varies between 11-14% and with its relatively high fat content, it is also a source of energy and minerals.

In addition to palm oil industry by-products, paitan (TD) is a plant that has the potential to serve as an alternative feed for livestock, especially for goats. The TD plant grows and spreads throughout Indonesia, especially in West Sumatra. It is often found growing on the roadside and in untapped rice fields. The TD plants are mostly wasted, although some are used as compost or natural pesticides. The TD plants have not yet been widely used as animal feed.

In West Sumatra, TD plants can produce 30 t of fresh material or 6 t of dry matter per year in a land area of approximately 1/5 ha. The nutrients in the whole plant (leaf+stem) are crude protein (21.14%), crude fiber (18.90%) and complex amino acids. The leaves of TD plants contain approximately 20% protein and contain various types of macromineral elements such as Ca and Mg, which are very useful for livestock. Paitan plants can be used as a feed supplement for ruminants, especially during the dry season where the availability of forage is limited[7]. In addition, Rodriguez and Preston[8] also stated from practical observations in Colombia that paitan plants can be used as goat feed to increase growth.

This study aimed to evaluate the production and quality of Etawa raw milk using palm oil industry waste and paitan plants as an early feed.

MATERIALS AND METHODS

This study examined 18 EC goats on their first and second lactation months. Goats were milked in the morning and quality analyses of protein and lactose were performed on the milk.

The experiment was designed using a Completely Randomized Design (CRD) and consisted of 6 treatment (concentrate rations) and 3 replicates. Palm oil concentrate rations (POCs) of the EC goat were adapted from the best POS and PKC ration results from Arief *et al.*[9] (40% PKC, 10% POS, 10% corn, 15% rice bran, 24% SMW and 1% mineral). The treatment rations provided to the EC goats in this study were as follows:

- A = 50% roughage+50.0% SMW+0.0% POC
- B = 50% TD+50.0% SMW+0.0% POC
- C = 50% TD+37.5% SMW+12.5% POC
- D = 50% TD+25.0% SMW+25.0% POC
- E = 50% TD+12.5% SMW+37.5% POC
- F = 50% TD+0.00% SMW+50.0% POC

The parameters measured were milk production, milk protein concentration and lactose concentration. The data were analyzed using a one-way analysis of variance (ANOVA). Eighteen goats were distributed in a completely randomized design consisting of 6 treatments and 3 replicates. Duncan's Multiple Range Test (DMRT)[10] was used to test the differences between treatments with confidence intervals of 5 and 1%.

RESULTS AND DISCUSSION

Milk production: Table 1 demonstrates that the highest production of goat milk was recovered in treatment group D (1.83$\pm$0.12), while the lowest production was observed in treatment group A (1.44$\pm$0.15). The results of the diversity analysis showed that feeding palm oil industry by-products and paitan affected milk production in a highly significant manner ($p<0.01$). Results of the DMRT test showed that milk production in the treatment D group was most significantly influenced, while there were no significant effects in treatment groups A, B, C, E and F.

The high milk production in the treatment D group was caused by the high protein content of palm oil industry by-product and paitan plant. This can supply the protein content so that the basic needs and production needs can be met, which will then increase milk production. It had also been shown by Mukhtar[11], that milk production is also influenced by feed and adequate nutritional needs can be met in the presence of high protein content, thus increasing milk production.

The rations derived from the palm oil industry by-product in treatment group D showed the highest crude protein content (17.94%) compared to other treatments. Therefore, the crude protein consumed by EC goats was also high in NH_3 precursors in the rumen. The NH_3 is used as a source of nitrogen for the growth of microorganisms to improve the process of fermentation into Volatile Fatty Acid (VFA). The increase in VFA will increase the energy source and therefore, increase milk production. A study by Arief[1] demonstrated that the application of palm oil industry by-products in EC goat rations can increase the VFA content of the ration. Furthermore, Suryahadi *et al.*[12] stated that protein-rich feed can improve metabolism and can increase the ability of microbes in degrading feed in the rumen.

The high milk production in treatment group D compared with other treatments can also be due to the presence of paitan, which is a plant with a high protein content (22.98%)[13]. Paitan also contains the anti-nutritional tannin (at a concentration of 0.39 mg/100 g[14]), which can help protect proteins from rumen degradation. Tamin forms a protein-tannin complex that can be efficiently utilized by the body for basic needs and production. This is in accordance with the hypothesis by Widyabroto *et al.*[15], who stated that protected proteins can directly experience enzymatic digestion in the abomasum and intestinum. This hypothesis was supported by Henson *et al.*[16], who demonstrated that feeding with non-degraded protein content in the rumen may increase the amount of protein and amino acids digested and absorbed in the small intestine, which can ultimately increase the synthesis of body proteins.

Current study found difference in milk production in treatment groups A (15.52% protein), B (16.64% protein), C (17.06% protein), E (15.98% protein) and F (15.70% protein). In these treatments, the nutrients in the feed will only be circulated via the blood to organs and tissues as a source of energy for basic living needs. This causes the precursors required for the synthesis of milk components to be available only in small quantities, thus affecting the volume of water flowing into the lumen and the volume of milk produced.

In treatment groups E and F, there was a decrease in feed consumption. These groups were given primarily concentrate feeds because the feed was derived from the palm oil industry by-product with high coarse fiber. Therefore, it was difficult for the goats to digest the feeds properly, which resulted in a decrease in palatability. This is consistent with the findings of Faverdin *et al.*[17], who stated that palatability is a major factor in explaining the differences in the consumption of low-yield feed. Furthermore, the palatability of feed is generally associated with high digestibility of a feed.

Milk protein: Table 2 showed that the protein content of milk from EC goats fed with palm oil industry by-products and Paitan ranged between 3.34-3.76%. Our analysis demonstrated that the presence of palm oil industry by-

Table 1: Milk production of EC dairy goats

Treatments	Milk production (kg/head/day)
A	1.44$\pm$0.15^{a}
B	1.47$\pm$0.15^{a}
C	1.57$\pm$0.08^{a}
D	1.83$\pm$0.12^{b}
E	1.45$\pm$0.10^{a}
F	1.46$\pm$0.04^{a}

Table 2: Milk protein from Etawa crossbred dairy goats (%)

Treatments	Milk protein (%)
A	3.61$\pm$0.43
B	3.34$\pm$0.41
C	3.73$\pm$0.72
D	3.76$\pm$0.23
E	3.66$\pm$0.18
F	3.48$\pm$0.49

Table 3: Milk lactose concentration in Etawa crossbred dairy goat milk (%)

Treatments	Milk lactose (%)
A	4.03±0.14
B	4.16±0.05
C	4.06±0.11
D	4.01±0.16
E	4.12±0.12
F	4.10±0.18

products and paitan plants in EC goat feed did not significantly affect milk protein content (p>0.05). The milk protein content in each treatment group was highly dependent on the presence of the same paitan plant in each treatment. The available protein and crude fiber content was insufficient to increase milk protein content. Only forage feeding can affect the quality of the milk produced[18].

The type of protein present in paitan is a protein that cannot be degraded by rumen microbes, which is known as bypass protein or rumen undegradable protein. Generally, this type of protein is not degraded because the feed ingredients of these proteins have substances that bind anti-nutritional protein. The anti-nutritional content of tannins (0.39 mg/100 g[14]) contained in paitan can help to protect proteins from rumen degradation so these can be directly digested and absorbed in the small intestine. However, with the same concentration of paitan in each treatment, the protein content was absorbed equally between the treatment groups. Smith *et al.*[19] suggested that feed with high-quality rough proteins and fibers can be protected from the degradation of rumen microorganisms so that it has more availability in the rumen gastrointestinal tract. The next proteins consumed from the palm oil industry by-product and paitan plant feed would be condensed and entered into the bloodstream to be converted into amino acids in the blood with a carbon precursor of non-essential amino acids.

Amino acids from the blood will be converted into amino acid deposits and enter into erythrocyte secretory cells to be synthesized into milk proteins. This process is explained by Collier[20], who stated that digestive tract absorption of amino acids into the blood results in the reshuffling of body proteins and amino acids in the epithelial cells of milk and the synthesis of milk proteins. Akers[21] stated that in the event of an increase in milk production, most of the proteins or amino acids from feed is focused on milk synthesis and thus, milk protein content does not increase.

Milk lactose: Table 3 shows that the lactose content of milk from ECs goats treated with palm oil industry by-product and paitan plant ranged from 4.01-4.16%. Treatment with palm oil industry by-products and paitan in the feed of EC goats was not significantly different between the treatments groups. All treatment groups (A, B, C, D, E and F) contained unfulfilled protein content, which is also a source of carbohydrate feed consumed by livestock. Therefore, the amount of carbohydrates produced was insufficient to increase VFA by rumen microbes, especially propionic acid, which has not been demonstrated to increase milk lactose levels.

The same paitan plant was present in each treatment group, with a crude fiber content of 18.17%[13]. The paitan was degraded in the rumen to produce propionic acid in equal amounts and therefore, did not affect milk lactose concentration. Prawirokusumo[22] and Suhendra *et al.*[23] suggested that the majority of propionic acid is used for milk lactose synthesis.

The resulting propionic acid is indispensable as a precursor in the formation of blood sugar. The lactose-forming feedstock and the amino acids absorbed in the intestine are converted into glucose in the liver through the process of gluconeogenesis to maintain blood glucose levels. Glucose substrate, when available, can assist in the process of milk lactose synthesis. This finding is supported by Schmidt *et al.*[24], who stated that glucose is the main precursor of milk lactose formation. Leng *et al.*[25] suggested that 54% of body glucose is derived from propionic acid. Propionic acid is the main precursor of glucose in ruminants, accounting for 60-80% of the glucose in lactated cow milk[26].

In addition, the process of lactose synthesis in the mammary glands is dependent on glucose and the aid of lactose synthetase enzymes. In the process of lactose synthesis, 85% of lactose carbon atoms come from glucose[27]. The lactose content of goat milk obtained in this study is in agreement with the standard lactose content of goat milk in the tropics according to Davendra and Burn[28], which ranged from 3.52-6.30%.

CONCLUSION

Based on the results of this study, it can be concluded that the optimal treatment with palm oil industry by-product and paitan plants in the feed of Etawa crossbreed goats is treatment D (50% paitan+25% tofu+25% palm oil concentrate). This treatment not only increased milk production in the EC goat but also maintained the quality of milk produced as measured by protein and lactose concentrations.

SIGNIFICANCE STATEMENT

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

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REFERENCES

1. Arief, 2013. Supplementation of probiotics in dairy goats rations based byproducts of palm oil processing industry. Ph.D. Thesis, Andalas University, Padang.
2. Daud, M.J., 1995. Technical inovation in the utilization of local feed resources for more officient animal production. Proceedings of the 17th Malaysian Society of Animal Product Annual Conference on Towards Corporizing the Animal and Feed Industries, May 28-30, 1995, Penang.
3. Sutardi, T., 1997. Peluang dan tantangan pengembangan ilmu-ilmu nutrisi ternak. Orasi Ilmiah Guru Besar Tetap Ilmu Nutrisi Ternak. Fakultas Peternakan. Institut Pertanian Bogor, Bogor.
4. Hanafi, N.D., 2004. Perlakuan silase dan amoniasi daun kelapa sawit sebagai bahan baku pakan domba. Program Studi Produksi Ternak Fakultas Pertanian Universitas Sumatera Utara. USU Digital Library, Medan.
5. Jarmani, S.N., 2007. Penerapan teknologi sebagai usaha untuk meningkatkan produksi susu dan memperbaiki budidaya sapi perah rakyat masalah dan pemecahannya. Semiloka Nasional Prospek Industri Sapi Perah Menuju Perdagangan Bebas-2020. http://peternakan.litbang.pertanian.go.id/fullteks/lokakarya/loksp08-74.pdf?secure=1
6. Harfiah, 2007. Lumpur minyak sawit kering sebagai sumber nutrisi ternak ruminansia. Buletin Nutrisi dan Makanan Ternak, Vol. 6, No. 2.
7. Osuga, I.M., S.A. Abdulrazak, T. Ichinohe and T. Fujihara, 2006. Rumen degradation and *in vitro* gas production parameters in some browse forages, grasses and maize stover from Kenya. J. Food Agric. Environ., 4: 60-64.
8. Rodriguez, L. and T.R. Preston, 1996. Comparative parameters of digestion and N metabolism in Mong Cai and Mong Cai*Large White cross piglets having free access to sugar cane juice and duck weed. Livest. Res. Rural Dev., Vol. 8, No. 1.
9. Arief, Elihasridas and S. Sowmen, 2016. Optimalisasi pemanfaatan limbah industri kelapa sawit dengan suplementasi probiotik menunjang peningkatan produktifitas kambing peranakan etawah. Lembaga Penelitian dan Pengabdian kepada Masyarakat Universitas Andalas, Padang.
10. Steel, R.G.D and J.H. Torrie, 1991. Prinsip dan Prosedur Statistik. Suatu Pendekatan Biometrik. Alih Bahasa, B. Sumantri, Gramedia, Jakarta.
11. Mukhtar, A., 2006. Ilmu Produksi Ternak Perah. Lembaga Pengembangan Pendidikan UNS dan Universitas Negeri Surakarta Press, Surakarta.
12. Suryahadi, K.W., I. Permana, H. Yano and R. Kawashima, 1996. The use of local yeast culture *Saccharomyces cerevisiae* to improve fermentation and nutrient utilization of buffaloes. Proc. 8th AAAP Anim. Sci. Congr., 2: 168-169.
13. Jamarun, N., M. Zain, Arief and R. Pazla, 2018. Populations of rumen microbes and the *in vitro* digestibility of fermented oil palm fronds in combination with Tithonia (*Tithonia diversifolia*) and elephant grass (*Pennisetum purpureum*). Pak. J. Nutr., 17: 39-45.
14. Fasuyi, A.O., F.A.S. Dairo and F.J. Ibitayo, 2010. Ensiling wild sunflower (*Tithonia diversifolia*) leaves with sugar cane molasses. Livest. Res. Rural Dev., Vol. 22, No. 3.
15. Widyobroto, B.P., S. Padmowijoto and R. Utomot, 1994. Degradasi bahan organik dan protein secara in sacco Lima rumput tropik. Buletin Peternakan, 19: 45-55.
16. Henson, J.E., D.J. Schingoethe and H.A. Maiga, 1997. Lactational evaluation of protein supplements of varying ruminal degradabilities. J. Dairy Sci., 80: 385-392.
17. Faverdin, P., R. Baumont and K.L. Ingvartsen, 1995. Control and Prediction of Feed Intake in Ruminants. In: Recent Developments in the Nutrition of Herbivores, Journet, M., E. Grenet, M.H. Farce, M. Theriez and C. Demarquilly (Eds.). INRA, Paris, France, pp: 95-120.
18. McCullough, M.E., 1973. Optimum Feeding of Dairy Animals for Meat and Milk. The University of Georgia Press, Athens.
19. Smith, A.H., E. Zoetendal and R.I. Mackie, 2005. Bacterial mechanisms to overcome inhibitory effects of dietary tannins. Microb. Ecol., 50: 197-205.
20. Collier, R.J., 1985. Nutritional Control of Milk Syntesis. In: Lactasion, Larson, B. (Ed.). Lowa State University Press, USA., pp: 80-128.
21. Akers, R.M., 2002. Lactation and the Mammary Gland. 1st Edn., John Wiley and Sons Inc., Ames, IA., USA., ISBN-13: 9780813829920, Pages: 278.
22. Prawirokusumo, S., 1993. Ilmu gizi komparatif. Edisi Pertama. Badan Penerbitan Fakultas Ekonomika dan Bisnis Universitas Gadjah Mada, Yogyakarta.

23. Suhendra, D., G.T. Anggiati, S. Sarah, A.F. Nasrullah, A. Thimoty and D.W.C. Utama, 2015. Tampilan kualitas susu sapi perah akibat imbangan konsentrat dan hijauan yang berbeda. J. Ilmu-Ilmu Peternakan, 25: 42-46.
24. Schmidt, G.H., L.D. van Vleck and M.F. Hutjens, 1988. Principles of Dairy Science. 2nd Edn., Prentice Hall, Englewood Cliffs, New Jersey.
25. Leng, R.A., J.W. Steel and J.R. Luick, 1967. Contribution of propionate to glucose synthesis in sheep. Biochem. J., 103: 785-790.
26. Steinhour, W.D. and D.E. Bauman, 1988. Propionate Metabolism: A New Interpretation. In: Aspects of Digestive Physiology in Ruminants, Dobson, A. and M.J. Dobson (Eds.). Comstock Publications, Ithaca, New York, pp: 238-256.
27. Ebner, K.E., 1971. Biosynthesis of Lactose. J. Dairy Sci., 54: 1229-1233.
28. Devendra, C. and M. Burns, 1994. Produksi Kambing di Daerah Tropis. Terjemahan IDK Harya Putra. Institut Teknologi Bandung, Bandung.