Research Article

Influence of *Tithonia diversifolia*, Cassava and Palm Concentrate Combinations on Milk Production and Traits in Etawa Crossbred

Arief[1], Roni Pazla[2*], Rizqan[1], Novirman Jamarun[2]

[1]Departement Technology and Animal Production, Faculty of Animal Science, Universitas Andalas, Padang 25163, Indonesia; [2]Department of Animal Nutrition and Feed Technology, Faculty of Animal Science, Universitas Andalas, Padang 25163, Indonesia.

Abstract | *Tithonia diversifolia* plants and cassava leaves have the potential to be used as a substitute for field grass. Palm kernel cake is a waste of the palm oil processing industry and can be used as a concentrated alternative. This study aims to determine the impact of giving *Tithonia diversifolia* plants, cassava leaves, and palm concentrates on the milk production and quality (fat and lactose), intake, and digestibility of Etawa Crossbred Goat. The supplemented treatments were: A; control ration (60% forage (CF) + 40% concentrate (CC)), B (30% CF + 30% *Tithonia diversifolia* (T) + cassava leaves (CL)) + 30% CC + 10% palm concentrate (PC)), C (30% CF + 30% (T+CL) + 20% CC + 20% PC), and D (30% CF + 30% (T+CL) + 10% CC + 30% PC). The parameters observed were milk production, milk fat, and lactose content, intake and digestibility of fat, crude fiber, and nitrogen-free extracts (NFE), and the correlations between fat intake and milk fat contents, crude fat intake, and milk fat content and between NFE intake and milk lactose contents. The results showed that the treatment had no significant effect on production, fat content, milk lactose, intake, and digestibility of fat, crude fiber, and NFE but there was a relationship between fat intake with milk fat contents, crude fat intake with milk fat contents, and NFE intake with milk lactose. *Tithonia diversifolia*, cassava leaves, and palm concentrate up to a level of 30% were able to maintain production, milk fat and lactose content, intake and digestibility of crude fat, crude fiber, and NFE.

Keywords | Cassava leaves, Etawa Crossbred goat, Milk production, Palm concentrate, *Tithonia diversifolia.*

Received | November 06, 2022; **Accepted** | December 20, 2022; **Published** | March 07, 2023
***Correspondence** | Roni Pazla, Department of Animal Nutrition and Feed Technology, Faculty of Animal Science, Universitas Andalas, Padang 25163, Indonesia; **Email:** ronipazla@ansci.unand.ac.id
Citation | Arief, Pazla R, Rizqan, Jamarun N (2023). Influence of *tithonia diversifolia*, cassava and palm concentrate combinations on milk production and traits in etawa crossbred. Adv. Anim. Vet. Sci. 11(4): 568-577.
DOI | http://dx.doi.org/10.17582/journal.aavs/2023/11.4.568.577
ISSN (Online) | 2307-8316

INTRODUCTION

Tithonia diversifolia plants and cassava leaves have the potential to be used as a substitute for field grass. The crude protein contents of this plant far exceed that of field grass. The crude protein of the *T. diversifolia* and cassava leaves is 22.98% (Pazla et al., 2018a) and 29.00% (Bernard et al., 2020), respectively. Protein is needed by livestock to increase productivity, especially during pregnancy and lactation (Rosmalia et al., 2022).

T. diversifolia is rich in amino acids and phosphorus (P), which can potentially increase ruminal bacterial populations and microbial protein synthesis (Adrizal et al., 2021; Fasuyi and Ibitayo., 2011; Pazla et al., 2021a, 2021b). Giving *T. diversifolia* combined with elephant grass (*Pennisetum purpureum*) can optimize the production and fat contents of Etawa cross-breed goat milk (Pazla et al., 2022). *T. diversifolia* plants up to 30% supplement can increase intake, digestibility, body weight gain, and feed efficiency for Pesisir cattle (Pazla et al., 2021c). Cassava leaves combined with ammoniated palm fronds produce optimal body weight gain in Simmental cattle (Suyitman et al., 2021). Oni et al. (2010) reported that the administration of cassava leaves with *Panicum maximum* for West African Dwarf Goats led to increased nitrogen retention, digestibility, body weight gain, and dry matter intake. Marjuki et al. (2008) have used cassava leaves for up to 30% of the dry matter of the ration.

Feeding concentrate can optimize the growth and production of livestock, and this is due to the high energy content in the feed (Arief and Pazla, 2023). Attention should be paid to some aspects when using concentrates such as cheap prices, ease to obtain, and availability. Palm kernel cake is a waste of the palm oil processing industry and can be used as a concentrated alternative. The protein content of palm kernel cake is as much high as 14-20% (Zarei et al., 2016). Suhendro et al. (2018) reported that substituting tofu dregs with palm kernel cake as a concentrate in Nubian goats had no negative impact and was able to maintain growth and intake. Concentrates based on palm kernel cake can increase milk production and quality in Etawa-breed goats (Arief et al., 2020, 2021a). This study aims to determine the effect of giving a combination of forage from *Tithonia diversifolia* with cassava leaves and palm concentrate on the production, fat, milk lactose, intake, and digestibility of crude fat, crude fiber, and NFE.

MATERIALS AND METHODS

This research was conducted at the Toni Farm located in Payakumbuh, West Sumatra, Indonesia. Chemical analysis of the ration constituents and the milk fat analysis and lactose was carried out at the Politeknik Pertanian Negeri Payakumbuh Laboratory, West Sumatra.

This study used 16 lactating Etawa crossbreed goats aged 1.5-2 years and weighing 58-60 kg which was in the second lactation. In addition, the conditions of the cage that need to be considered before conducting research include cleaning the area of the goat pen so that it is free from rodents and other disturbances. Environmental temperature checking was also carried out where the temperature range in the study area was 18-22 ^{0}C with 78% humidity. as well as giving anthelmintic to goats before being given treatment. The experiment used a completely randomized design with four treatments of four replicates consisting of A is the company ration as control (60% company forages (CF) + 40% company concentrates (CC)), B (30% CF + *Tithonia diversifolia* (T) + cassava leaves (CL)) + 30% CC + 10% palm concentrate (PC)), C (30 % CF + 30% (T+CL) + 20% CC + 20% PC), D (30% CF + 30% (T+CL) + 10% CC + 30% PC). Company forages consist of field grasses and shrubs while company concentrates consist of tofu dregs, cassava peels, and jackfruit skins. Palm concentrate is composed of palm kernel cake, bran, corn, and minerals. The ratio between forage and concentrate was 60:40. The feed ingredients making up the ration are presented in Table 1. The chemical composition and the nutritional contents of the ration are presented in Table 2.

Parameter Measurement

The experiment was designed to last for 45 days with three stages; the adaptation stage for 25 days, the preliminary stage for 15 days, and the collection stage for five days. The feces were collected during the five collection days to determine the feed digestibility. The sewage collection (n=16) from the Etawa crossbreed was carried out from the 41th and 45th day. Total fresh feces were weighed and taken as much as 200 g per goat as a sample. Samples were in the oven at 60^{o}C for 48 h and then weighed. The feces samples were ground and analyzed after AOAC (1995). Milk fat and lactose test using LACTOSCAN SP MILKOTRONIC Ltd. The digestibility calculation formula is as follows:

Statistical analysis

The measured data on milk production, milk fat, milk lactose, intake and digestibility of crude fat, crude fiber, and NFE, a correlation between crude fat intake with milk fat content, a correlation between crude fiber intake with milk fat content, and a correlation between NFE intake with milk lactose content were analyzed using Analysis of Variance (ANOVA) with SPSS software version 21.0 and Duncan's Multiple Range Test as a follow-up test if there is a significant difference (P<0.05) in the treatment (Steel and Torrie, 1991).

Ethics approval

This experiment has referred to research ethics using livestock based on the Republic of Indonesia government law number 41/2014 concerning Animal Science and Health.

RESULTS

Milk Production

Feeding treatment had no significant effect on milk production. *T. diversifolia* and cassava leaves by 30% and palm oil concentrate by 30% were able to maintain milk production. Milk production in treatments B, C, and D was higher than in treatment A (Figure 1).

Milk Fat And Lactose Content

Feeding treatment had no significant effect on the fat and lactose content of milk. *T. diversifolia* and cassava leaves by 30% and palm concentrate by 30% were able to maintain the fat and lactose content of milk (Table 3, Figures 2 and 3).

Table 1: Chemical composition of feed ingredients

Nutrients (%)	Feed stuff				
	Company forages	**T**	**CL**	**PC**	**Company Concentrate**
DM	26.03	23.13	26.21	93.24	23.81
OM	87.93	84.65	86.33	90.23	96.92
CP	25.43	25.07	30.18	13.46	17.27
CF	28.02	22.62	19.92	18.33	20.98
NDF	48.27	55.03	56.13	62.84	61.86
Cfat	2.73	1.62	3.10	4.96	2.07
TDN	54.53	53.54	56.44	66.36	73.46
NFE	31.75	35.34	33.13	53.48	56.62
ASH	12.07	15.35	13.67	9.77	3.08
ADF	36.45	34.2	33.69	36.02	35.33
Hemi	11.82	20.83	22.44	26.82	26.53
Lignin	11.72	5.81	6.87	3.92	4.38
Cellulose	24.4	27.54	28.48	16.97	22.95

Dry matter (DM), Organic matter (OM), Crude protein (CP), Crude fiber (CF), Neutral detergent fiber, Crude fat (Cfat), Total digestible nutrient (TDN), Nitrogen free extract (NFE), Acid detergent fiber (ADF), Hemicellulose (Hemi), *Tithonia diversifolia diversifolia* (T). Cassava leaves (CL), Palm concentrate (PC)

Table 2: Composition of ration and nutritional content of treatment ration

Feedstuff	Treatments			
	A	**B**	**C**	**D**
Company Forages	60	30	30	30
Tithonia diversifolia	-	15	15	15
Cassava Leaves	-	15	15	15
PC	-	10	20	30
Company Concentrate	40	30	20	10
Total	100	100	100	100
Nutrient Composition				
Dry Matter	25.14	31.68	38.62	45.56
Organic Matter	91.53	90.13	89.45	88.79
Crude Protein	22.17	22.44	22.06	21.68
Crude Fiber	25.20	22.91	22.64	22.38
NDF	53.71	56.00	56.09	56.19
Crude Fat	2.47	2.64	2.93	3.22
TDN	62.10	61.53	60.82	60.11
NFE	41.70	42.13	41.81	41.50
Ash	8.47	9.88	10.54	11.21
ADF	36.00	35.32	35.38	35.46
Hemi	17.70	20.68	20.70	20.74
Lignin	8.78	7.12	7.07	7.03
Cellulose	23.82	24.31	23.70	23.11

Neutral detergent fiber, Total digestible nutrient (TDN), Nitrogen free extract (NFE), Palm concentrate (PC)

Table 3: Quality of Etawa Crossbreed Dairy Goat's Milk Treatment

Parameter	Goat milk			
	A	**B**	**C**	**D**
Fat Level (%)	4.52±0.23	4.44±0.22	3.91±0.26	5.29±0.20
Lactose (%)	4.08±0.17	5.17±0.33	5.00±0.27	4.99±0.31

There is no significant between treatments (P>0.05)

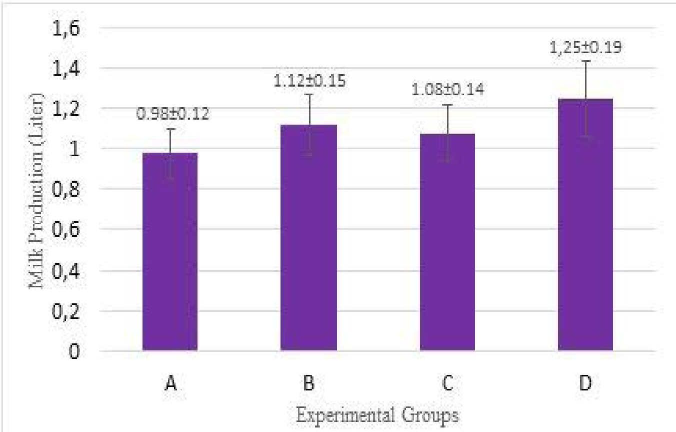

Figure 1: Milk Production of Etawa Crossbreed Dairy Goats Treatment

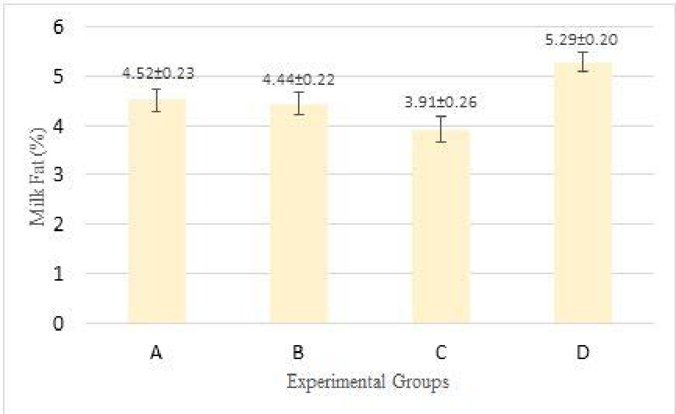

Figure 2: Milk Fat of Etawa Crossbreed Dairy Goats Treatment

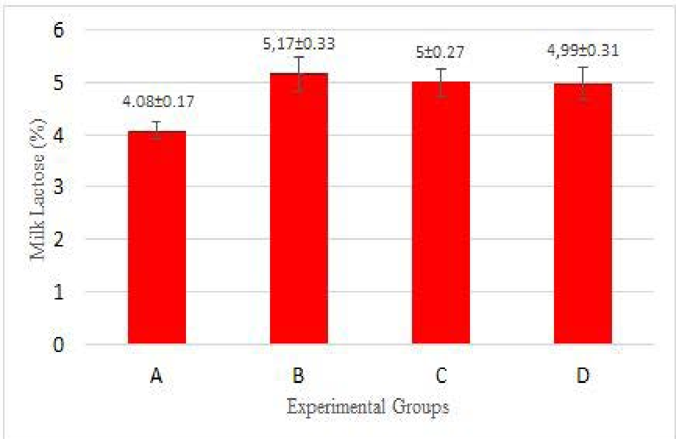

Figure 3: Milk Lactose of Etawa Crossbreed Dairy Goats Treatment

Feed Intake

The ration treatment had no significant effect on the intake of fat, crude fiber, and NFE. *T. diversifolia* and cassava leaves by 30% and palm concentrate by 30% were able to maintain the intake of fat, crude fiber, and NFE (Table 4).

Correlation of Fat Intake With Milk Fat

Figure 4 showed that there is a linear relation (r=0.367, R^2=0.135) between crude fat intake with milk fat contents.

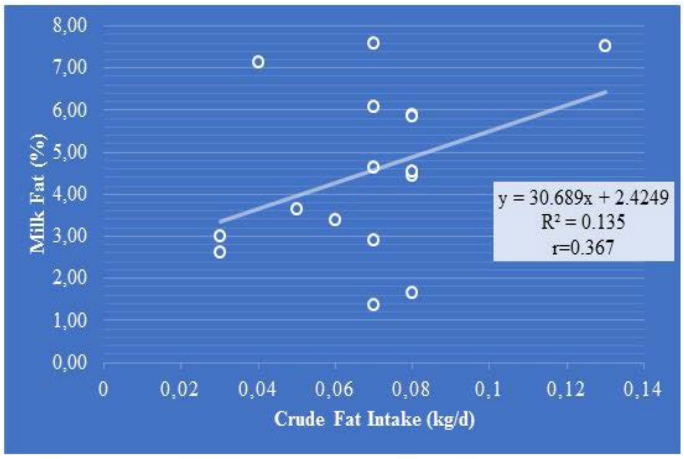

Figure 4: Correlation Milk Fat with fat Intake of Etawa Crossbreed Dairy Goats Treatment

Correlation of Crude Fiber Intake with Milk Fat

Figure 5 showed that there is a linear regression relation (r=0.38, R^2=0.147) between crude fiber intake and milk fat content.

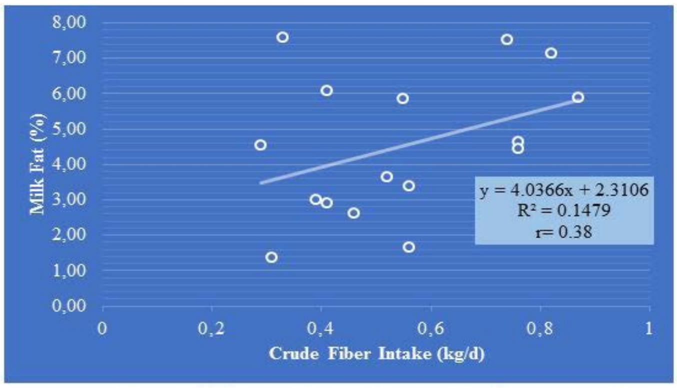

Figure 5: Correlation Milk Fat with crude fibre Intake of Etawa Crossbreed Dairy Goats Treatment

Links Researchers

Table 4: Feed Intake of Etawa Crossbreed Dairy Goats Treatment

Intake (kg/e/day)	Treatment			
	A	B	C	D
Crude fat	0.06±0.007	0.06±0.008	0.07±0.005	0.08±0.007
Crude Fiber	0.60±0.07	0.52±0.08	0.51±0.05	0.50±0.07
NFE	1.08±0.07	1.13±0.08	1.11±0.05	1.09±0.07

There is no significant between treatments (P>0.05)

Table 5: Digestibility of Etawa Crossbreed Dairy Goats Treatment

Digestibility (%)	Treatment			
	A	B	C	D
Crude fat	72.40±2.17	73.25±2.76	74.21±2.63	76.36±2.48
Crude Fiber	64.13±2.03	63.64±3.11	67.09±3.24	67.06±2.41
NFE	74.37±2.03	75.47±2.11	75.57±2.24	75.89±2.41

There is no significant between treatment (P>0.05)

Correlation of NFE Intake with Milk Lactose

Figure 6 showed that there is a linear regression relation ($r=0.572$, $R^2=0.3271$) between NFE intake with milk lactose levels.

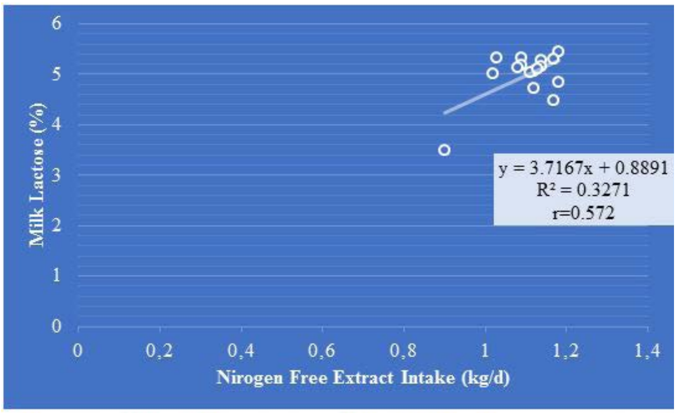

Figure 6: Correlation Milk Lactose with NFE Intake of Etawa Crossbreed Dairy Goats Treatment

Feed Digestibility

Feeding treatment had no significant effect on the digestibility of fat, crude fiber, and NFE. *T. diversifolia* and cassava by 30% with palm concentrate by 30% were able to maintain the digestibility of crude fat, crude fiber, and NFE (Table 5).

DISCUSSION

Milk Production

The insignificant difference between treatments was attributed to the same quality of the rations given. The rations prepared had a protein that was not much different. Feed protein plays an important role in the formation of milk lactose (Prihatminingsih et al., 2015). The lactose contents and milk production did not differ between treatments because lactose was able to bind to water.

The feed intake was not significantly different and resulted in no significant differences in milk production. Milk is synthesized from food substances consumed by livestock. The more rations consumed, the more nutrients will be converted into milk (Arief et al., 2021b)

Milk Fat and Lactose Contents

The milk fat contents obtained were not significant between treatments because the crude fiber contents of the rations were not much different between treatments. The crude fiber of the treated rations relies on milk fat content which is the most volatile nutritional component and is very dependent on the crude fiber content of the diet. The low nutritional crude fiber will produce low acetate in the rumen, so milk fat will be lower (Florendo et al., 2018; Fatmawati et al., 2022).

The results of this study are relatively the same as Arief et al. (2018a) who reported that the fat content of goat's milk is 4-5%, while Jamarun et al. (2020) and Dzarnisa & Ramaya (2022) get goat's milk fat content of 7.29% and 6.55%, respectively. The difference in milk fat content is due to the different types of rations. Milk fat in this study has met the goat's milk standard by the Thai Agricultural Standard (2008), namely the fat content of goat's milk is 3.4 - 4% (Good category). In addition, the same fat content in milk was also affected by the same ratio of forage and concentrate in each treatment ration, namely 60:40. Differences in the ratio of forage and concentrate in the ration can affect the fat content of milk. Schmidely et al. (2021) reported a decrease in milk fat content with increasing concentrates in the ration.

Lactose levels between treatments did not differ due to the crude fiber and NFE from the treatments. Lactose is formed from one molecule of glucose and one molecule of galactose. Glucose molecules are produced from the fermentation of carbohydrates (crude fiber and NFE). NFE is an easily digestible carbohydrate consisting of monosaccharides, especially starch, and glucose. According to Sondakh et al. (2017), The amount of NFE consumed affects the concentration of propionic acid which is an ingredient in glucose formation. Propionic acid will be absorbed from the rumen wall to the liver to be transformed into glucose. Glucose will enter the circulation to the secretory cells of the mammary gland, and be employed in lactose synthesis.

The lactose content of milk was not significantly different due to the use of concentrate in the ration and the same amount (40% from treatments A to D). This was reinforced by Arief et al, (2018b; 2021c) who stated that lactose formation was influenced by propionic acid, which was mainly derived from concentrate feed or high-energy sources. The lactose content in this study was almost the same as Jamarun et al. (2021) by 4.45-5.83% based on palm fronds, elephant grass, and *T. diversifolia* with concentrates composed of palm kernel cake, tofu waste, and rice bran.

Feed Intake

Intake of crude fat in Etawa crossbred goats is about 67.5 g/head/day (60-80 g/head/day). The results were lower than Nurhajah (2016). who reported a crude fat intake of 140 g/head/day This difference is due to dry matter intake and the fat content of the rations. The crude fat intake between treatments did not differ due to the nearly same fat content of the rations. The fat range of treatments was 2.47-3.22%. The amount of feed consumed can affect the nutrients consumed so more feed consumed will increase the nutrients intake (Pazla et al., 2018b).

The average crude fiber intake and treatment NFE were 532.5 and 1102.5 g/head/day. The intake of crude fiber and NFE did not differ between treatments because the dry matter intake and the content of crude fiber and NFE rations were not much different. Febrina et al. (2017) stated that the amount of nutrient intake depends on the dry matter amount consumed by livestock and the nutrient contents. Intake in goats is heavily influenced by the feed quality, the digestion rate, the removal rate of the remaining feed, and the fulfillment of nutrients (Marques et al., 2022).

Feed intake is closely related to the palatability of the ration. These results prove that the use of *T. diversifolia* combinations with cassava and palm concentrate up to a level of 30% is still palatable for livestock. Anti-nutritional substances in *T. diversifolia* such as phytic acid, tannins, saponins, oxalates, flavonoids, and alkaloids are still tolerated by livestock. High doses of *T. diversifolia* cause a bitter taste in livestock due to the high phytic acid levels (79.2 mg/100 g) (Oluwasola and Dairo, 2016). *T. diversifolia* can maintain a ration intake of up to 30% in Pesisir cattle (Pazla et al., 2021c).

Correlation of Crude Fat Intake with Milk Fat

Figure 4 showed a linear regression between crude fat intake with milk fat content. The correlation coefficient (r=0.367) means that there is a low relationship between crude fat intake and milk fat content (Sugiyoni, 2007). The coefficient (R^2=0.135) indicates that 13.5% of the milk fat content is affected by crude fat intake. Crude fat intake plays a role in milk fat formation. Feed fat provides fatty acids and glycerol which are raw materials for milk fat synthesis. Tyler and Ensminger (2006) stated that the feed fat consumed by livestock will be directly digested and produce fatty acids and glycerol which are used as ingredients for the synthesis of milk fat. Cannas and Paulina (2007) stated that about 40-45% of milk fatty acids are directed from feed fat and body tissue. Crude fat intake can increase the milk fat contents because some of the milk fatty acids, especially long-chain fatty acids, come from a feed.

Correlation of Crude Fiber Intake with Milk Fat

The results showed that there was a linear regression relationship between crude fiber intake with milk fat content. The correlation coefficient (r=0.38) according to Sugiyono (2007) indicated that there is a low relationship between crude fiber intake with milk fat contents. The coefficient of determination (R^2= 0.147) indicated that 14.7% of the milk fat contents are affected by the crude fiber intake, while 85.3% are influenced by crude fat intake. The relationship between the intake of crude fiber with milk fat showed that the higher the crude fiber intake, the higher the milk fat content. The relationship between crude fiber intake and milk fat can be attributed to the nature of crude fiber as a raw material provider for the volatile fatty acids formation of the milk fat.

Marwah et al. (2013) reported that milk fat is strongly influenced by intake and crude fiber contents. The crude fiber consumed is broken down into cellulose which is digested by rumen microbes and produces VFA (Pazla et al., 2021d; 2021e). The VFA (acetic and butyric acids) is utilized for forming milk fat, especially fatty acids, while glycerol is partly derived from feed fat and body fat reserves, as well as the glycolysis pathway. Acetic acid and Β-hydroxy butyrate are utilized as short-chain fatty acid precursors in milk fat synthesis. Tyler and Ensminger (2006) revealed that most of the milk fatty acids arise from acetic and butyric acids. Propionic acid is converted to glucose which can be used in lactose and glycerol production. Glucose is converted to glycerol-3-phosphate via the Meyerhof pathway and to glycerol for milk fat synthesis.

Correlation of NFE Intake with Milk Lactose

The results showed that there was a linear regression relationship between NFE intake and milk lactose levels. The correlation coefficient (r= 0.572) according to Sugiyono (2007) indicated that there is a moderate relationship between NFE intake and milk lactose contents. The coefficient of determination (R^2= 0.3271) means that 32.71% of the milk lactose contents are affected by NFE intake, while 67.21% are influenced by crude fiber intake. The relationship between NFE intake and milk lactose showed that the higher the intake of NFE, the higher the lactose content of milk. There is a relationship between the intake of NFE and lactose milk because lactose is formed from glucose and galactose. Glucose is produced from carbohydrates fermentation, especially NFE. NFE consists of monosaccharides (glucose). NFE fermentation in the rumen produces more VFA in the form of propionic acid. Sondakh et al. (2017) stated that the amount of NFE consumed affects the propionic acid concentration which is an ingredient in glucose formation.

Feed Digestibility

Non-significant crude fat digestibility was caused by the crude fat contents in the rations. The use of cassava leaves with *T. diversifolia* and palm concentrate from 0% to 30% in the ration causes the toleration of the ration and did not interfere with the crude fat digestibility, namely with a fat content ranging from 2.47% to 3.22%. Jamarun et al. (2021) reported that a fat content above 5% will affect the utilization abilities of the livestock. The crude fat digestibility was influenced by the nutrient contents, one of which was crude fat. Ningrat et al. (2020) stated that one of the factors that affect feed digestibility is ration composition. The high crude fat digestibility is attributed to absorbed fat with triglycerides as an energy source.

The non-significant differences in the crude fiber digestibility in each treatment were caused by the lignin contents which were not different. The difference in the lignin contents of the rations was 1.75% in the rations from treatment A to treatment D. Apart from the lignin content, the ADF and cellulose contents were not much different. The crude fiber digestibility was affected by the relatively equal fiber contents between treatment A to treatment D rations, causing the crude fiber digestibility to be not significantly different. Pazla et al. (2020) reported that crude fiber digestibility is affected by the fiber fraction (lignin, cellulose, and hemicellulose). Other factors that can affect crude fiber digestibility are fiber in feed, fiber composition, and microorganism activity (Jamarun et al., 2017a, 2017b, 2017c). The crude fiber digestibility between treatments A, B, C, and D was not significantly different because the chemical composition of the rations was almost the same. Digesting crude fiber requires sufficient and balanced protein and energy for rumen microbial activity to digest food substances, including crude fiber. Crude protein will undergo fermentation in the rumen to produce NH_3 which is used to increase the microbial population in the rumen. TDN is derived from rations and acts as an energy source for rumen microbes. The large ruminal microbes population will affect digestibility so that the same chemical composition in dairy goat rations will cause the crude fiber digestibility to be relatively the same. Zain et al.(2016) also stated that crude fiber digestibility is influenced by fiber composition and the ruminal microbes' activity.

The non-significant differences were because the NFE digestibility was affected by the NFE in treatment rations A (41.50%) to D (41.70%) which were relatively the same. The NFE digestibility was in line with the results of crude fiber digestibility, this proved that digestibility was influenced by the nutrient contents, one of which was crude fiber. Pazla et al. (2023) stated that the NFE content is influenced by the other nutrient contents (crude protein, ash, crude fat, and crude fiber). The NFE digestibility was not significantly affected by the balance between the TDN and the crude protein of the ration. Budiman et al. (2006) stated that an increase in protein affects the absorption and utilization of nutrients so NFE increases.

CONCLUSION

T. diversifolia, cassava leaves, and palm concentrate up to 30% were able to maintain production, milk fat and lactose contents, fat intake and digestibility, crude fiber, and NFE.

ACKNOWLEDGEMENTS

Thank you to LPPM Universitas Andalas for funding this research with an indexed publication research scheme with contract number: T/16/UN.16.17/PT.01.03/Pangan-RPT/2022.

NOVELTY STATEMENT

This study found Etawa crossbreed ration formulation to optimize milk production and quality by using *T. diversifolia*, cassava leaves, and palm concentrate.

AUTHOR'S CONTRIBUTION

Arief and Novirman Jamarun designed the concept and searched for funding. Roni Pazla drafted, reviewed the paper, and conducted data analysis. Rizqan supervised the field and laboratory work.

REFERENCES

Adriani, Latif A, Fakhri, Saitul, Sulaksana I (2014). Peningkatan Produksi dan Kualitas Susu Kambing Peranakan Etawah Sebagai Respon Perbaikan Kualitas Pakan. J. Ilmiah Ilmu-Ilmu Peternakan. XVII.

Adrizal, Pazla R, Sriagtula R, Adrinal, Gusmini (2021). Evaluation of potential and local forages nutrition as ruminant feed-in Payo Agro-Tourism Area, Solok City, West Sumatera, Indonesia. IOP Conference Series: Earth Environ. Sci. 888: 012055. https://doi.org/10.1088/1755-1315/888/1/012055

Arief, Jamarun N, Satria B, Pazla, R (2021c). Milk lactose, specific gravity and mineral of etawa dairy goat fed with palm kernel cake based concentrate, Tithonia (*Tithonia diversifolia*), sweet potato leaves (*Ipomoea batatas L*) and gamal (*Gliricidia sepium*). IOP Conference Series: Earth Environ. Sci. 888. 012004. https://dx.doi.org/10.1088/1755-1315/888/1/012004.

Arief, Jamarun N, Pazla R, Satria B (2018a). Production and quality of Etawa raw milk using palm oil industry waste and *Tithonia diversifolia* plants as an early Feed. Int. J. Dairy Sci. 13: 15-21. https://dx.doi.org/10.3923/pjn.2018.399.404

Arief, Elihasridas, Sowmen S, Roza E, Pazla R, Rizqan (2018b). Production and quality of Etawa raw milk using palm oil industry waste and paitan plants as an early Feed. Pakistan J. Nutrit. 17(8): 399-404. https://dx.doi.org/10.3923/pjn.2018.399.404

Arief, Jamarun N, Satria B, Pazla R (2021a). Milk quality of Etawa dairy goat-fed palm kernel cake, Tithonia (*Tithonia diversifolia*), and Sweet potato leaves (*Ipomea batatas L*). IOP Conference Series: Earth Environ. Sci. 709(01): 2023. http://doi.org/10.1088/1755-1315/709/1/012023

Arief, Rusdimansyah, Sowmen S, Pazla R (2021b). Milk production, intake, and digestibility of ration based on the palm kernel cake, Tithonia (*Tithonia diversifolia*), and corn waste on Etawa crossbreed dairy goat. IOP Conference Series: Earth Environ. Sci. 709(01): 2024. http://doi.org/10.1088/1755-1315/709/1/012024

Arief, Rusdimansyah, Sowmen S, Pazla R, Rizqan (2020). Milk production and quality of Etawa crossbreed dairy goat that given *Tithonia diversifolia*, corn waste and concentrate based palm kernel cake. Biodiversitas. 21(9): 4004-4009. http://doi.org/10.1088/1755-1315/709/1/012023

Arief, Pazla R (2023). Milk Production and Quality of Etawa Crossbred Goats with Non-Conventional Forages and Palm Concentrates. American J. Anim. Vet. Sci. 18(1): 9-18. https://doi.org/10.3844/ajavsp.2023.9.18

AOAC (1995). Official Methods of Analysis of AOAC International. Arlington, Virginia. USA.

Bernard K, Wanyoike M & Kuria J, Mwangi D, Muge E (2020). Cassava leaves and azolla as crude protein supplement feed to east african short horned Zebu Heifers. African J. Agricult. Res.. 16. 1458-1463. https://dx.doi.org/10.5897/AJAR2020.15061

Budiman A, Dhalika T, Ayuningsih B (2006). Evaluation of Crude Fibre and Non Nitrogen Free Extract (NNFE) Digestibility on Sugar Cane (*Saccharum officanirum*). J. Anim. Sci. 6(2): 132-135. https://doi.org/10.24198/jit.v6i2.2281

Cannas, Antonello, Pulina G., Francesconi, A.H.D (2007). Dairy goats feeding and nutrition.

Dzarnisa, Ramaya A (2022). The effect of fed on feeding combination of the ark with ammonized citronella grass waste to the quality of lactated Etawah crossbreed goat milk. IOP Conference Series: Earth Environ. Sci. 951. 012018. https://dx.doi.org/10.1088/1755-1315/951/1/012018.

Fasuyi AO, Dairo FAS, Ibitayo FJ (2010). Ensiling wild sunflower (*Tithonia diversifolia diversifolia*) leaves with sugar cane molasses. Livest. Res. Rural Develop. 22: 42.

Fasuyi, Ibitayo (2011). Preliminary analyses and amino acid profile of wild sunflower (Tithonia diversifolia) leaves. Int. J. Biolog. Chem. Sci. 5. https://dx.doi.org/10.4314/ijbcs.v5i1.68094.

Fatmawati M, Suwanti L, Hambarrukmi W, Sukesi L, Novianto E, Wahyutyas K (2022). A comparative study among dairy goat breeds in Lumajang and Malang (East Java, Indonesia) based on milk organoleptic and milk composition. Biodiversitas J. Biolog. Diver.. 23. https://dx.doi.org/10.13057/biodiv/d230616.

Febrina D, Jamarun N, Zain M, Khasrad (2017). Effects of using different levels of oil Palm Fronds (FOPFS) fermented with *Phanerochaete chrysosporium* plus minerals (P, S and Mg) instead of Napier grass on nutrient intake and the growth performance of goats. Pakistan J. Nutrit. 16(8): 612-617. https://doi.org/10.3923/pjn.2017.612.617

Florendo PDC, Sharma SR, Vfellner V (2018). Cattle rumen microorganisms hydrolysis for switchgrass saccharification, volatile fatty acids and methane production. Int. J. Agricult. Technol. 14. 31-43.

Jamarun N, Pazla R, Zain M, Arief (2020). Milk quality of Etawa crossbred dairy goat fed combination of fermented oil palm fronds, Tithonia (*Tithonia diversifolia*), and Elephant grass (*Pennisetum purpureum*). Journal of Physics: Conference Series.1469 012004. http://doi.org/10.1088/1742-6596/1469/1/012004

Jamarun N, Welan R, Arief, Gusri Y, Pazla R (2022). Nutrition Evaluation of Etawa Crossbreed Dairy Goat's Milk as Human Food to Increase Immunity During The Covid-19 Pandemic. https://dx.doi.org/10.2991/ahsr.k.220303.023.

Jamarun N, Zain M, Pazla R (2021). Dasar Nutrisi Ruminansia Edisi ke II. Andalas University Press, Padang, Indonesia. ISBN: 9786236234570.

Jamarun N, Zain M, Arief, Pazla R (2017a). Effects of Calcium, Phosphorus and Manganese supplementation during oil Palm Frond fermentation by *Phanerochaete chrysosporium* on laccase activity and in vitro digestibility. Pakistan J. Nutrit. 16 (3): 119-124. https://doi.org/10.3923/pjn.2017.119.124

Jamarun N, Zain M, Arief, Pazla R (2017b). Effects of calcium (Ca), phosphorus (P) and manganese (Mn) supplementation during oil palm frond fermentation by *Phanerochaete chrysosporium* on rumen fluid characteristics and microbial protein synthesis. Pakistan J. Nutrit. 16:393-399. https://doi.org/10.3923/pjn.2017.393.399.

Jamarun N, Zain M, Arief, Pazla R (2017c). 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*). Pakistan J. Nutrit. 17: 39-45. https://doi.org/10.3923/pjn.2018.39.45

Marjuki, Sulistyo HE, Wahyuni, Rini, Irsyammawati, Artharini, Soebarinoto, Howeler, Reinhardt (2008). The Use of Cassava Leaf Silage as a Feed Supplement in Diets for Ruminants and its Introduction to Smallholder Farmers.

Marques RO, Gonçalves HC, Meirelles PRL, Ferreira RP, Gomes HFB, Lourençon RV, Brito P, Cañizares GIL (2022). Production, intake, and feeding behavior of dairy goats fed alfalfa via grazing and cassava. Rev. Brasil. de Zoot. 51: e20210102. https://doi.org/10.37496/rbz5120210102

Marwah M, Suranindyah, Yustina Y, Murti TW (2012). Produksi dan Komposisi susu kambing Peranakan Ettawa yang diberi suplemen daun katu (*Sauropus androgynus (L.) Merr*) pada Awal Masa Laktasi (Milk Production and Milk Composition of Ettawa Crossbred Goat, Fed Katu Leaves (*Sauropus androgynus (L.) Merr*) as. Buletin Peternakan. 34. https://dx.doi.org/10.21059/buletinpeternak.v34i2.95.

Ningrat R, Zain M, Elihasridas E, Malik M, Ezi MP, Yesi CS (2020). Effect of Dietary Supplementation Based on Ammoniated Palm Frond with *Saccharomyces cerevisiae* and Gambier Leaves Waste on Nutrient Intake and Digestibility, Daily Gain and Methane Production of Simmental Cattle. Adv. Anim. Vet. Sci. 8. https://dx.doi.org/10.17582/journal.aavs/2020/8.12.1325.1332.

Nurhajah A, Purnomoadi A, Harjanti D (2016). Hubungan Antara Konsumsi Serat Kasar dan Lemak Kasar dengan Kadar Total Solid dan Lemak Susu Kambing Peranakan Ettawa. J. Agripet. 16. 1. https://dx.doi.org/10.17969/agripet.v16i1.3755.

Oluwasola TA, Dairo FAS (2016). Proximate composition, amino acid profile, and some anti-nutrients of *Tithonia diversifolia* cut at two different times. African J. Agricult. 11(38): 3659-3663. https://doi.org/10.5897/AJAR2016.10910

Oni A, Arigbede O, Oni OO, Onwuka CC, Anele U, Oduguwa BO, Adebayo K (2010). Effects of feeding different levels of dried cassava leaves (*Manihot esculenta, Crantz*) based concentrates with *Panicum maximum* basal on the performance of growing West African Dwarf goats. Livestock Science - LIVEST. SCI. 129. 24-30. https://dx.doi.org/10.1016/j.livsci.2009.12.007.

Pazla R, Jamarun N, Zain M, Yanti G, Chandra RH (2021a). Quality evaluation of Tithonia (*Tithonia diversifolia*) with fermentation using *Lactobacillus plantarum* and *Aspergillus ficuum* at different incubation times. Biodiversitas. 22(9): 3936-3942. https://doi.org/10.13057/biodiv/d220940

Pazla R, Yanti G, Jamarun N, Arief, Elihasridas, Sucitra LS (2021b). Degradation of phytic acid from Tithonia (*Tithonia diversifolia*) leaves using *Lactobacillus bulgaricus* at different fermentation times. Biodiversitas. 22: 4794–4798. https://doi.org/10.13057/biodiv/d221111

Pazla R, Adrizal, Sriagtula R (2021c). Intake, nutrient digestibility, and production performance of pesisir cattle fed *Tithonia diversifolia* and *Calliandra calothyrsus*-based rations with different protein and energy ratios. Adv. Anim. Vet. Sci. 9(10): 1608-1615. http://dx.doi.org/10.17582/journal.aavs/2021/9.10.1608.1615

Pazla R, Jamarun N, Agustin F, Zain M, Arief, Cahyani N (2021d). In vitro nutrient digestibility, volatile fatty acids and gas production of fermented palm fronds combined with Tithonia (*Tithonia diversifolia*) and elephant grass (*Pennisetum purpureum*). IOP Conference Series: Earth Environ. Sci. 888. 012067. https://doi.org/10.1088/1755-1315/888/1/012067

Pazla R, Jamarun N, Warly L, Yanti G, Nasution NA (2021e). Lignin Content, Ligninase Enzyme Activity and in vitro Digestability of Sugarcane Shoots using *Pleurotus ostreatus* and *Aspergillus oryzae* at Different Fermentation Times. American J. Anim. Vet. Sci. 16(3): 192-201. https://doi.org/10.3844/ajavsp.2021.192.201

Pazla R, Jamarun N, Agustin F, Zain M, Arief, Cahyani NO (2020). Effects of supplementation with phosphorus, calcium, and manganese during oil palm frond fermentation by *Phanerochaete chrysosporium* on ligninase enzyme activity. Biodiversitas. 21: 1833–1838. https://doi.org/10.13057/biodiv/d210509

Pazla R, Jamarun N, Zain M, Arief A (2018a). Microbial protein synthesis and in vitro fermentability of fermented oil palm fronds by *Phanerochaete chrysosporium* in combination with Tithonia (*Tithonia diversifolia*) and elephant grass (*Pennisetum purpureum*). Pakistan J. Nutrit. 17(10): 462-470. https://doi.org/10.3923/pjn.2018.462.470

Pazla R, Jamarun N, Zain M, Arief, Yanti G, Putri EM, Candra RH (2022). Impact of *Tithonia diversifolia* and *Pennisetum purpureum*-based ration on nutrient intake, nutrient digestibility, and milk yield of Etawa crossbreed dairy goat. Int. J. Vet. Sci. 11(3): 327-335. https://doi.org/10.47278/journal.ijvs/2021.119

Pazla R, Zain M, Ryanto HI, Dona A (2018b). Supplementation of minerals (phosphorus and sulfur) and *Saccharomyces cerevisiae* in a sheep diet based on a cocoa by-product. Pakistan J. Nutrit. 17(7): 329-335. https://doi.org/10.3923/pjn.2018.329.335

Pazla R, Jamarun N, Arief, Elihasridas, Yanti G, Putri EM (2023). *In vitro* Evaluation of Feed Quality of Fermented Tithonia diversifolia with *Lactobacillus bulgaricus* and Persea americana miller Leaves as Forages for Goat. Trop. Anim. Sci. J. 46(1):43-54. https://doi.org/10.5398/tasj.2023.46.1.43

Prihatminingsih GE, Purnomoadi A, Harjanti DW (2015). Correlation between protein intake and milk production, protein and lactose of Ettawa Crossbreed Goats. J. Ilmu-Ilmu Peternakan. 25 (2): 20 – 27. DOI. https://doi.org/10.21776/ub.jiip.2015.025.02.03

Rosmalia A, Permana I, Despal (2022). Synchronization of rumen degradable protein with non-fiber carbohydrate on microbial protein synthesis and dairy ration digestibility. Vet. World. 15: 252-261. : www.doi.org/10.14202/vetworld.2022.252-261

Schmidely P, Sauvant D (2001). Fat content yield and composition of milk in small ruminants: Effects of concentrate level and addition of fat). Productions Animales -Paris- Institut National de la Recherche Agronomique-. 14. 337-354.

Sondakh E, Kalele JAD, Ratulangi FS (2017). The use of coconut pulp as a feed substrate to methanogenesis inhibitor in in vitro rumen fluid fermentation. J. Indonesian Trop. Anim. Agricult. 42. 202. https://dx.doi.org/10.14710/jitaa.42.3.202-209.

Steel PGD, Torrie JH (1991). Prinsip dan Prosedur Statistika suatu Pendekatan Geometrik. Terjemahan B. Sumantri. PT Gramedia. Jakarta.

Sugiyono (2007). Statistik untuk penelitian. CV. Alfabeta, Bandung.

Suhendro, Hidayat, Akbarillah T (2018). Pengaruh Penggunaan Bungkil Inti Sawit, Minyak Sawit, dan Bungkil Inti Sawit Fermentasi Pengganti Ampas Tahu dalam Ransum terhadap Pertumbuhan Kambing Nubian Dara. J. Sain Peternakan Indonesia. 13. 55-62. https://dx.doi.org/10.31186/jspi.id.13.1.55-62.

Suyitman, Warly L, Rahmat A, Pazla R (2020). Digestibility and performance of beef cattle fed ammoniated palm leaves, and fronds supplemented with minerals, cassava leaf meal, and their combinations. Adv. Anim. Vet. Sci. 8(9): 991-996. http://dx.doi.org/10.17582/journal.aavs/2020/8.9.991.996

Thai Agricultural Standard. TAS 6006-2008. Raw Goat Milk. National Bureau of Agricultural Commodity and Food Standards, Ministry of Agriculture and Cooperatives. ICS 67.100.01. Published in the Royal Gazette Vol. 125 Section 139 D. Thailand. http://extwprlegs1.fao.org/docs/pdf/tha166272.pdf

Tyler HD, Ensminger ME (2006). Dairy Cattle Science. 4th Ed. Pearson Prentice Hall, Ohio.

Zain M, Rahman J, Khasrad, Erpomen (2016). Supplementation of *Saccharomyces cerevisiae* and Sapindus rarak in Diet Based of Oil Palm Frond (OPF) on Nutrient Digestibility and Daily Weight Gain of Goat. Asian J. Anim. Vet. Adv. 27. https://dx.doi.org/10.3923/ajava.2016.314.318.

Zarei, Mohammad, Ebrahimpour, Afshin, Abdul Hamid, Azizah, Anwar, Farooq, Saari, Nazamid (2016). Production of Defatted Palm Kernel Cake Protein Hydrolysate as a Valuable Source of Natural Antioxidants.