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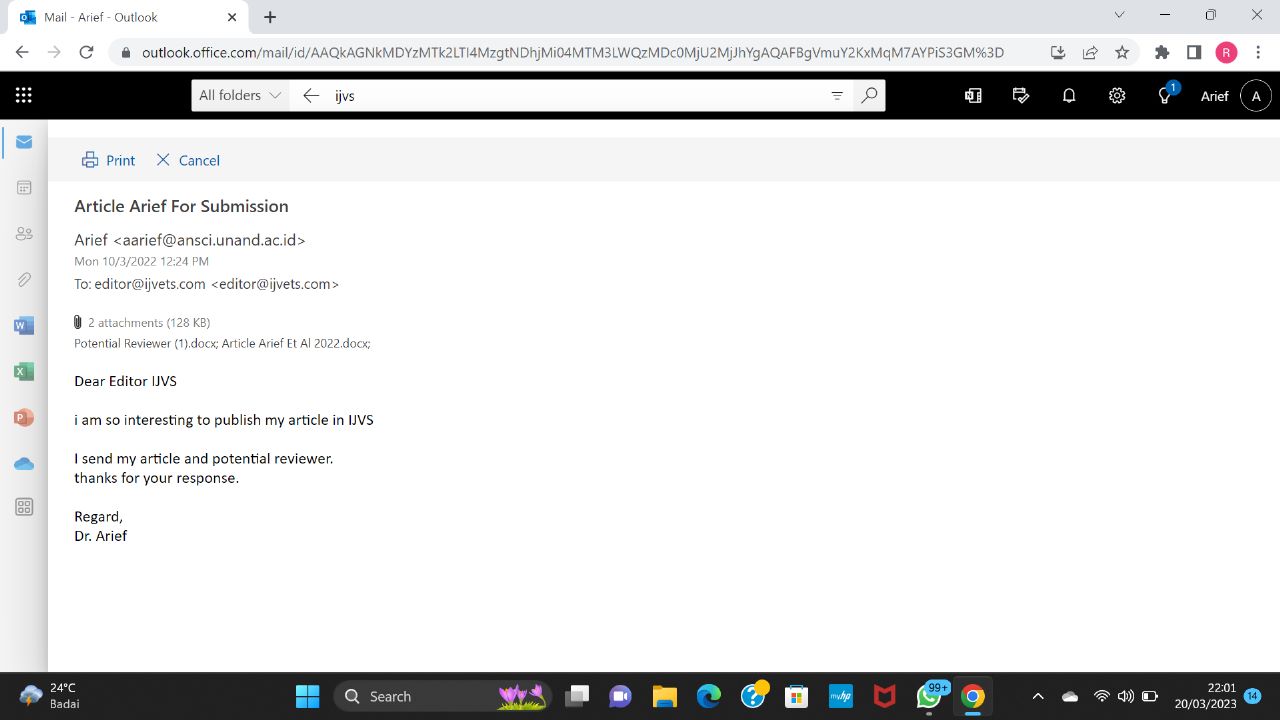
of Etawa Crossbreed Dairy Goats Fed Tithonia (Tithonia

diversifolia), Cassava Leaves and Palm Kernel Cake

Concentrate

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#### Bukti Submit

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**Artikel yang di Submit**

#### PRODUCTION PERFORMANCE, FEED INTAKE AND NUTRIENT DIGESTIBILITY

1. **OF ETAWA CROSBREED DAIRY GOATS FED TITHONIA (*Tithonia diversifolia*),**

#### CASSAVA LEAVES AND PALM KERNEL CAKE CONCENTRATE

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#### ABSTRACT

1. This research aimed at the intake, digestibility, production, and milk quality of Etawa
2. crossbreeds dairy goat (ECDG) fed conventional mixed forage; tithonia (*Tithonia diversifolia*)
3. (T) and cassava leaves (CL) with palm kernel cake concentrate (PKCC). Completely
4. randomized design (four treatments and four replications) was used in this study. The treatments
5. consisted of A was company rations (50% company forages + 50% company concentrate(CC)),

17 B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC + 20% PKCC), D (50%

1. (T+CL)+ 20% CC + 30% PKCC). The variables analyzed were as follows; milk production,
2. milk quality (total solid,lactose, protein, fat, solid non-fat, water content, specific gravity, pH,
3. Ca and P minerals), dry matter intake (DMI), organic matter intake (OMI), crude protein intake
4. (CPI), dry matter digestibility (DMD), organic matter digestibility (OMD), crude protein
5. digestibility (CPD). Data analysis used analysis ov Variance. Further test to determine
6. differences between treathments using Duncan multiple range. The analysis showed that the
7. treatment had no significant effect (P>0.05) on feed intake, feed digestibility, production, and
8. milk quality. Using palm kernel cake concentrate and a mixture of tithonia and cassava leaves
9. was able to maintain the feed intake, feed digestibility, production, and milk quality of ECDG.

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1. **Keywords**: cassava leaves, Etawa crossbreed dairy goat, milk production, palm kernel cake
2. concentrate, *Tithonia diversifolia*.
3. **Novelty:** This study found a ration formulation to optimize the production and quality of dairy
4. goats using titonia forage and cassava leaves as a source of forage, while the
5. concentrate was palm kernel cake concentrate.

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#### INTRODUCTION

1. The availability of forage and the high price of concentrate are severe problems in developing
2. the Etawa crossbreed dairy goat (ECDG) farm. The increase in residential areas impacts reducing
3. forage for animal feed. At the same time, the price of concentrate is getting more expensive day
4. by day. So it is necessary to find alternative sources of forage and concentrates with high
5. production and good nutritional quality.
6. Tithonia (*Tithonia diversifolia*) is a forage with good nutritional content (Pazla et al. 2021a).
7. The crude protein content is 22.89%, and organic matter is 84.01% (Pazla et al. 2018a). Tithonia
8. is also rich in P mineral, which can potentially increase the number of rumen bacterial
9. populations (Fasuyi et al. 2010; Pazla et al. 2021b; Adrizal et al. 2021). Oluwasola & Dairo
10. (2016) reported that tithonia plants are also rich in amino acids. The mixture of tithonia with
11. elephant grass as a fiber source in ECDG ration can optimize intake, digestibility, and milk
12. production (Pazla et al. 2022).
13. Cassava leaves contain Branched Chain Amino Acids (BCAA) such as isoleucine, valine, and
14. leucine were 4.4%, 8.43%, 8.75%, respectively (Suyitman et al. 2017a). BCAAs increase the
15. nutrient digestibility likes dry matter, organic matter, and acid detergent fiber through the growth
16. of cellulolytic bacteria (Zain et al. 2002). Supplementation of cassava leaves on ammoniated
17. palm stems increased rumen microbial growth and increased digestibility of DM, ADF, and
18. neutral detergent fiber (NDF) (Nurhaita and ningrat, 2011). Suyitman et al. (2020) reported that
19. supplementing cassava leaves in Simmental cattle rations improved digestibility and production
20. performance.
21. Palm kernel cake concentrate (PKCC) is made from a mixture of feed ingredients that have
22. good nutrition for livestock growth and production, such as rice bran, corn, palm kernel cake,
23. and minerals. Energy (total digestible nutrient) and crude protein (CP) of PKCC are 60-64% and
24. 14-16%, respectively (Arief et al. 2020). This research aims to determine the impact of replacing
25. company forages with a mixture of cassava and tithonia and replacing company concentrate with
26. PKCC on intake, digestibility, production, and quality of ECDG.

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#### MATERIALS AND METHODS

1. **Experimental Site**

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1. This study was carried out on Toni Farm company, Payakumbuh, West Sumatra, Indonesia (-
2. 0.2330638,100.6268024, and 516 m asl); this area has two seasons (dry and rainy). The rainy
3. season is from September to February, and summer is from March to August. This research was
4. conducted in May – June 2022. The temperature of this area at the time of the study was in the
5. range of 22-35 0C.

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#### Animal Ethics

1. This research has referred to the ethics of research using livestock based on the law of the
2. government of the Republic of Indonesia Number 18 of 2009 article 66, which discusses animal
3. maintenance, killing, treatment, and reasonable care.

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#### 78 Animal Experiment and Feeding Formulation

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1. The livestock used in the study were 16 ECDG with an average body weight of 60±1.23 Kg
2. and were in the second lactation, distributed in a completely randomized design with four
3. treatments (ration formulation) and four replications. The treatments consisted of A was
4. company ration as control (50% company forages + 50% company concentrate(CC)), B (50%

84 (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC + 20% PKCC), D (50% (T+CL)+

1. 20% CC + 30% PKCC). The ratio of tithonia with cassava is 1:1
2. PKCC concentrate is made by formulating the following feed ingredients, namely 37% rice
3. bran + 40% palm kernel cake + 22% corn, and 1% minerals. All materials were mixed
4. homogeneously and stored in plastic at less than 12% moisture content.
5. The company forage was bush and native grass. The company's concentrate is made by
6. formulating feed ingredients along with tofu dregs, jackfruit skin, and skinless cassava. All
7. ingredients are stirred evenly and given in a fresh state. Meanwhile, forage company forages,
8. cassava leaves, and tithonia were given three times a day: in the morning at 08.00, noon at 13.00,
9. and in the afternoon at 18.00. The concentrate is given twice a day, in the morning at 07.00 and
10. noon.
11. The experimental ration was formulated based on the NRC (2007) to fulfill the nutrition of
12. dairy goats weighing 60 Kg and having the capacity to produce 2-3 Kg of milk with 4% fat
13. content per day. The chemical composition of each feed ingredient used is presented in Table 1.
14. the composition of the feed ingredients in the treatment ration and the nutritional composition of
15. the treatment ration are presented in Table 2.
16. Proximate analysis (dry matter, ash, crude protein, extract ether, and crude fiber) of research
17. feed ingredients was carried out based on AOAC international (1995). Fiber fractions (cellulose,
18. lignin, ADF, and NDF) were analyzed according to the technique described by Van Soest
19. (1982). TDN is calculated based on Moran (2005). The nitrogen-free extract was calculated
20. according to Jamarun et al. (2021).

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106 TDN (%) = 5.31 +1.444 Cfat + 0.412 CP + 0.937 NFE + 0.249 CF

107 NFE= 100 - (ash+ CP+Cfat+CF)

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Note:

TDN= total digestible nutrient CP= crude protein

CF= crude fiber Cfat= crude fat

NFE= nitrogen free extract.

1. The study lasted 45 days, divided into three periods: the adaptation period of 25 days, the
2. preliminary period of 15 days, and the 5-day collection period. The fresh ration intake was
3. calculated by calculating the difference between the amount of ration and the rest of the ration.
4. DMI (Kg/h/day) = Fresh Intake \* DMCR
5. OMI (Kg/h/day) = DMI \* OMCR
6. CPI (Kg/h/day) = DMI \* CPCR
7. Note:

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1. DMI= dry matter intake
2. OMI= organic matter intake
3. CPI= crude protein intake
4. DMCR= dry matter content of the ration
5. OMCR= organic matter content of the ration
6. CPCR= crude protein content of the ration

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1. Feces were collected at 6 am. All fresh feces were weighed, 10% was taken for each
2. treatment, then dried in the sun. The dried feces were then ground into a fine powder for analysis
3. of chemical composition samples. The difference between ration intake and fecal production
4. calculates feed digestibility. The formula used is:

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| **134** | **DMD (%) = (DMI- Feces)/ DMI \* 100%)** |
| **135** | **OMD (%) = (OMI- Feces)/ OMI \* 100%)** |
| **136** | **CPD = (CPI- Feces)/ CPI \* 100%)** |
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| 138 | Goats were milked two times a day, in the morning and evening, using a mechanical milking |

1. machine. Milk production is calculated for five days during the collection period in liters and
2. converted to kg and FCM (Fat Corrected Milk) 4% based on the formula of Mavrogenis and
3. Papachristoforou (1988):

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| 142 | **4%FCM (Kg)= M (0.144+ 0.1444F)** |
| **143** | **Note:** |
| **144** | **M = milk production in Kg** |
| **145** | **F= Fat content in %** |
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| 147 | During the collection period, 250 ml of milk samples were taken for each treatment. The |

1. components for the milk quality test (total solid (milk dry matter), protein, fat, lactose, solid non-
2. fat, specific gravity, and pH) were tested using Lactoscan Pro 202.

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#### Statistical Analysis

1. A completely randomized design (Model) (Steel & Torrie, 1991) was used to analyze intake,
2. feed digestibility, production, and milk quality. The data were analyzed with the analysis of
3. variance using the Excel 2019 program at a significance level of @= 0.05. Duncan's Advanced
4. Multiple range tests were used to test the differences between treatments.

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#### RESULTS

1. **Milk Production of Etawa Crossbreed Dairy Goats Treatment**
2. Replacement of company forages with a mixture of cassava and tithonia and replacement of
3. company concentrate with PKCC were not significantly different (P>0.05) in increasing milk
4. production. Using cassava leaves, tithonia, and PKCC is expected to increase milk production.
5. The average daily milk production results from replacing company forages with a mixture of
6. cassava leaves and tithonia and replacing company concentrate with PKCC in various
7. percentages are presented in Table 3. The analysis of the variance of the highest milk production
8. after being converted to 4% FCM was in treatment D, and the lowest was in treatment A
9. (control).

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#### Milk Quality of Etawa Crossbreed dairy Goat Treatment

1. The results of statistical analysis showed that there was no significant difference (P>0.05) in
2. all milk quality parameters. Replacing the company forages with a mixture of cassava and
3. tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The
4. average milk quality results from replacing company forages with a mixture of cassava leaves
5. and tithonia and replacing company concentrate with PKCC in various percentages are presented
6. in Table 4.

#### Feed Intake of Etawa Crossbreed dairy Goats Treatment

1. The analysis results of dry matter intake, organic matter intake, and crude protein intake by
2. replacing company concentrate with PKCC and replacing company forages with tithonia and
3. cassava leaves are presented in Table 5. Replacing company concentrate with PKCC and
4. replacing company forages with tithonia and cassava leaves in the ration gave no significant
5. difference (P>0.05) in each treatment on the value of dry matter intake, organic matter intake,
6. and crude protein intake.

#### Digestibility of Etawa Crossbreed Dairy Goats Treatment

1. The analysis results of dry matter digestibility (DMD), organic matter digestibility (OMD),
2. and crude protein digestibility (CPD) by replacing company concentrate with PKCC and
3. replacing company forages with tithonia and cassava leaves are presented in Table 6. Table 6
4. shows that the treatment of replacing company concentrate with PKCC and replacing company
5. forages with a mixture of cassava leaves and tithonia had no significant effect (P>0.05) on DMD,
6. OMD, and CPD.

#### DISCUSSION

1. **Milk Production of Etawa Crossbreed Dairy Goats Treatment**
2. Replacement of company forages with a mixture of cassava and tithonia and replacement of
3. company concentrate with PKCC were not significantly different (P>0.05) in increasing milk
4. production. Milk production in dairy goats is strongly influenced by feed quality. Good quality
5. feed will increase milk production. Using cassava leaves, tithonia, and PKCC is expected to
6. increase milk production. The average daily milk production results from replacing company
7. forages with a mixture of cassava leaves and tithonia and replacing company concentrate with
8. PKCC in various percentages are presented in Table 3.
9. The analysis of the variance of the highest milk production after being converted to 4% FCM
10. was in treatment D, and the lowest was in treatment A (control). The insignificant difference
11. between treatments A, B, C, and D could be caused by the feed quality. The prepared rations had
12. a crude protein that was not much different between A (21.35%) rations, B(22.07%), C(21.69%),
13. and D (21.31%) rations (Table 2). The intake of feed protein also influences milk production.
14. Saskia (2022) stated that feed protein plays a role in forming lactose. Lactose is water-binding,
15. so the more lactose is formed, the more milk will be produced. In the research conducted, the
16. lactose content obtained in each treatment was A=4.52%, B=4.44%, C=3.91%, and D= 5.29%
17. (Tabel 4)
18. Good dairy goats have a high amount of milk production and are standardized at 4% FCM
19. (Christi & Rohayati, 2018). From the average value of 4% FCM milk production, it can be seen
20. that the highest production was in treatment D (1.32 kg/head/day). This indicates that after being
21. standardized to 4% FCM, it turns out that treatment D has a high milk fat content, which affects
22. the production of 4% FCM milk. Based on the results of the study, it was found that the milk fat
23. content in each treatment was: A = 4.52%, B = 4.44%, C = 3.91%, and D = 5.29% (Table 4),
24. with the highest increase in milk fat content in treatment D was thought to be because the fat
25. from the D ration was higher from other rations (Table 2), causing high milk production as well.
26. Milk production of 4% FCM is carried out to equalize the energy level in the milk content.

#### Quality of Etawa Crossbreed dairy Goat's Milk Treatment

1. Nutrient components in feed greatly affect the quality of milk. Good quality milk is milk that
2. meets milk quality standards. The results of statistical analysis showed that there was no
3. significant difference (P>0.05) in all milk quality parameters. Replacing the company forages
4. with a mixture of cassava and tithonia and replacing the company's concentrate with PKCC did
5. not affect milk quality. The quality of milk produced in treatments A, B, C, and D were within
6. the normal range based on Thai Agricultural Standards (2008). This value indicates that the
7. response of ECDG to rations containing PKCC concentrate and forages of cassava leaves and
8. tithonia is quite good.
9. The feed quality factors (TDN and CP), which were almost the same between treatments,
10. were thought to be the reason the milk quality did not differ between treatments (P>0.05). Arief
11. et al. (2018a) and Arief et al. (2018b) strengthen the results of this study, which states that The
12. sort of feed influences the best of the milk produced, and the best of the feed will have an effect
13. on the metabolism withinside the animal's frame in order that it influences the supply of
14. electricity and vitamins for the synthesis of milk components. In addition, the same intake of dry
15. matter, organic matter, and crude protein between treatments also caused no difference in the
16. milk quality. The intake and digestibility of the same feed will not affect the final fermented
17. product in the rumen. Volatile fatty acid (VFA) is a product of rumen fermentation. VFA
18. manufacturing will offer enough strength for rumen bacterial to develop and growth (Jamarun et
19. al. 2019) and the supply of uncooked substances for milk synthesis (Jamarun et al. 2020). The
20. outcomes of this have a look at also are much like the outcomes of studies via way of means of
21. Pazla et al. (2022). They also found no difference in milk quality in ECDG given a mixture of
22. tithonia forage with elephant grass with the addition of a concentrate consisting of corn, rice
23. bran, tofu dregs, and palm kernel cake. Marques et al. (2022) also found the same quality of
24. goat's milk when given forage with a combination of cassava and alfalfa.

#### Feed Intake of Etawa Crossbreed dairy Goats Treatment

1. Intake of dry matter can produce energy for milk production because it contains food
2. substances consisting of organic materials such as protein, fat, and carbohydrates (Jamarun et al.
3. 2021). The analysis results of DMI, OMI and CPI by replacing company concentrate with PKCC
4. and replacing company forages with tithonia and cassava leaves are presented in Table 5.
5. Replacing company concentrate with PKCC and replacing company forages with tithonia and
6. cassava leaves in the ration gave no significant difference (P>0.05) in each treatment on the
7. value of DMI, OMI and CPI. The insignificant difference in each treatment could be caused by
8. the type of ration given. In replacing the company's concentrate with PKCC and company
9. forages with tithonia and cassava leaves, it is necessary to pay attention to the dry matter content
10. of each feed ingredient. The dry matter content of the company's concentrate is 23.81%, while
11. the dry matter content of PKCC is 93.24% (Table 1). Meanwhile, the dry matter content of
12. company forages with tithonia and cassava did not differ much. Of course, the difference in the
13. substituted ingredients changed the form of an increase in the dry matter content of the ration
14. (ration A 24.91%, ration B 31.10%, ration C 38.04%, and ration D 44.98%) (Table 2). However,
15. there was an increase in the dry matter content of the ration, and it had no significant difference
16. Against intake. This is supported by Pazla et al. (2018b) that the amount of nutrient intake
17. depends on the amount of dry matter in the feed consumed and the nutrient content of the feed
18. given. In the research conducted, it was also observed that livestock have the ability to eat high
19. feed, which is also influenced by the needs of the livestock themselves, following the opinion of
20. Arief et al. (2021b), which states that the volume of feed needed by livestock, especially goats,
21. depends on their ability to eat feed and total weight body. The results obtained were higher than
22. that of Setyaningsih et al. (2013), whose average dry matter intake is 1.55-1.66 kg/e/day with an
23. average body weight of 43 kg. This is presumably because the capacity of the livestock rumen
24. influences dry matter intake.
25. Another factor that plays a role in dry matter intake is the level of palatability or livestock
26. preference on the feed given. In this study, it was found that the level of palatability of tithonia,
27. cassava leaves, and PKCC in its administration was favored by dairy goats. This is under the
28. opinion of Pazla et al. (2021c) that the palatability of feed will directly affect interest and can
29. cause appetite in livestock. Flavour, texture, smell, and taste significantly affect palatability.
30. Based on the observations made during the study, it was found that Tithonia, cassava leaves, and
31. PKCC have a flavour, The intake of organic matter is in line with the intake of dry matter
32. because organic matter is part of dry matter, which has been reduced by inorganic matter. The
33. pattern of increasing and decreasing intake of organic matter is strongly influenced by the
34. components contained in dry matter (Kamalidin et al. 2012). This is also supported by Febrina et
35. al. (2017) that organic matter is carefully associated with dry matter due to the fact organic
36. matter is a part of dry matter; if the intake of dry matter from livestock is low, it will be followed
37. by a low level of intake of organic matter as well. Intake of organic matter is also primarily
38. determined by the constituent components of the organic material itself, namely crude protein,
39. extract ether, and crude fiber.
40. High intake of dry matter is indeed a factor that causes high intake of organic matter, but the
41. factor that increases intake of organic matter is not only fed; livestock is also one of the factors
42. that can increase intake of organic matter. The ability of livestock to eat feed and the level of
43. preference is also a factor in increasing the intake of organic matter. Murni et al. (2012) stated
44. that other factors influencing intake are animal body weight, feed digestibility, palatability, feed
45. quality, and the age of livestock. Intake of crude protein that did not differ between treatments
46. (P>0.05) was due to the protein content of the ration between treatments that were not much
47. different (A=21.35%, B=22.07%, C=21.69%, D=21.31%)(Table 2). The intake of crude protein
48. feed will be directly proportional to dry and organic matter intake. Pazla et al. (2021c) stated that
49. feed protein positively correlated with the dry matter, protein, and energy intake. The amount of

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| 300 | feed consumed will affect other nutrients consumed. Martawidjaja et al. (1999) stated that the |
| 301 | factors that influence the intake of feed protein are dry matter intake and protein content. Intake |
| 302 | of crude protein in this study was higher than Marwah et al. (2010), who received crude protein |
| 303 | intake of ECDG of 0.34 Kg/head/day by feeding Calliandra calothyrsus and concentrate, and |
| 304 | Krisnan et al. (2015), who received 0.24 kg/head/day by feeding *Pennisetum purpupoides*, |
| 305 | *Leucaena leucocephala* and concentrates. |
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| **307** | **Digestibility of Etawa Crossbreed Dairy Goats Treatment** |
| 308308 |  |
| 309 | Table 6 shows that the treatment of replacing company concentrate with PKCC and replacing |
| 310 | company forages with a mixture of cassava leaves and tithonia had no significant effect (P>0.05) |
| 311 | on DMD, OMD, and CPD. The non-significant difference between treatments was due to the |
| 312 | lignin content of the A, B, C, and D rations not being much different. The difference in the lignin |
| 313 | content of the ration is only 2.83%. In addition, the lignin content of tithonia and cassava is |
| 314 | lower than that of the company forages. In contrast, the lignin content of PKCC is not much |
| 315 | different from that of the firm concentrate. High lignin content in livestock rations will reduce |
| 316 | digestibility because Lignin is a timber substance that can't be digested with the aid of using |
| 317 | rumen microbes (Pazla et al. 2020; Pazla et al. 2021d). |
| 318 | The chemical composition of the ration also influences the digestibility of dry matter, organic |
| 319 | matter, and crude protein. The chemical composition of rations A, B, C, and D is almost |
| 320 | identical. The rations of this study were prepared with a TDN content of 62-64%. In digesting |
| 321 | feed ingredients, sufficient and balanced protein and energy are needed for rumen microbial |
| 322 | activity to digest food substances, including dry matter, organic matter, and crude protein. Crude |
| 323 | protein will undergo fermentation in the rumen, which produces ammonia (NH3) (Suyitman et al. |
| 324 | 2021). NH3 increases the rumen's microbial population (Putri et al. 2019; Putri et al. 2021). TDN |
| 325 | derived from the diet acts as an energy source for rumen microbes. The large population of |
| 326 | rumen microbes will affect the digestibility of food substances so that the same protein and TDN |
| 327 | composition in the treatment rations will cause the digestibility of dry matter, organic matter, and |
| 328 | crude protein to be relatively the same and give an effect that is not significantly different |
| 329 | (P>0.05). This follows the opinion of Jamarun et al. (2017), which states that feed digestibility is |
| 330 | influenced by the ration composition and the activity of microorganisms. |

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| 333 | **CONCLUSION** |
| 334 | Replacement of company forages with a mixture of cassava and tithonia and replacement of |
| 335 | company concentrate with PKCC did not affect the intake, digestibility, production, and quality |
| 336 | of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and tithonia) + 10% |
| 337 | company concentrate + 40% PKCC was able to maintain the intake, digestibility, production, and |
| 338 | quality of Etawa crossbreed dairy goat milk. |
| 339 | **CONFLICT OF INTEREST** |
| 340 | The author declares that there is no conflict of interest |
| 341 | **AUTHOR CONTRIBUTIONS** |
| 342 | Conceptualization: Arief and Roni Pazla, Data Curation: Roni Pazla. Formal analysis: Roni Pazla |
| 343 | and Rizqan. Funding acquisition: Arief and Novirman Jamarun. Methodology: Arief, Roni Pazla, |
| 344 | and Novirman JAmarun. Project administration: Rizqan. Supervision: Arief and Novirman |
| 345 | Jamarun. Validation: Roni Pazla. Writing-original draft: Roni Pazla and Arif. Writing-review & |
| 346 | editing: Rizqan. |
| 347 |  |
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5. polytany laboratory technician who has assisted in the analysis of feed ingredients, feces, and
6. milk.

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1. **Table 1.** Chemical composition of feed ingredients

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Nutrients (%) |  |  |  |  |  | Feedstuff | |  |  |  |  |
| Compan  yforages | T | CL | JS | Rice  bran | Tofu  waste | PKC | Corn | PKCC | skinless  cassava | Company  Concentrate |
| DM | 26.03 | 23.13 | 26.21 | 13.01 | 87.8 | 28.4 | 91.83 | 85.8 | 93.24 | 29.04 | 23.81 |
| OM | 87.93 | 84.65 | 86.33 | 95.02 | 90.8 | 97.67 | 91.41 | 99.1 | 90.23 | 98.78 | 96.92 |
| CP | 25.43 | 25.07 | 30.18 | 12.06 | 10.72 | 20.11 | 12.36 | 7.70 | 13.46 | 11.66 | 17.27 |
| CF | 28.02 | 22.62 | 19.92 | 28.01 | 11.6 | 19 | 26.68 | 2.44 | 18.33 | 4.28 | 20.98 |
| NDF | 48.27 | 55.03 | 56.13 | 71.54 | 55.13 | 59.28 | 66.7 | 49.96 | 62.84 | 37.38 | 61.86 |
| Cfat | 2.73 | 1.62 | 3.10 | 4.00 | 8.73 | 1.25 | 8.23 | 3.50 | 4.96 | 1.13 | 2.07 |
| TDN | 54.53 | 53.54 | 56.44 | 68.8 | 66.63 | 74.61 | 65.4 | 81.9 | 66.36 | 86.53 | 73.46 |
| NFE | 31.75 | 35.34 | 33.13 | 50.93 | 59.75 | 57.31 | 44.14 | 85.46 | 53.48 | 81.71 | 56.62 |
| ASH | 12.07 | 15.35 | 13.67 | 5.00 | 9.2 | 2.33 | 8.59 | 0.90 | 9.77 | 1.22 | 3.08 |
| ADF | 36.45 | 34.2 | 33.69 | 58.55 | 29.35 | 26.65 | 46.10 | 36.76 | 36.02 | 8.92 | 35.33 |
| Hemi | 11.82 | 20.83 | 22.44 | 12.99 | 25.78 | 32.63 | 20.60 | 13.20 | 26.82 | 28.46 | 26.53 |
| Lignin | 11.72 | 5.81 | 6.87 | 8.54 | 06.90 | 2.3 | 17.29 | 07.50 | 3.92 | 6.49 | 4.38 |
| Cellulose | 24.4 | 27.54 | 28.48 | 24.46 | 15.52 | 22.93 | 43.25 | 29.52 | 16.97 | 14.07 | 22.95 |

1. Dry matter (DM), Organic matter (OM), Crude protein (CP), Crude fiber (CF),Neutral detergent
2. fiber, Crude fat (Cfat), Total digestible nutrient (TDN), Nitrogen free extract (NFE), Acid
3. detergent fiber (ADF), Hemicellulose (Hemi),*Tithonia diversifolia* (T). Cassava leaves (CL),
4. Jackfruit skin (JS), Palm kernel cake (PKC), Palm kernel cake concentrate (PKCC)

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499 **Table 2.** Composition of ration and nutritional content of treatment ration

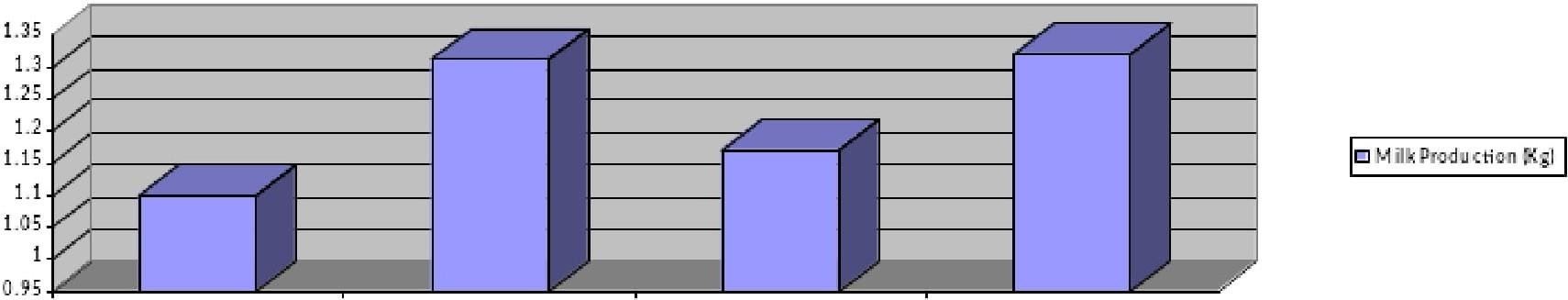
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Feedstuff |  | Treatments | |  |
| A | B | C | D |
| Company forages | 50 | 0 | 0 | 0 |
| *Tithonia diversifolia* | - | 25 | 25 | 25 |
| Cassava Leaves | - | 25 | 25 | 25 |
| PKCC | - | 10 | 20 | 30 |
| Company Concentrate | 50 | 40 | 30 | 20 |
| Total | 100 | 100 | 100 | 100 |
| Nutrient Composition |  |  |  |  |
| Dry Matter | 24.91 | 31.10 | 38.04 | 44.98 |
| Organic Matter | 92.43 | 90.54 | 89.87 | 89.20 |
| Crude Protein | 21.35 | 22.07 | 21.69 | 21.31 |
| Crude Fiber | 24.49 | 20.85 | 20.59 | 20.33 |
| NDF | 55.07 | 58.82 | 58.92 | 59.01 |
| Crude fat | 2.40 | 2.50 | 2.79 | 3.08 |
| TDN | 64.00 | 63.52 | 62.81 | 62.10 |
| NFE | 44.18 | 45.11 | 44.80 | 44.48 |
| Ash | 7.57 | 9.46 | 10.13 | 10.80 |
| Lignin | 8.05 | 5.31 | 5.27 | 5.22 |

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

501 kernel cake concentrate (PKCC)

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503 **Figure 1.** Milk Production of Etawa Crossbreed Dairy Goats Treatment



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505 **Table 4.** Quality of Etawa Crossbreed dairy Goat's Milk Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | A | Goat milk | |  |
|  | B | C | D |
| Ph | 6.23 | 6.32 | 6.36 | 6.52 |
| Fat level(%) | 4.52 | 4.44 | 3.91 | 5.29 |
| Lactose(%) | 4.52 | 4.44 | 3.91 | 5.29 |
| SNF(%) | 9.53 | 9.46 | 9.01 | 8.99 |
| Protein(%) | 3.46 | 3.44 | 3.28 | 3.26 |
| Specific Gravity | 1.033 | 1.032 | 1.031 | 1.030 |
| phosphorus(%) | 3.17 | 3.40 | 3.19 | 2.92 |
| Calcium(%) | 2.51 | 2.46 | 2.32 | 2.90 |
| Water content(%) | 14.05 | 13.89 | 12.91 | 14.28 |
| Dry matter (%) | 85.95 | 86.11 | 87.09 | 85.73 |

506 Solid non fat (SNF)

507 **Table 5.** Ration Intake of Etawa Crossbreed dairy Goats Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Intake  (Kg/e/day) |  | Treatment | |  |
| A | B | C | D |
| Dry Matter | 2.44 | 2.51 | 2.48 | 2.46 |
| Organic Matter | 2.20 | 2.27 | 2.25 | 2.21 |
| Crude Protein | 0.60 | 0.65 | 0.62 | 0.61 |

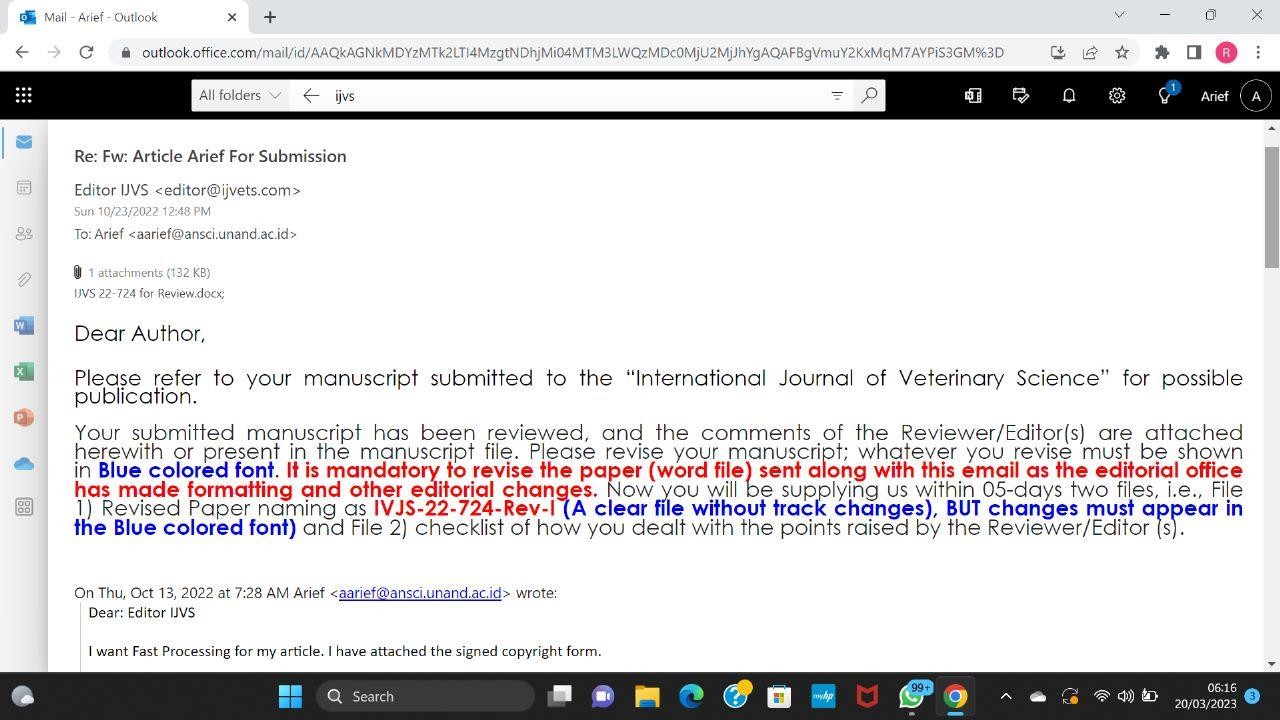
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509 **Table 6.** Digestibility of Etawa Crossbreed Dairy Goats Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Digestibility  (%) |  | Treatment | |  |
| A | B | C | D |
| Dry Matter | 65.85 | 66.17 | 67.23 | 67.98 |
| Organic Matter | 67.76 | 68.02 | 68.88 | 69.32 |
| Crude Protein | 69.56 | 70.34 | 71.38 | 71.97 |

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**Email dari Editor untuk Revisi (1)**



### Reviewer’s copy IJVS 22-724

1 **Lampiran Revisi Dari Editor dan Reviewer**

2

1. **Production Performance, Feed Intake and Nutrient Digestibility of Etawa Crosbreed**
2. **Dairy Goats Fed Tithonia (*Tithonia diversifolia*), Cassava Leaves and Palm Kernel Cake**
3. **Concentrate**

6

1. **Novelty:** This study found a ration formulation to optimize the production and quality of
2. dairy goats using titonia forage and cassava leaves as a source of forage, while the
3. concentrate was palm kernel cake concentrate.

## 10 Follow the green

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12 **ABSTRACT**

13

1. This research aimed at the intake, digestibility, production, and milk quality of Etawa
2. crossbreeds dairy goat (ECDG) fed conventional mixed forage; tithonia (*Tithonia*
3. *diversifolia*) (T) and cassava leaves (CL) with palm kernel cake concentrate (PKCC). A
4. completely randomized design (four treatments and four replications) was used in this study.
5. The treatments consisted of followings: A was company rations (50% company forages +
6. 50% company concentrate(CC)), B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL)

20 + 30% CC + 20% PKCC), D (50% (T+CL)+ 20% CC + 30% PKCC). The variables analyzed

1. were as follows; milk production, milk quality (total solid, lactose, protein, fat, solid non-fat,
2. water content, specific gravity, pH, Ca and P minerals), dry matter intake (DMI), organic
3. matter intake (OMI), crude protein intake (CPI), dry matter digestibility (DMD), organic
4. matter digestibility (OMD), crude protein digestibility (CPD). Data analysis used analysis of
5. variance—a further test to determine differences between treatments using Duncan's multiple
6. ranges. The analysis showed that the treatment had no significant effect (P>0.05) on feed
7. intake, digestibility, production, and milk quality. Using palm kernel cake concentrate and a
8. mixture of tithonia and cassava leaves was able to maintain the feed intake, feed digestibility,
9. production, and milk quality of ECDG.

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1. **Keywords**: cassava leaves, Etawa crossbreed dairy goat, milk production, palm kernel cake
2. concentrate, *Tithonia diversifolia*.

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**Comment [R1]:** Add conclusion of the study

**Comment [rp2]:** We have added conclusion at manuscript revisin

### Reviewer’s copy IJVS 22-724

34 **INTRODUCTION**

35

1. The availability of forage and the high price of concentrate are severe problems in
2. developing the Etawa crossbreed dairy goat (ECDG) farming. The increase in residential
3. areas impacts reducing forage for animal feed. At the same time, the price of concentrate is
4. getting more expensive day by day. ~~So~~So, it is necessary to find alternative sources of forage
5. and concentrates with high production and good nutritional quality.
6. Tithonia (*Tithonia diversifolia*) is a forage with good nutritional content (Pazla et al.
7. 2021a). The crude protein content is 22.89%, and organic matter is 84.01% (Pazla et al.
8. 2018a). Tithonia is also rich in P mineral, which can potentially increase the number of
9. rumen bacterial populations (Fasuyi et al. 2010; Adrizal et al. 2021; Pazla et al. 2021b;
10. ~~Adrizal et al. 2021~~). Oluwasola & Dairo (2016) reported that tithonia plants are also rich in
11. amino acids. The mixture of tithonia with elephant grass as a fiber source in ECDG ration can
12. optimize intake, digestibility, and milk production (Pazla et al. 2022).
13. Cassava leaves contain Branched Chain Amino Acids (BCAA) such as isoleucine, valine,
14. and leucine 4.4~~%~~, 8.43~~%~~, and 8.75%, respectively (Suyitman et al. 2017a). BCAAs increase
15. nutrient digestibility like dry matter, organic matter, and acid detergent fiber through the
16. growth of cellulolytic bacteria (Zain et al. 2002). Supplementation of cassava leaves on
17. ammoniated palm stems increased rumen microbial growth and ~~increased~~ digestibility of
18. DM, ADF, and neutral detergent fiber (NDF) (Nurhaita and ningrat, 2011). Suyitman et al.
19. (2020) reported that supplementing cassava leaves in Simmental cattle rations improved
20. digestibility and production performance.
21. Palm kernel cake concentrate (PKCC) is made from a mixture of feed ingredients that
22. have good nutrition for livestock growth and production, such as rice bran, corn, palm kernel
23. cake, and minerals. Energy (total digestible nutrient) and crude protein (CP) of PKCC are 60-
24. 64~~%~~ and 14-16%, respectively (Arief et al. 2020). This research aims to determine the impact
25. of replacing company forages with a mixture of cassava and tithonia and replacing company
26. concentrate with PKCC on intake, digestibility, production, and quality of ECDG.

62

1. **MATERIALS AND METHODS**
2. **Animal Ethics**
3. This research has referred to the ethics of research using livestock based on the law of the
4. government of the Republic of Indonesia Number 18 of 2009 article 66, which discusses
5. animal maintenance, killing, treatment, and reasonable care.

**Comment [R3]:** Add some more information on the need of alternative sources of forage and concentrate to justify importance and scope of your study.

**Comment [rp4]:** We have added literature to give information at the manuscript revision

**Comment [CH-AK-PAK5]:** Throughou t the paper, use no & but use "and"

**Comment [rp6]:** We have change it at the manuscript revisin

### Reviewer’s copy IJVS 22-724

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**Experimental Site**

This study was carried out on Toni Farm company, Payakumbuh, West Sumatra, Indonesia (-0.2330638,100.6268024, and 516 m asl); this area has two seasons (dry and rainy). The rainy season is from September to February, and summer is from March to August. This research was conducted in May – June 2022. The temperature of this area at the time of the study was in the range of 22-35 0°C.

**Animal Experiment and Feeding Formulation**

The livestock used in the study were 16 ECDG with an average body weight of 60±1.23 Kg and were in the second lactation, distributed in a completely randomized design with four treatments (ration formulation) and four replicates~~ions~~. The treatments consisted of followings: A was company ration as control (50% company forages + 50% company concentrate(CC)), B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC +

20% PKCC), D (50% (T+CL)+ 20% CC + 30% PKCC). The ratio of tithonia with cassava ~~is~~was 1:1

PKCC concentrate ~~is~~was made by formulating the following feed ingredients, namely 37% rice bran + 40% palm kernel cake + 22% corn, and 1% minerals. All materials were mixed homogeneously and stored in plastic at less than 12% moisture content.

The company forage was bush and native grass. The company's concentrate ~~is~~was made by formulating feed ingredients along with tofu dregs, jackfruit skin, and skinless cassava. All ingredients ~~are~~were stirred evenly and given in a fresh state. Meanwhile, forage company forages, cassava leaves, and tithonia were given three times a day: in the morning at 08.00, at noon at 13.00, and in the afternoon at 18.00. The concentrate ~~is~~was given twice daily, in the morning at 07.00 and noon.

The experimental ration was formulated based on the NRC (2007) to fulfill the nutrition of dairy goats weighing 60 Kg and having the capacity to produce 2-3 k~~K~~g of milk with 4% fat content per day. The chemical composition of each feed ingredient used is presented in Table

1. tThe composition of the feed ingredients in the treatment ration and the nutritional composition of the treatment ration are presented in Table 2.

Proximate analysis (dry matter, ash, crude protein, extract ether, and crude fiber) of research feed ingredients was carried out based on AOAC international (1995). Fiber

**Comment [CH-AK-PAK7]:** Write Kg as kg

**Comment [rp8]:** Thanks, we have change to kg

### Reviewer’s copy IJVS 22-724

1. fractions (cellulose, lignin, ADF, and NDF) were analyzed according to the technique
2. described by Van Soest (1982). TDN ~~is~~was calculated based on Moran (2005). The nitrogen-
3. free extract was calculated according to Jamarun et al. (2021).

106 TDN (%) = 5.31 +1.444 Cfat + 0.412 CP + 0.937 NFE + 0.249 CF

1. NFE= 100 - (ash+ CP+Cfat+CF)
2. Note:
3. TDN= tTotal digestible nutrient
4. CP= ~~c~~Crude protein
5. CF= ~~c~~Crude fiber
6. Cfat= ~~c~~Crude fat
7. NFE= ~~n~~Nitrogen-free extract.
8. The study lasted 45 days, divided into three periods: the adaptation period of 25 days, the
9. preliminary period of 15 days, and the 5-day collection period. The fresh ration intake was
10. calculated by calculating the difference between the amount of ration and the rest of the
11. ration.
12. DMI (Kg/h/day) = Fresh Intake \* DMCR
13. OMI (Kg/h/day) = DMI \* OMCR
14. CPI (Kg/h/day) = DMI \* CPCR
15. Note:
16. DMI= ~~d~~Dry matter intake
17. OMI= ~~o~~Organic matter intake
18. CPI= ~~c~~Crude protein intake
19. DMCR= ~~d~~Dry matter content of the ration
20. OMCR= ~~o~~Organic matter content of the ration
21. CPCR= ~~c~~Crude protein content of the ration
22. Feces were collected at 6 am. All fresh feces were weighed, 10% was taken for each
23. treatment, then dried in the sun. The dried feces were then ground into a fine powder for
24. analysis of chemical composition samples. The difference between ration intake and fecal
25. production calculates feed digestibility. The formula used is:
26. DMD (%) = (DMI- Feces)/ DMI \* 100%)

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1. OMD (%) = (OMI- Feces)/ OMI \* 100%)
2. CPD = (CPI- Feces)/ CPI \* 100%)
3. Goats were milked ~~two times~~twice a day, in the morning and evening, using a mechanical
4. milking machine. Milk production ~~is~~was calculated for five days during the collection period
5. in liters and converted to ~~k~~Kg and FCM (Fat Corrected Milk) 4% based on the formula of
6. Mavrogenis and Papachristoforou (1988):

144 4%FCM (Kg)= M (0.144+ 0.1444F)

1. Note:
2. M = ~~m~~Milk production in Kg
3. F= Fat content in %
4. During the collection period, 250 ml of milk samples was~~ere~~ taken for each treatment. The
5. components for the milk quality test (total solid (milk dry matter), protein, fat, lactose, solid
6. non-fat, specific gravity, and pH) were tested using Lactoscan Pro 202.
7. **Statistical Analysis**
8. A completely randomized design (Model) (Steel & Torrie, 1991) was used to analyze
9. intake, feed digestibility, production, and milk quality. The data were analyzed with the
10. analysis of variance using the Excel 2019 program at a significance level of @= 0.05.
11. Duncan's Advanced Multiple range tests were used to test the differences between treatments.
12. **RESULTS**
13. **Milk Production of Etawa Crossbreed Dairy Goats Treatment**
14. Replacement of company forages with a mixture of cassava and tithonia and replacement
15. of company concentrate with PKCC were not significantly different (P>0.05) in increasing
16. milk production. Using cassava leaves, tithonia, and PKCC is expected to increase milk
17. production. The average daily milk production results from replacing company forages with a
18. mixture of cassava leaves and tithonia and replacing company concentrate with PKCC in
19. various percentages are presented in Table 3. The analysis of the variance of the highest milk
20. production after being converted to 4% FCM was in treatment D, and the lowest was in
21. treatment A (control).

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1. **Milk Quality of Etawa Crossbreed dairy Goat Treatment**
2. The results of statistical analysis showed that there was no significant difference (P>0.05)
3. in all milk quality parameters. Replacing the company forages with a mixture of cassava and
4. tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The
5. average milk quality results from replacing company forages with a mixture of cassava leaves
6. and tithonia and replacing company concentrate with PKCC in various percentages are
7. presented in Table 4.
8. **Feed Intake of Etawa Crossbreed dairy Goats Treatment**
9. The analysis results of dry matter intake, organic matter intake, and crude protein intake by
10. replacing company concentrate with PKCC and replacing company forages with tithonia and
11. cassava leaves are presented in Table 5. Replacing company concentrate with PKCC and
12. replacing company forages with tithonia and cassava leaves in the ration gave no significant
13. difference (P>0.05) in each treatment on the value of dry matter intake, organic matter intake,
14. and crude protein intake.
15. **Digestibility of Etawa Crossbreed Dairy Goats Treatment**
16. The analysis results of dry matter digestibility (DMD), organic matter digestibility (OMD),
17. and crude protein digestibility (CPD) by replacing company concentrate with PKCC and
18. replacing company forages with tithonia, and cassava leaves are presented in Table 6. Table 6
19. shows that the treatment of replacing company concentrate with PKCC and replacing
20. company forages with a mixture of cassava leaves and tithonia had no significant effect
21. (P>0.05) on DMD, OMD, and CPD.
22. **DISCUSSION**
23. **Milk Production of Etawa Crossbreed Dairy Goats Treatment**
24. Replacement of company forages with a mixture of cassava and tithonia and replacement
25. of company concentrate with PKCC were not significantly different (P>0.05) in increasing
26. milk production. Milk production in dairy goats is strongly influenced by feed quality. Good
27. quality feed will increase milk production. Using cassava leaves, tithonia, and PKCC is
28. expected to increase milk production. ~~The average daily milk production results from~~
29. ~~replacing company forages with a mixture of cassava leaves and tithonia and replacing~~
30. ~~company concentrate with PKCC in various percentages are presented in Table 3.~~

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The analysis of the variance of the highest milk production after being converted to 4% FCM was in treatment D, and the lowest was in treatment A (control). The insignificant difference between treatments A, B, C, and D could be caused by the feed quality. The prepared rations had a crude protein that was not much different between A (21.35%) rations, B(22.07%), C(21.69%), and D (21.31%) rations (Table 2). The intake of feed protein also influences milk production. Saskia (2022) stated that feed protein plays a role in forming lactose. Lactose is water-binding, so the more lactose is formed, the more milk will be produced. In the research conducted, the lactose content obtained in each treatment was A=4.52%, B=4.44%, C=3.91%, and D= 5.29% (Tabel 4)

Good dairy goats have a high amount of milk production and are standardized at 4% FCM (Christi & Rohayati, 2018). From the average value of 4% FCM milk production, it can be seen that the highest production was in treatment D (1.32 kg/head/day). This indicates that after being standardized to 4% FCM, it turns out that treatment D has a high milk fat content, which affects the production of 4% FCM milk. Based on the results of the study, it was found that the milk fat content in each treatment was: A = 4.52%, B = 4.44%, C = 3.91%, and D = 5.29% (Table 4), with the highest increase in milk fat content in treatment D was thought to be because the fat from the D ration was higher from other rations (Table 2), causing high milk production as well. Milk production of 4% FCM is carried out to equalize the energy level in the milk content.

**Quality of Etawa Crossbreed dairy Goat's Milk Treatment**

Nutrient components in feed significantly affect the quality of milk. Good quality milk ~~is~~ ~~milk that~~ meets milk quality standards. The results of statistical analysis showed that there was no significant difference (P>0.05) in all milk quality parameters. Replacing the company forages with a mixture of cassava and tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The quality of milk produced in treatments A, B, C, and D was within the normal range based on Thai Agricultural Standards (2008). This value indicates that the response of ECDG to rations containing PKCC concentrate and forages of cassava leaves and tithonia is quite good.

The feed quality factors (TDN and CP), which were almost the same between treatments, were thought to be the reason the milk quality did not differ between treatments (P>0.05).

Arief et al. (2018a, ~~) and Arief et al. (~~2018b) strengthen the results of this study, whoich

states that ~~T~~the sort of feed influences the best of the milk produced, and the best of the feed will have an effect on the metabolism within~~side~~ the animal's frame in order that it influences the supply of electricity and vitamins for the synthesis of milk components. In addition, the

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same intake of dry matter, organic matter, and crude protein ~~between~~among treatments also caused no difference in the milk quality. The intake and digestibility of the same feed ~~will~~do not affect the final fermented product in the rumen. Volatile fatty acid (VFA) is a product of rumen fermentation. VFA manufacturing ~~will~~ offers enough strength for rumen bacteria to develop and grow (Jamarun et al. 2019) and the supply of uncooked substances for milk synthesis (Jamarun et al. 2020). The outcomes of this look also are much like the outcomes of studies via way of means by Pazla et al. (2022). They also found no difference in milk quality in ECDG given a mixture of tithonia forage with elephant grass with the addition of a concentrate consisting of corn, rice bran, tofu dregs, and palm kernel cake. Marques et al. (2022) also found the same quality of goat's milk when given forage with a combination of cassava and alfalfa.

**Feed Intake of Etawa Crossbreed ~~d~~Dairy Goats Treatment**

Intake of dry matter can produce energy for milk production because it contains food substances consisting of organic materials such as protein, fat, and carbohydrates (Jamarun et al. 2021). The analysis results of DMI, OMI, and CPI by replacing company concentrate with PKCC and replacing company forages with tithonia and cassava leaves are presented in Table

5. Replacing company concentrate with PKCC and replacing company forages with tithonia and cassava leaves in the ration ~~gave~~showed no significant difference (P>0.05) in each treatment on the value of DMI, OMI, and CPI. The insignificant difference in each treatment could be caused by the type of ration given. In replacing the company's concentrate with PKCC and company forages with tithonia and cassava leaves, it is necessary to pay attention to the dry matter content of each feed ingredient. The dry matter content of the company's concentrate is 23.81%, while the dry matter content of PKCC is 93.24% (Table 1). Meanwhile, the dry matter content of company forages with tithonia and cassava did not differ much. Of course, the difference in the substituted ingredients changed the form of an increase in the dry matter content of the ration (ration A 24.91%, ration B 31.10%, ration C 38.04%, and ration D 44.98%) (Table 2). However, there was an increase in the dry matter content of the ration, and it had no significant difference ~~A~~against intake. This is supported by Pazla et al. (2018b) that the amount of nutrient intake depends on the amount of dry matter in the feed consumed and the nutrient content of the feed given. In the research conducted, it was also observed that livestock have the ability to eat high feed, which is also influenced by the needs of the livestock themselves, following the opinion of Arief et al. (2021b), which states that the volume of feed needed by livestock, especially goats, depends on their ability to eat feed and total weight body. The results obtained were higher than that of Setyaningsih

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et al. (2013), whose average dry matter intake ~~is~~was 1.55-1.66 kg/e/day with an average body weight of 43 kg. This is presumably because the capacity of the livestock rumen influences dry matter intake.

Another factor that plays a role in dry matter intake is the level of palatability or livestock preference on the feed given. In this study, it was found that the level of palatability of tithonia, cassava leaves, and PKCC in its administration was favored by dairy goats. This is under the opinion of Pazla et al. (2021c) that the palatability of feed ~~will~~ directly affects interest and causes appetite in livestock. Flavour, texture, smell, and taste significantly affect palatability. Based on the observations made during the study, it was found that Tithonia, cassava leaves, and PKCC have a flavor. The intake of organic matter is in line with the intake of dry matter because organic matter is part of dry matter, which has been reduced by inorganic matter. The pattern of increasing and decreasing organic matter intake is strongly influenced by the components contained in dry matter (Kamalidin et al. 2012). This is also supported by Febrina et al. (2017) that organic matter is carefully associated with dry matter since organic matter is a part of dry matter; if the intake of dry matter from livestock is low, it will be followed by a low level of intake of organic matter as well. Intake of organic matter is also primarily determined by the constituent components of the organic material itself, namely crude protein, extract ether, and crude fiber.

High intake of dry matter is a factor that causes a high intake of organic matter, but the

factor that increases intake of organic matter is not only feed; livestock is also one of the factors that can increase intake of organic matter. The ability of livestock to eat feed and the level of preference is also a factor in increasing the intake of organic matter. Murni et al. (2012) stated that other factors influencing intake are animal body weight, feed digestibility, palatability, feed quality, and the age of livestock. Intake of crude protein that did not differ between treatments (P>0.05) was due to the protein content of the ration between treatments that were not much different (A=21.35%, B=22.07%, C=21.69%, D=21.31%) (Table 2). The intake of crude protein feed ~~will be~~is directly proportional to dry and organic matter intake. Pazla et al. (2021c) stated that feed protein positively correlated with dry matter, protein, and energy intake. The amount of feed consumed ~~will~~ affects other nutrients consumed. Martawidjaja et al. (1999) stated that the factors influencing feed protein intake are dry matter intake and protein content. Intake of crude protein in this study was higher than Marwah et al. (2010), who received crude protein intake of ECDG of 0.34 Kg/head/day by feeding *Calliandra calothyrsus* and concentrate, and Krisnan et al. (2015), who

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~~received~~reported 0.24 kg/head/day by feeding *Pennisetum purpupoides*, *Leucaena leucocephala* and concentrates.

**Digestibility of Etawa Crossbreed Dairy Goats Treatment**

Table 6 shows that the treatment of replacing company concentrate with PKCC and replacing company forages with a mixture of cassava leaves and tithonia had no significant effect (P>0.05) on DMD, OMD, and CPD. The non-significant difference between treatments was due to the lignin content of the A, B, C, and D rations not being much different. The difference in the lignin content of the ration is only 2.83%. In addition, the lignin content of tithonia and cassava is lower than that of the company forages. In contrast, the lignin content of PKCC is not much different from that of the firm concentrate. High lignin content in livestock rations ~~will~~ reduces digestibility because lignin is a timber substance that cannot be digested using rumen microbes (Pazla et al. 2020; Pazla et al. 2021d).

The chemical composition of the ration also influences the digestibility of dry matter, organic matter, and crude protein. The chemical composition of rations A, B, C, and D is almost identical. The rations of this study were prepared with a TDN content of 62-64%. In digesting feed ingredients, sufficient and balanced protein and energy are needed for rumen microbial activity to digest food substances, including dry matter, organic matter, and crude protein. Crude protein ~~will~~ undergos fermentation in the rumen, which produces ammonia (NH3) (Suyitman et al. 2021). NH3 increases the rumen's microbial population (Putri et al. 2019; Putri et al. 2021). TDN derived from the diet acts as an energy source for rumen microbes.

The large population of rumen microbes ~~will~~ affects the digestibility of food

substances so that the same protein and TDN composition in the treatment rations ~~will~~ cause the digestibility of dry matter, organic matter, and crude protein to be relatively the same and give an effect that is not significantly different (P>0.05). This follows the opinion of Jamarun et al. (2017), which states that feed digestibility is influenced by the ration composition and the activity of microorganisms.

**Conclusion**

Replacement of company forages with a mixture of cassava and tithonia and replacement of company concentrate with PKCC did not affect the intake, digestibility, production, and quality of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and tithonia)

+ 10% company concentrate + 40% PKCC was able to maintain the intake, digestibility, production, and quality of Etawa crossbreed dairy goat milk.

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**Author Contributions**

Conceptualization: Arief and Roni Pazla, Data Curation: Roni Pazla. Formal analysis: Roni Pazla and Rizqan. Funding acquisition: Arief and Novirman Jamarun. Methodology: Arief, Roni Pazla, and Novirman JAmarun. Project administration: Rizqan. Supervision: Arief and Novirman Jamarun. Validation: Roni Pazla. Writing-original draft: Roni Pazla and Arif. Writing-review & editing: Rizqan.

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|  |  |  |  |  |  | | |  |  |  |  |
| 511 | **Table 1:** Chemic | al comp | osition | of feed i | ngredients  Feed stuff | | |  |  |  | **Format** |
| Nutrients  (%) | Company  forages | T | CL | JS | Rice bran | Tofu waste | PKC | Corn | PKCC | sSkinless cassava | Company Concentrate |
| DM | 26.03 | 23.13 | 26.21 | 13.01 | 87.8 | 28.4 | 91.83 | 85.8 | 93.24 | 29.04 | 23.81 |
| OM | 87.93 | 84.65 | 86.33 | 95.02 | 90.8 | 97.67 | 91.41 | 99.1 | 90.23 | 98.78 | 96.92 |
| CP | 25.43 | 25.07 | 30.18 | 12.06 | 10.72 | 20.11 | 12.36 | 7.70 | 13.46 | 11.66 | 17.27 |
| CF | 28.02 | 22.62 | 19.92 | 28.01 | 11.6 | 19 | 26.68 | 2.44 | 18.33 | 4.28 | 20.98 |
| NDF | 48.27 | 55.03 | 56.13 | 71.54 | 55.13 | 59.28 | 66.7 | 49.96 | 62.84 | 37.38 | 61.86 |
| Cfat | 2.73 | 1.62 | 3.10 | 4.00 | 8.73 | 1.25 | 8.23 | 3.50 | 4.96 | 1.13 | 2.07 |
| TDN | 54.53 | 53.54 | 56.44 | 68.8 | 66.63 | 74.61 | 65.4 | 81.9 | 66.36 | 86.53 | 73.46 |
| NFE | 31.75 | 35.34 | 33.13 | 50.93 | 59.75 | 57.31 | 44.14 | 85.46 | 53.48 | 81.71 | 56.62 |
| ASH | 12.07 | 15.35 | 13.67 | 5.00 | 9.2 | 2.33 | 8.59 | 0.90 | 9.77 | 1.22 | 3.08 |
| ADF | 36.45 | 34.2 | 33.69 | 58.55 | 29.35 | 26.65 | 46.10 | 36.76 | 36.02 | 8.92 | 35.33 |
| Hemi | 11.82 | 20.83 | 22.44 | 12.99 | 25.78 | 32.63 | 20.60 | 13.20 | 26.82 | 28.46 | 26.53 |
| Lignin | 11.72 | 5.81 | 6.87 | 8.54 | 06.90 | 2.3 | 17.29 | 07.50 | 3.92 | 6.49 | 4.38 |
| Cellulose | 24.4 | 27.54 | 28.48 | 24.46 | 15.52 | 22.93 | 43.25 | 29.52 | 16.97 | 14.07 | 22.95 |

1. Dry matter (DM), Organic matter (OM), Crude protein (CP), Crude fiber (CF), Neutral
2. detergent fiber, Crude fat (Cfat), Total digestible nutrient (TDN), Nitrogen free extract
3. (NFE), Acid detergent fiber (ADF), Hemicellulose (Hemi), *Tithonia diversifolia* (T). Cassava
4. leaves (CL), Jackfruit skin (JS), Palm kernel cake (PKC), Palm kernel cake concentrate
5. (PKCC)

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**Table 2.** Composition of ration and nutritional content of treatment ration

Treatments

Feedstuff

A B C D

Company fForages 50 0 0 0

*Tithonia diversifolia* - 25 25 25

Cassava Leaves - 25 25 25

PKCC - 10 20 30

Company Concentrate 50 40 30 20

Total 100 100 100 100

Nutrient Composition

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Dry Matter 24.91 31.10 38.04 44.98

Organic Matter 92.43 90.54 89.87 89.20

Crude Protein 21.35 22.07 21.69 21.31

Crude Fiber 24.49 20.85 20.59 20.33

NDF 55.07 58.82 58.92 59.01

Crude fFat 2.40 2.50 2.79 3.08

TDN 64.00 63.52 62.81 62.10

NFE 44.18 45.11 44.80 44.48

Ash 7.57 9.46 10.13 10.80

Lignin 8.05 5.31 5.27 5.22

1. Neutral detergent fiber, Total digestible nutrient (TDN), Nitrogen free extract (NFE), Palm
2. kernel cake concentrate (PKCC)

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**~~Figure 1.~~** ~~Milk Production of Etawa Crossbreed Dairy Goats Treatment~~

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Fig. :~~1~~.** Milk Production of  mean+SE/SD with ba  **Table 4.** Quality of Etawa Parameter | Etawa Crossbree  rs because th  Crossbreed ~~d~~Dairy | d Dairy Goats Treatment; There ese are not reading of one  Goat's Milk Treatment Goat milk | | should be gaot |
|  |  |  |  |
| A | B | C | D |
| pH~~Ph~~ | 6.23 | 6.32 | 6.36 | 6.52 |
| Fat lLevel (%) | 4.52 | 4.44 | 3.91 | 5.29 |
| Lactose (%) | 4.52 | 4.44 | 3.91 | 5.29 |
| SNF (%) | 9.53 | 9.46 | 9.01 | 8.99 |
| Protein (%) | 3.46 | 3.44 | 3.28 | 3.26 |
| Specific ~~G~~Gravity | 1.033 | 1.032 | 1.031 | 1.030 |
| Phosphorus (%) | 3.17 | 3.40 | 3.19 | 2.92 |
| Calcium (%) | 2.51 | 2.46 | 2.32 | 2.90 |
| Water ~~c~~Content (%) | 14.05 | 13.89 | 12.91 | 14.28 |
| Dry ~~m~~Matter (%) | 85.95 | 86.11 | 87.09 | 85.73 |

Solid non-fat (SNF)

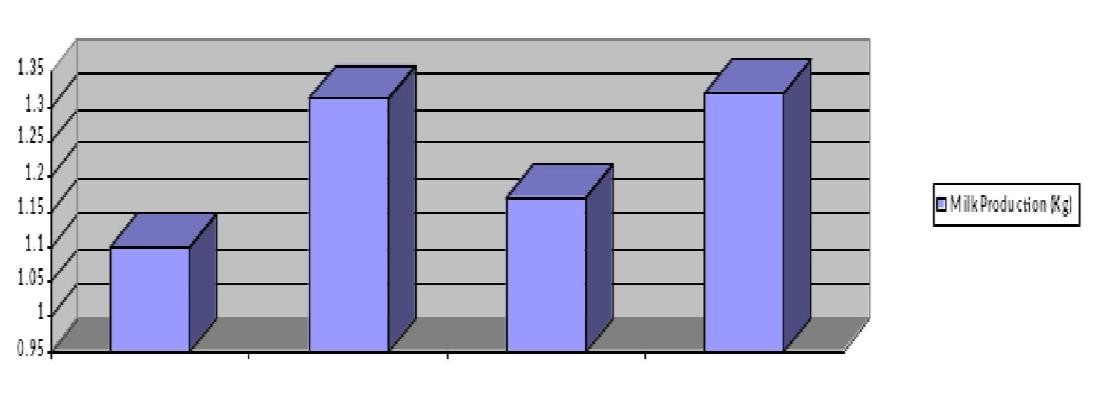
**Table 5.** Ration Intake of Etawa Crossbreed ~~d~~Dairy Goats Treatment

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**Comment [rp25]:** We have added meam +SD at manuscript revision

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Intake |  |  | Treatment |  | |
| (k~~K~~g/e/day) | A | B |  | C | D |
| Dry Matter | 2.44 | 2.51 |  | 2.48 | 2.46 |

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Organic Matter | 2.20 | 2.27 | 2.25 | 2.21 |
|  | Crude Protein | 0.60 | 0.65 | 0.62 | 0.61 |

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| --- | --- | --- | --- | --- |
| **Table 6.** Digestibility Digestibility  (%) | of Etawa Crossbr | eed Dairy Goats Treatment  Treatment | |  |
| A | B | C | D |
| Dry Matter | 65.85 | 66.17 | 67.23 | 67.98 |
| Organic Matter | 67.76 | 68.02 | 68.88 | 69.32 |
| Crude Protein | 69.56 | 70.34 | 71.38 | 71.97 |

## Missing in all tables except Tables 1 and 2: Mean+SD/SE; statistical analysis?

**Comment [rp26]:** We have added Mean + SD and statistical analysis have is describes on the result and discussion. There is no significant between treatments (P>0.05)

#### Hasil Revisi ke 1

* 1. **Production Performance, Feed Intake and Nutrient Digestibility of Etawa Crosbreed**
  2. **Dairy Goats Fed Tithonia (*Tithonia diversifolia*), Cassava Leaves and Palm Kernel Cake**

#### Concentrate

5

1. **Novelty:** This study found a ration formulation to optimize the production and quality of
2. dairy goats using titonia forage and cassava leaves as a source of forage, while the
3. concentrate was palm kernel cake concentrate.

9

10 **ABSTRACT**

11

1. This research aimed at the intake, digestibility, production, and milk quality of Etawa
2. crossbreeds dairy goat (ECDG) fed conventional mixed forage; tithonia (*Tithonia*
3. *diversifolia*) (T) and cassava leaves (CL) with palm kernel cake concentrate (PKCC). A
4. completely randomized design (four treatments and four replications) was used in this study.
5. The treatments consisted of followings: A was company rations (50% company forages +
6. 50% company concentrate(CC)), B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL)

18 + 30% CC + 20% PKCC), D (50% (T+CL)+ 20% CC + 30% PKCC). The variables analyzed

1. were as follows; milk production, milk quality (total solid, lactose, protein, fat, solid non-fat,
2. water content, specific gravity, pH, Ca and P minerals), dry matter intake (DMI), organic
3. matter intake (OMI), crude protein intake (CPI), dry matter digestibility (DMD), organic
4. matter digestibility (OMD), crude protein digestibility (CPD). Data analysis used analysis of
5. variance—a further test to determine differences between treatments using Duncan's multiple
6. ranges. The Analysis showed that the treatment had no significant effect (P>0.05) on feed
7. intake, digestibility, production, and milk quality. Using palm kernel cake concentrate and a
8. mixture of tithonia and cassava leaves was able to maintain the feed intake, feed digestibility,
9. production, and milk quality of ECDG. The conclusion of this study is that by replacing
10. Replacement of company forages with a mixture of cassava and tithonia and replacement of
11. company concentrate with PKCC did not affect the intake, digestibility, production, and
12. quality of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and
13. tithonia) + 10% company concentrate + 40% PKCC was able to maintain the intake,
14. digestibility, production, and quality of Etawa crossbreed dairy goat milk.

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1. **Keywords**: cassava leaves, Etawa crossbreed dairy goat, milk production, palm kernel cake
2. concentrate, *Tithonia diversifolia*.

36

#### 37 INTRODUCTION

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1. The availability of forage and the high price of concentrate are severe problems in
2. developing the Etawa crossbreed dairy goat (ECDG) farming. The increase in residential
3. areas impacts reducing forage for animal feed. At the same time, the price of concentrate is
4. getting more expensive day by day. Arief et al. (2018a) stated that alternative feed
5. exploration is very urgent to increase productivity and efficiency of livestock business. So, it
6. is necessary to find alternative sources of forage and concentrates with high production and
7. good nutritional quality.
8. Tithonia (*Tithonia diversifolia*) is a forage with good nutritional content (Pazla et al.
9. 2021a). The crude protein content is 22.89%, and organic matter is 84.01% (Pazla et al.
10. 2018a). Tithonia is also rich in P mineral, which can potentially increase the number of
11. rumen bacterial populations (Fasuyi et al. 2010; Adrizal et al. 2021; Pazla et al. 2021b).
12. Oluwasola and Dairo (2016) reported that tithonia plants are also rich in amino acids. The
13. mixture of tithonia with elephant grass as a fiber source in ECDG ration can optimize intake,
14. digestibility, and milk production (Pazla et al. 2022).
15. Cassava leaves contain Branched Chain Amino Acids (BCAA) such as isoleucine, valine,
16. and leucine 4.4, 8.43, and 8.75%, respectively (Suyitman et al. 2017a). BCAAs increase
17. nutrient digestibility like dry matter, organic matter, and acid detergent fiber through the
18. growth of cellulolytic bacteria (Zain et al. 2002). Supplementation of cassava leaves on
19. ammoniated palm stems increased rumen microbial growth and digestibility of DM, ADF,
20. and neutral detergent fiber (NDF) (Nurhaita and ningrat 2011). Suyitman et al. (2020)
21. reported that supplementing cassava leaves in Simmental cattle rations improved digestibility
22. and production performance.
23. Palm kernel cake concentrate (PKCC) is made from a mixture of feed ingredients that
24. have good nutrition for livestock growth and production, such as rice bran, corn, palm kernel
25. cake, and minerals. Energy (total digestible nutrient) and crude protein (CP) of PKCC are 60-
26. 64 and 14-16%, respectively (Arief et al. 2020). This research aims to determine the impact
27. of replacing company forages with a mixture of cassava and tithonia and replacing company
28. concentrate with PKCC on intake, digestibility, production, and quality of ECDG.

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#### Animal Ethics

**MATERIALS AND METHODS**

1. This research has referred to the ethics of research using livestock based on the law of the
2. government of the Republic of Indonesia Number 18 of 2009 article 66, which discusses
3. animal maintenance, killing, treatment, and reasonable care.

73

#### 74 Experimental Site

75

1. This study was carried out on Toni Farm company, Payakumbuh, West Sumatra,
2. Indonesia (-0.2330638,100.6268024, and 516 m asl); this area has two seasons (dry and
3. rainy). The rainy season is from September to February, and summer is from March to
4. August. This research was conducted in May – June 2022. The temperature of this area at the
5. time of the study was in the range of 22-35°C.

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82

#### Animal Experiment and Feeding Formulation

1. The livestock used in the study were 16 ECDG with an average body weight of 60±1.23
2. Kg and were in the second lactation, distributed in a completely randomized design with four
3. treatments (ration formulation) and four replicates. The treatments consisted of followings:
4. A was company ration as control (50% company forages + 50% company concentrate(CC)),

88 B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC + 20% PKCC), D

1. (50% (T+CL)+ 20% CC + 30% PKCC). The ratio of tithonia with cassava was 1:1
2. PKCC concentrate was made by formulating the following feed ingredients, namely 37%
3. rice bran + 40% palm kernel cake + 22% corn, and 1% minerals. All materials were mixed
4. homogeneously and stored in plastic at less than 12% moisture content.
5. The company forage was bush and native grass. The company's concentrate was made by
6. formulating feed ingredients along with tofu dregs, jackfruit skin, and skinless cassava. All
7. ingredients were stirred evenly and given in a fresh state. Meanwhile, forage company
8. forages, cassava leaves, and tithonia were given three times a day: in the morning at 08.00, at
9. noon at 13.00, and in the afternoon at 18.00. The concentrate was given twice daily, in the
10. morning at 07.00 and noon.
11. The experimental ration was formulated based on the NRC (2007) to fulfill the nutrition of
12. dairy goats weighing 60 kg and having the capacity to produce 2-3kg of milk with 4% fat
13. content per day. The chemical composition of each feed ingredient used is presented in Table
14. 1. The composition of the feed ingredients in the treatment ration and the nutritional
15. composition of the treatment ration are presented in Table 2.
16. Proximate analysis (dry matter, ash, crude protein, extract ether, and crude fiber) of
17. research feed ingredients was carried out based on AOAC international (1995). Fiber
18. fractions (cellulose, lignin, ADF, and NDF) were analyzed according to the technique
19. described by Van Soest (1982). TDN was calculated based on Moran (2005). The nitrogen-
20. free extract was calculated according to Jamarun et al. (2021).

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| --- | --- | --- |
| 109 |  | |
| 110 |  | TDN (%) = 5.31 +1.444 Cfat + 0.412 CP + 0.937 NFE + 0.249 CF |
| 111 |  | NFE= 100 - (ash+ CP+Cfat+CF) |
| 112 | Note: |  |
| 113 |  | TDN= Total digestible nutrient |
| 114 |  | CP= Crude protein |
| 115 |  | CF= Crude fiber |
| 116 |  | Cfat= Crude fat |
| 117 |  | NFE= Nitrogen-free extract. |
| 118 |  |  |

1. The study lasted 45 days, divided into three periods: the adaptation period of 25 days, the
2. preliminary period of 15 days, and the 5-day collection period. The fresh ration intake was
3. calculated by calculating the difference between the amount of ration and the rest of the
4. ration.
5. DMI (Kg/h/day) = Fresh Intake \* DMCR
6. OMI (Kg/h/day) = DMI \* OMCR
7. CPI (Kg/h/day) = DMI \* CPCR
8. 126
9. Note:
10. DMI= Dry matter intake
11. OMI= Organic matter intake
12. CPI= Crude protein intake
13. DMCR= Dry matter content of the ration
14. OMCR= Organic matter content of the ration
15. CPCR= Crude protein content of the ration
16. 134
17. Feces were collected at 6am. All fresh feces were weighed, 10% was taken for each
18. treatment, then dried in the sun. The dried feces were then ground into a fine powder for
19. analysis of chemical composition samples. The difference between ration intake and fecal
20. production calculates feed digestibility. The formula used is:
21. DMD (%) = (DMI- Feces)/ DMI \* 100%)
22. OMD (%) = (OMI- Feces)/ OMI \* 100%)
23. CPD = (CPI- Feces)/ CPI \* 100%)
24. 142
25. Goats were milked twice a day, in the morning and evening, using a mechanical milking
26. machine. Milk production was calculated for five days during the collection period in liters
27. and converted to Kg and FCM (Fat Corrected Milk) 4% based on the formula of Mavrogenis
28. and Papachristoforou (1988):
29. 147

148 4%FCM (Kg)= M (0.144+ 0.1444F)

1. Note:
2. M = Milk production in Kg
3. F= Fat content in %
4. 152
5. During the collection period, 250ml of milk samples was taken for each treatment. The
6. components for the milk quality test (total solid (milk dry matter), protein, fat, lactose, solid
7. non-fat, specific gravity, and pH) were tested using Lactoscan Pro 202.
8. 156

#### Statistical Analysis

1. A completely randomized design (Model) (Steel and Torrie 1991) was used to analyze
2. intake, feed digestibility, production, and milk quality. The data were analyzed with the study
3. concludes that of variance using the Excel 2019 program at a significance level of @=0.05.
4. Duncan's Advanced Multiple range tests were used to test the differences between treatments.
5. 162

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| --- | --- |
| 163 | **RESULTS** |
| 164 |  |
| 165 | **Milk Production of Etawa Crossbreed Dairy Goats Treatment** |
| 166 | Replacement of company forages with a mixture of cassava and tithonia and replacement |
| 167 | of company concentrate with PKCC were not significantly different (P>0.05) in increasing |
| 168 | milk production. Using cassava leaves, tithonia, and PKCC is expected to increase milk |

1. production. The average daily milk production results from replacing company forages with a
2. mixture of cassava leaves and tithonia and replacing company concentrate with PKCC in
3. various percentages are presented in Table 3. The study concludes that of the variance of the
4. highest milk production after being converted to 4% FCM was in treatment D, and the lowest
5. was in treatment A (control).
6. 174

#### Milk Quality of Etawa Crossbreed dairy Goat Treatment

1. The results of statistical analysis showed that there was no significant difference (P>0.05)
2. in all milk quality parameters. Replacing the company forages with a mixture of cassava and
3. tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The
4. average milk quality results from replacing company forages with a mixture of cassava leaves
5. and tithonia and replacing company concentrate with PKCC in various percentages are
6. presented in Table 4.

#### Feed Intake of Etawa Crossbreed dairy Goats Treatment

1. The study concludes that results of dry matter intake, organic matter intake, and crude
2. protein intake by replacing company concentrate with PKCC and replacing company forages
3. with tithonia and cassava leaves are presented in Table 5. Replacing company concentrate
4. with PKCC and replacing company forages with tithonia and cassava leaves in the ration
5. gave no significant difference (P>0.05) in each treatment on the value of dry matter intake,
6. organic matter intake, and crude protein intake.

#### Digestibility of Etawa Crossbreed Dairy Goats Treatment

1. The study concludes that results of dry matter digestibility (DMD), organic matter
2. digestibility (OMD), and crude protein digestibility (CPD) by replacing company concentrate
3. with PKCC and replacing company forages with tithonia, and cassava leaves are presented in
4. Table 6. Table 6 shows that the treatment of replacing company concentrate with PKCC and
5. replacing company forages with a mixture of cassava leaves and tithonia had no significant
6. effect (P>0.05) on DMD, OMD, and CPD.
7. 196

#### DISCUSSION

1. 198

#### Milk Production of Etawa Crossbreed Dairy Goats Treatment

1. Replacement of company forages with a mixture of cassava and tithonia and replacement
2. of company concentrate with PKCC were not significantly different (P>0.05) in increasing
3. milk production. Milk production in dairy goats is strongly influenced by feed quality. Good
4. quality feed will increase milk production. Using cassava leaves, tithonia, and PKCC is
5. expected to increase milk production.
6. The study concludes that of the variance of the highest milk production after being
7. converted to 4% FCM was in treatment D, and the lowest was in treatment A (control). The
8. insignificant difference between treatments A, B, C, and D could be caused by the feed
9. quality. The prepared rations had a crude protein that was not much different between A

209 (21.35%) rations, B (22.07%), C (21.69%), and D (21.31%) rations (Table 2). The intake of

1. feed protein also influences milk production. Saskia (2022) stated that feed protein plays a
2. role in forming lactose. Lactose is water-binding, so the more lactose is formed, the more
3. milk will be produced. In the research conducted, the lactose content obtained in each

213 treatment was A=4.52%, B=4.44%, C=3.91%, and D= 5.29% (Table 4)

1. Good dairy goats have a high amount of milk production and are standardized at 4% FCM
2. (Christi & Rohayati 2018). From the average value of 4% FCM milk production, it can be
3. seen that the highest production was in treatment D (1.32 kg/head/day). This indicates that
4. after being standardized to 4% FCM, it turns out that treatment D has a high milk fat content,
5. which affects the production of 4% FCM milk. Based on the results of the study, it was found
6. that the milk fat content in each treatment was: A = 4.52%, B = 4.44%, C = 3.91%, and D =
7. 5.29% (Table 4), with the highest increase in milk fat content in treatment D was thought to
8. be because the fat from the D ration was higher from other rations (Table 2), causing high
9. milk production as well. Milk production of 4% FCM is carried out to equalize the energy
10. level in the milk content.

#### Quality of Etawa Crossbreed dairy Goat's Milk Treatment

1. Nutrient components in feed significantly affect the quality of milk. Good quality milk
2. meets milk quality standards. The results of statistical analysis showed that there was no
3. significant difference (P>0.05) in all milk quality parameters. Replacing the company forages
4. with a mixture of cassava and tithonia and replacing the company's concentrate with PKCC
5. did not affect milk quality. The quality of milk produced in treatments A, B, C, and D was
6. within the normal range based on Thai Agricultural Standards (2008). This value indicates
7. that the response of ECDG to rations containing PKCC concentrate and forages of cassava
8. leaves and tithonia is quite good.
9. The feed quality factors (TDN and CP), which were almost the same between treatments,
10. were thought to be the reason the milk quality did not differ between treatments (P>0.05).
11. Arief et al. (2018a) strengthened this study, stated that the sort of feed influences the milk
12. produced. The good feed also improve animal metabolism by increasing the supply of
13. electricity and vitamins for the synthesis of milk components (Arief et al. 2018b). In addition,
14. the same intake of dry matter, organic matter, and crude protein among treatments also
15. caused no difference in the milk quality. The intake and digestibility of the same feed do not
16. affect the final fermented product in the rumen. Volatile fatty acid (VFA) is a product of
17. rumen fermentation. VFA manufacturing offers enough strength for rumen bacteria to
18. develop and grow (Jamarun et al. 2019) and the supply of uncooked substances for milk
19. synthesis (Jamarun et al. 2020). This results are similar with the study from Pazla et al.
20. (2022). They also found no difference in milk quality in ECDG given a mixture of tithonia
21. forage with elephant grass with the addition of a concentrate consisting of corn, rice bran,
22. tofu dregs, and palm kernel cake. Marques et al. (2022) also found the same quality of goat's
23. milk when given forage with a combination of cassava and alfalfa.

#### Feed Intake of Etawa Crossbreed Dairy Goats Treatment

1. Intake of dry matter can produce energy for milk production because it contains food
2. substances consisting of organic materials such as protein, fat, and carbohydrates (Jamarun et
3. al. 2021). The study concludes that results of DMI, OMI, and CPI by replacing company
4. concentrate with PKCC and replacing company forages with tithonia and cassava leaves are
5. presented in Table 5. Replacing company concentrate with PKCC and replacing company
6. forages with tithonia and cassava leaves in the ration showed no significant difference
7. (P>0.05) in each treatment on the value of DMI, OMI, and CPI. The insignificant difference
8. in each treatment could be caused by the type of ration given. In replacing the company's
9. concentrate with PKCC and company forages with tithonia and cassava leaves, it is necessary
10. to pay attention to the dry matter content of each feed ingredient. The dry matter content of
11. the company's concentrate is 23.81%, while the dry matter content of PKCC is 93.24%
12. (Table 1). Meanwhile, the dry matter content of company forages with tithonia and cassava
13. did not differ much. Of course, the difference in the substituted ingredients changed the form
14. of an increase in the dry matter content of the ration (ration A 24.91%, ration B 31.10%,
15. ration C 38.04%, and ration D 44.98%) (Table 2). However, there was an increase in the dry
16. matter content of the ration, and it had no significant difference against intake. This is
17. supported by Pazla et al. (2018b) that the amount of nutrient intake depends on the amount of
18. dry matter in the feed consumed and the nutrient content of the feed given. In the research
19. conducted, it was also observed that livestock have the ability to eat high feed, which is also
20. influenced by the needs of the livestock themselves, following the opinion of Arief et al.
21. (2021b), which states that the volume of feed needed by livestock, especially goats, depends
22. on their ability to eat feed and total weight body. The results obtained were higher than that
23. of Setyaningsih et al. (2013), whose average dry matter intake was 1.55-1.66 kg/e/day with
24. an average body weight of 43 kg. This is presumably because the capacity of the livestock
25. rumen influences dry matter intake.
26. Another factor that plays a role in dry matter intake is the level of palatability or livestock
27. preference on the feed given. In this study, it was found that the level of palatability of
28. tithonia, cassava leaves, and PKCC in its administration was favored by dairy goats. This is
29. under the opinion of Pazla et al. (2021c) that the palatability of feed directly affects interest
30. and causes appetite in livestock. Flavor, texture, smell, and taste significantly affect
31. palatability. Based on the observations made during the study, it was found that Tithonia,
32. cassava leaves, and PKCC have a flavor. The intake of organic matter is in line with the
33. intake of dry matter because organic matter is part of dry matter, which has been reduced by
34. inorganic matter. The pattern of increasing and decreasing organic matter intake is strongly
35. influenced by the components contained in dry matter (Kamalidin et al. 2012). This is also
36. supported by Febrina et al. (2017) that organic matter is carefully associated with dry matter
37. since organic matter is a part of dry matter; if the intake of dry matter from livestock is low, it
38. will be followed by a low level of intake of organic matter as well. Intake of organic matter is
39. also primarily determined by the constituent components of the organic material itself,
40. namely crude protein, extract ether, and crude fiber.
41. High intake of dry matter is a factor that causes a high intake of organic matter, but the
42. factor that increases intake of organic matter is not only feed; livestock is also one of the
43. factors that can increase intake of organic matter. The ability of livestock to eat feed and the
44. level of preference is also a factor in increasing the intake of organic matter. Murni et al.
45. (2012) stated that other factors influencing intake are animal body weight, feed digestibility,
46. palatability, feed quality, and the age of livestock. Intake of crude protein that did not differ
47. between treatments (P>0.05) was due to the protein content of the ration between treatments

296 that were not much different (A=21.35%, B=22.07%, C=21.69%, D=21.31%) (Table 2). The

1. intake of crude protein feed is directly proportional to dry and organic matter intake. Pazla et
2. al. (2021c) stated that feed protein positively correlated with dry matter, protein, and energy
3. intake. The amount of feed consumed affects other nutrients consumed. Martawidjaja et al.
4. (1999) stated that the factors influencing feed protein intake are dry matter intake and protein
5. content. Intake of crude protein in this study was higher than Marwah et al. (2010), who
6. received crude protein intake of ECDG of 0.34 Kg/head/day by feeding *Calliandra*
7. *calothyrsus* and concentrate, and Krisnan et al. (2015), who reported 0.24 kg/head/day by
8. feeding *Pennisetum purpupoides*, *Leucaena leucocephala* and concentrates.

|  |  |
| --- | --- |
| 305 |  |
| 306 | **Digestibility of Etawa Crossbreed Dairy Goats Treatment** |
| 307 | Table 6 shows that the treatment of replacing company concentrate with PKCC and |
| 308 | replacing company forages with a mixture of cassava leaves and tithonia had no significant |
| 309 | effect (P>0.05) on DMD, OMD, and CPD. The non-significant difference between treatments |
| 310 | was due to the lignin content of the A, B, C, and D rations not being much different. The |
| 311 | difference in the lignin content of the ration is only 2.83%. In addition, the lignin content of |
| 312 | tithonia and cassava is lower than that of the company forages. In contrast, the lignin content |
| 313 | of PKCC is not much different from that of the firm concentrate. High lignin content in |
| 314 | livestock rations reduces digestibility because lignin is a timber substance that cannot be |
| 315 | digested using rumen microbes (Pazla et al. 2020; Pazla et al. 2021d). |
| 316 | The chemical composition of the ration also influences the digestibility of dry matter, |
| 317 | organic matter, and crude protein. The chemical composition of rations A, B, C, and D is |
| 318 | almost identical. The rations of this study were prepared with a TDN content of 62-64%. In |
| 319 | digesting feed ingredients, sufficient and balanced protein and energy are needed for rumen |
| 320 | microbial activity to digest food substances, including dry matter, organic matter, and crude |
| 321 | protein. Crude protein undergos fermentation in the rumen, which produces ammonia (NH3) |
| 322 | (Suyitman et al. 2021). NH3 increases the rumen's microbial population (Putri et al. 2019; |
| 323 | Putri et al. 2021). TDN derived from the diet acts as an energy source for rumen microbes. |
| 324 | The large population of rumen microbes affects the digestibility of food substances. The same |
| 325 | protein and TDN composition in the treatment rations causes the digestibility of dry matter, |
| 326 | organic matter, and crude protein to be relatively the same (P>0.05). This follows the opinion |
| 327 | of Jamarun et al. (2017), which states that feed digestibility is influenced by the ration |
| 328 | composition and the activity of microorganisms. |
| 329  330 | **Conclusion** |
| 331 | Replacement of company forages with a mixture of cassava and tithonia and replacement of |
| 332 | company concentrate with PKCC did not affect the intake, digestibility, production, and |
| 333 | quality of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and tithonia) |
| 334 | + 10% company concentrate + 40% PKCC was able to maintain the intake, digestibility, |
| 335 | production, and quality of Etawa crossbreed dairy goat milk. |
| 336  337 | **Author Contributions** |

1. Conceptualization: Arief and Roni Pazla, Data Curation: Roni Pazla. Formal analysis: Roni
2. Pazla and Rizqan. Funding acquisition: Arief and Novirman Jamarun. Methodology: Arief,
3. Roni Pazla, and Novirman JAmarun. Project administration: Rizqan. Supervision: Arief and
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5. Writing-review and editing: Rizqan.
6. 343
7. 344

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8. concludes that of feed ingredients, feces, and milk.

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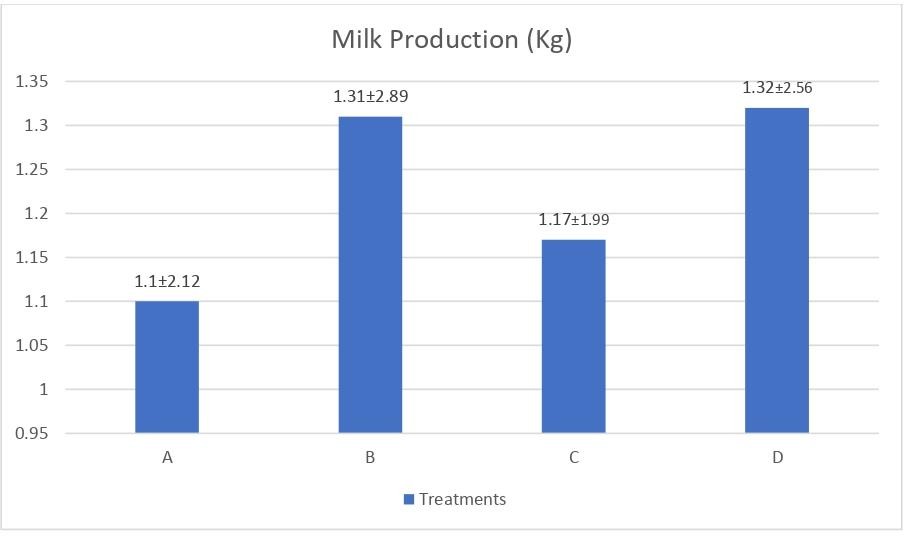
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6. 498
7. 499
8. 500
9. **Table 1:** Chemical composition of feed ingredients

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Nutrients (%) |  |  |  |  | Feed stuff | | |  |  |  |  |
| Company  forages | T | CL | JS | Rice  bran | Tofu  waste | PKC | Corn | PKCC | Skinless  cassava | Company  Concentrate |
| DM | 26.03 | 23.13 | 26.21 | 13.01 | 87.8 | 28.4 | 91.83 | 85.8 | 93.24 | 29.04 | 23.81 |
| OM | 87.93 | 84.65 | 86.33 | 95.02 | 90.8 | 97.67 | 91.41 | 99.1 | 90.23 | 98.78 | 96.92 |
| CP | 25.43 | 25.07 | 30.18 | 12.06 | 10.72 | 20.11 | 12.36 | 7.70 | 13.46 | 11.66 | 17.27 |
| CF | 28.02 | 22.62 | 19.92 | 28.01 | 11.6 | 19 | 26.68 | 2.44 | 18.33 | 4.28 | 20.98 |
| NDF | 48.27 | 55.03 | 56.13 | 71.54 | 55.13 | 59.28 | 66.7 | 49.96 | 62.84 | 37.38 | 61.86 |
| Cfat | 2.73 | 1.62 | 3.10 | 4.00 | 8.73 | 1.25 | 8.23 | 3.50 | 4.96 | 1.13 | 2.07 |
| TDN | 54.53 | 53.54 | 56.44 | 68.8 | 66.63 | 74.61 | 65.4 | 81.9 | 66.36 | 86.53 | 73.46 |
| NFE | 31.75 | 35.34 | 33.13 | 50.93 | 59.75 | 57.31 | 44.14 | 85.46 | 53.48 | 81.71 | 56.62 |
| ASH | 12.07 | 15.35 | 13.67 | 5.00 | 9.2 | 2.33 | 8.59 | 0.90 | 9.77 | 1.22 | 3.08 |
| ADF | 36.45 | 34.2 | 33.69 | 58.55 | 29.35 | 26.65 | 46.10 | 36.76 | 36.02 | 8.92 | 35.33 |
| Hemi | 11.82 | 20.83 | 22.44 | 12.99 | 25.78 | 32.63 | 20.60 | 13.20 | 26.82 | 28.46 | 26.53 |
| Lignin | 11.72 | 5.81 | 6.87 | 8.54 | 06.90 | 2.3 | 17.29 | 07.50 | 3.92 | 6.49 | 4.38 |
| Cellulose | 24.4 | 27.54 | 28.48 | 24.46 | 15.52 | 22.93 | 43.25 | 29.52 | 16.97 | 14.07 | 22.95 |

1. Dry matter (DM), Organic matter (OM), Crude protein (CP), Crude fiber (CF), Neutral
2. detergent fiber, Crude fat (Cfat), Total digestible nutrient (TDN), Nitrogen free extract
3. (NFE), Acid detergent fiber (ADF), Hemicellulose (Hemi), *Tithonia diversifolia* (T). Cassava
4. leaves (CL), Jackfruit skin (JS), Palm kernel cake (PKC), Palm kernel cake concentrate
5. (PKCC)
6. 507
7. 508
8. **Table 2:** Composition of ration and nutritional content of treatment ration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Feedstuff |  | Treatments | |  |
| A | B | C | D |
| Company Forages | 50 | 0 | 0 | 0 |
| *Tithonia diversifolia* | - | 25 | 25 | 25 |
| Cassava Leaves | - | 25 | 25 | 25 |
| PKCC | - | 10 | 20 | 30 |
| Company Concentrate | 50 | 40 | 30 | 20 |
| Total | 100 | 100 | 100 | 100 |
| Nutrient Composition |  |  |  |  |
| Dry Matter | 24.91 | 31.10 | 38.04 | 44.98 |
| Organic Matter | 92.43 | 90.54 | 89.87 | 89.20 |
| Crude Protein | 21.35 | 22.07 | 21.69 | 21.31 |
| Crude Fiber | 24.49 | 20.85 | 20.59 | 20.33 |
| NDF | 55.07 | 58.82 | 58.92 | 59.01 |
| Crude Fat | 2.40 | 2.50 | 2.79 | 3.08 |
| TDN | 64.00 | 63.52 | 62.81 | 62.10 |
| NFE | 44.18 | 45.11 | 44.80 | 44.48 |
| Ash | 7.57 | 9.46 | 10.13 | 10.80 |
| Lignin | 8.05 | 5.31 | 5.27 | 5.22 |

1. Neutral detergent fiber, Total digestible nutrient (TDN), Nitrogen free extract (NFE), Palm
2. kernel cake concentrate (PKCC)
3. 512
4. 513
5. 514
6. 515
7. 516
8. 517
9. 518
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11. 520
12. 521
13. 522



1. 523
2. **Fig.** 1.Milk Production of Etawa Crossbreed Dairy Goats Treatment;
3. 525
4. 526
5. **Table 3:** Quality of Etawa Crossbreed Dairy Goat's Milk Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter |  | Goat milk | |  |
| A | B | C | D |
| pH | 6.23±0.05 | 6.32±0.06 | 6.36±0.05 | 6.52±0.07 |
| Fat Level (%) | 4.52±2.27 | 4.44±1.26 | 3.91±2.29 | 5.29±1.21 |
| Lactose (%) | 4.52±0.19 | 4.44±0.31 | 3.91±1.23 | 5.29±1.35 |
| SNF (%) | 9.53±2.27 | 9.46±1.26 | 9.01±2.29 | 8.99±1.21 |
| Protein (%) | 3.46±0.05 | 3.44±0.07 | 3.28±0.07 | 3.26±0.09 |
| Specific Gravity | 1.033±0.07 | 1.032±0.11 | 1.031±0.13 | 1.030±0.07 |
| Phosphorus (%) | 3.17±0.25 | 3.40±0.37 | 3.19±0.49 | 2.92±1.45 |
| Calcium (%) | 2.51±0.12 | 2.46±0.17 | 2.32±0.21 | 2.90±0.51 |
| Water Content (%) | 14.05±1.72 | 13.89±2.57 | 12.91±1.98 | 14.28±1.81 |
| Dry Matter (%) | 85.95±1.72 | 86.11±2.57 | 87.09±1.98 | 85.73±1.81 |

1. Solid non-fat (SNF)
2. **Table 4:** Ration Intake of Etawa Crossbreed Dairy Goats Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Intake  (kg/e/day) |  | Treatment | |  |
| A | B | C | D |
| Dry Matter | 2.44±3.21 | 2.51±2.47 | 2.48±3.11 | 2.46±2.68 |
| Organic Matter | 2.20±3.09 | 2.27±2.13 | 2.25±3.26 | 2.21±2.39 |

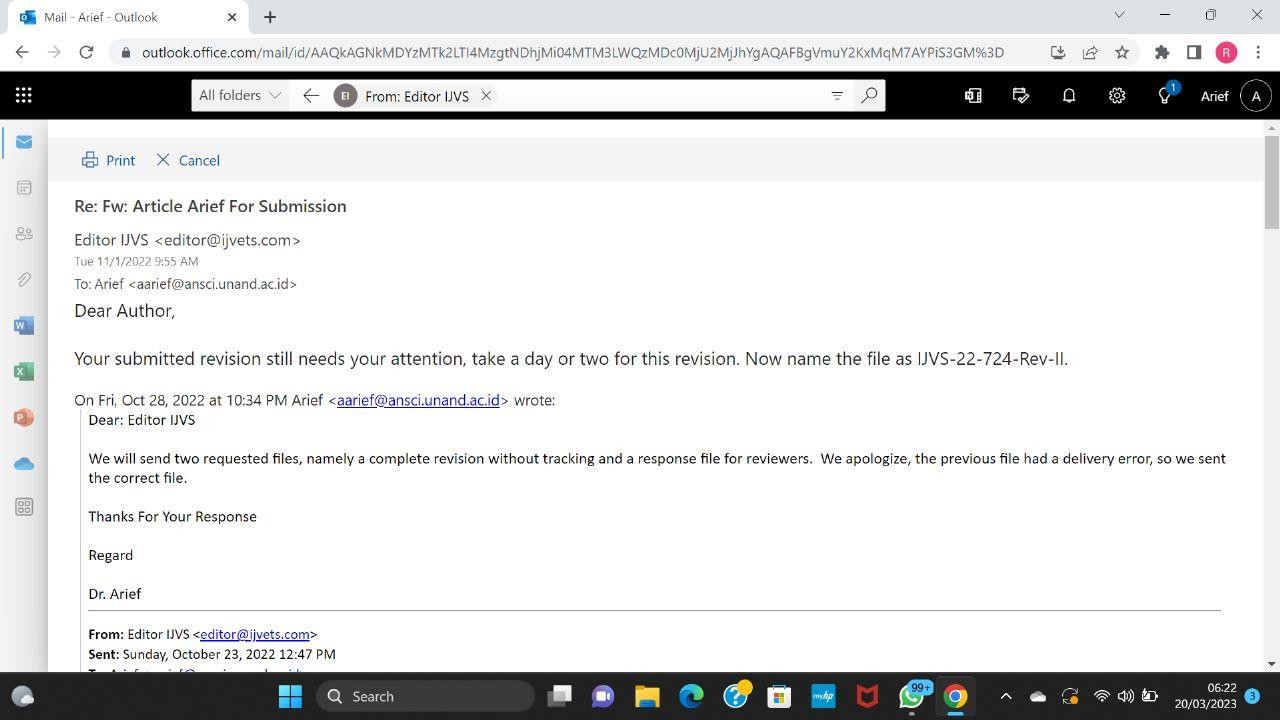
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Crude Protein | 0.60±1.91 | 0.65±1.87 | 0.62±1.37 | 0.61±1.49 |

1. 530
2. **Table 5:** Digestibility of Etawa Crossbreed Dairy Goats Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Digestibility  (%) |  | Treatment | |  |
| A | B | C | D |
| Dry Matter | 65.85±1.19 | 66.17±1.89 | 67.23±1.78 | 67.98±1.55 |
| Organic Matter | 67.76±1.17 | 68.02±1.76 | 68.88±1.63 | 69.32±1.48 |
| Crude Protein | 69.56±1.03 | 70.34±1.11 | 71.38±1.24 | 71.97±1.41 |

1. 532

#### Email dari Editor untuk Revisi ke 2



* 1. **Revisi ke 2**

#### Production Performance, Feed Intake and Nutrient Digestibility of Etawa Crosbreed

* 1. **Dairy Goats Fed Tithonia (*Tithonia diversifolia*), Cassava Leaves and Palm Kernel Cake**

#### Concentrate

5

#### 6 13-Oct-22; 29-Oct-22;

7 **ABSTRACT**

8

1. This research aimed at the intake, digestibility, production, and milk quality of Etawa
2. crossbreeds dairy goat (ECDG) fed conventional mixed forage; tithonia (*Tithonia*
3. *diversifolia*) (T) and cassava leaves (CL) with palm kernel cake concentrate (PKCC). A
4. completely randomized design (four treatments and four replications) was used in this study.
5. The treatments consisted of followings: A was company rations (50% company forages +
6. 50% company concentrate(CC)), B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL)

15 + 30% CC + 20% PKCC), D (50% (T+CL)+ 20% CC + 30% PKCC). The variables analyzed

1. were as follows; milk production, milk quality (total solid, lactose, protein, fat, solid non-fat,
2. water content, specific gravity, pH, Ca and P minerals), dry matter intake (DMI), organic
3. matter intake (OMI), crude protein intake (CPI), dry matter digestibility (DMD), organic
4. matter digestibility (OMD), crude protein digestibility (CPD). Data analysis used analysis of
5. variance—a further test to determine differences between treatments using Duncan's multiple
6. ranges. The Analysis showed that the treatment had no significant effect (P>0.05) on feed
7. intake, digestibility, production, and milk quality. Using palm kernel cake concentrate and a
8. mixture of tithonia and cassava leaves was able to maintain the feed intake, feed digestibility,
9. production, and milk quality of ECDG. Replacement of company forages with a mixture of
10. cassava and tithonia and replacement of company concentrate with PKCC did not affect the
11. intake, digestibility, production, and quality of Etawa crossbreed dairy goat's milk. The
12. combination of 50% (cassava and tithonia) + 10% company concentrate + 40% PKCC was
13. able to maintain the intake, digestibility, production, and quality of Etawa crossbreed dairy
14. goat milk.

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1. **Keywords**: cassava leaves, Etawa crossbreed dairy goat, milk production, palm kernel cake
2. concentrate, *Tithonia diversifolia*.

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#### 34 INTRODUCTION

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1. The availability of forage and the high price of concentrate are severe problems in
2. developing the Etawa crossbreed dairy goat (ECDG) farming. The increase in residential
3. areas impacts reducing forage for animal feed. At the same time, the price of concentrate is
4. getting more expensive day by day. Arief et al. (2018a) stated that alternative feed
5. exploration is very urgent to increase productivity and efficiency of livestock business. So, it
6. is necessary to find alternative sources of forage and concentrates with high production and
7. good nutritional quality.
8. Tithonia (*Tithonia diversifolia*) is a forage with good nutritional content (Pazla et al.
9. 2021a). The crude protein content is 22.89%, and organic matter is 84.01% (Pazla et al.
10. 2018a). Tithonia is also rich in P mineral, which can potentially increase the number of
11. rumen bacterial populations (Fasuyi et al. 2010; Adrizal et al. 2021; Pazla et al. 2021b).
12. Oluwasola and Dairo (2016) reported that tithonia plants are also rich in amino acids. The
13. mixture of tithonia with elephant grass as a fiber source in ECDG ration can optimize intake,
14. digestibility, and milk production (Pazla et al. 2022).
15. Cassava leaves contain Branched Chain Amino Acids (BCAA) such as isoleucine, valine,
16. and leucine 4.4, 8.43, and 8.75%, respectively (Suyitman et al. 2017a). BCAAs increase
17. nutrient digestibility like dry matter, organic matter, and acid detergent fiber through the
18. growth of cellulolytic bacteria (Zain et al. 2002). Supplementation of cassava leaves on
19. ammoniated palm stems increased rumen microbial growth and digestibility of DM, ADF,
20. and neutral detergent fiber (NDF) (Nurhaita and ningrat 2011). Suyitman et al. (2020)
21. reported that supplementing cassava leaves in Simmental cattle rations improved digestibility
22. and production performance.
23. Palm kernel cake concentrate (PKCC) is made from a mixture of feed ingredients that
24. have good nutrition for livestock growth and production, such as rice bran, corn, palm kernel
25. cake, and minerals. Energy (total digestible nutrient) and crude protein (CP) of PKCC are 60-
26. 64 and 14-16%, respectively (Arief et al. 2020). This research aims to determine the impact
27. of replacing company forages with a mixture of cassava and tithonia and replacing company
28. concentrate with PKCC on intake, digestibility, production, and quality of ECDG.

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#### MATERIALS AND METHODS

1. **Animal Ethics**
2. This research has referred to the ethics of research using livestock based on the law of the
3. government of the Republic of Indonesia Number 18 of 2009 article 66, which discusses
4. animal maintenance, killing, treatment, and reasonable care.

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#### 71 Experimental Site

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1. This study was carried out on Toni Farm company, Payakumbuh, West Sumatra,
2. Indonesia (-0.2330638,100.6268024, and 516 m asl); this area has two seasons (dry and
3. rainy). The rainy season is from September to February, and summer is from March to
4. August. This research was conducted in May – June 2022. The temperature of this area at the
5. time of the study was in the range of 22-35°C.

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#### Animal Experiment and Feeding Formulation

1. The livestock used in the study were 16 ECDG with an average body weight of 60±1.23
2. Kg and were in the second lactation, distributed in a completely randomized design with four
3. treatments (ration formulation) and four replicates. The treatments consisted of followings:
4. A was company ration as control (50% company forages + 50% company concentrate(CC)),

85 B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC + 20% PKCC), D

1. (50% (T+CL)+ 20% CC + 30% PKCC). The ratio of tithonia with cassava was 1:1
2. PKCC concentrate was made by formulating the following feed ingredients, namely 37%
3. rice bran + 40% palm kernel cake + 22% corn, and 1% minerals. All materials were mixed
4. homogeneously and stored in plastic at less than 12% moisture content.
5. The company forage was bush and native grass. The company's concentrate was made by
6. formulating feed ingredients along with tofu dregs, jackfruit skin, and skinless cassava. All
7. ingredients were stirred evenly and given in a fresh state. Meanwhile, forage company
8. forages, cassava leaves, and tithonia were given three times a day: in the morning at 08.00, at
9. noon at 13.00, and in the afternoon at 18.00. The concentrate was given twice daily, in the
10. morning at 07.00 and noon.
11. The experimental ration was formulated based on the NRC (2007) to fulfill the nutrition of
12. dairy goats weighing 60 kg and having the capacity to produce 2-3kg of milk with 4% fat
13. content per day. The chemical composition of each feed ingredient used is presented in Table
14. 1. The composition of the feed ingredients in the treatment ration and the nutritional
15. composition of the treatment ration are presented in Table 2.
16. Proximate analysis (dry matter, ash, crude protein, extract ether, and crude fiber) of
17. research feed ingredients was carried out based on AOAC international (1995). Fiber
18. fractions (cellulose, lignin, ADF, and NDF) were analyzed according to the technique
19. described by Van Soest (1982). TDN was calculated based on Moran (2005). The nitrogen-
20. free extract was calculated according to Jamarun et al. (2021).

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| --- | --- | --- |
| 106 |  | |
| 107 |  | TDN (%) = 5.31 +1.444 Cfat + 0.412 CP + 0.937 NFE + 0.249 CF |
| 108 |  | NFE= 100 - (ash+ CP+Cfat+CF) |
| 109 | Note: |  |
| 110 |  | TDN= Total digestible nutrient |
| 111 |  | CP= Crude protein |
| 112 |  | CF= Crude fiber |
| 113 |  | Cfat= Crude fat |
| 114 |  | NFE= Nitrogen-free extract. |
| 115 |  |  |

1. The study lasted 45 days, divided into three periods: the adaptation period of 25 days, the
2. preliminary period of 15 days, and the 5-day collection period. The fresh ration intake was
3. calculated by calculating the difference between the amount of ration and the rest of the
4. ration.
5. DMI (Kg/h/day) = Fresh Intake \* DMCR
6. OMI (Kg/h/day) = DMI \* OMCR
7. CPI (Kg/h/day) = DMI \* CPCR
8. 123
9. Note:
10. DMI= Dry matter intake
11. OMI= Organic matter intake
12. CPI= Crude protein intake
13. DMCR= Dry matter content of the ration
14. OMCR= Organic matter content of the ration
15. CPCR= Crude protein content of the ration
16. 131
17. Feces were collected at 6am. All fresh feces were weighed, 10% was taken for each
18. treatment, then dried in the sun. The dried feces were then ground into a fine powder for
19. analysis of chemical composition samples. The difference between ration intake and fecal
20. production calculates feed digestibility. The formula used is:
21. DMD (%) = (DMI- Feces)/ DMI \* 100%)
22. OMD (%) = (OMI- Feces)/ OMI \* 100%)
23. CPD = (CPI- Feces)/ CPI \* 100%)
24. 139
25. Goats were milked twice a day, in the morning and evening, using a mechanical milking
26. machine. Milk production was calculated for five days during the collection period in liters
27. and converted to Kg and FCM (Fat Corrected Milk) 4% based on the formula of Mavrogenis
28. and Papachristoforou (1988):
29. 144

145 4%FCM (Kg)= M (0.144+ 0.1444F)

1. Note:
2. M = Milk production in Kg
3. F= Fat content in %
4. 149
5. During the collection period, 250ml of milk samples was taken for each treatment. The
6. components for the milk quality test (total solid (milk dry matter), protein, fat, lactose, solid
7. non-fat, specific gravity, and pH) were tested using Lactoscan Pro 202.
8. 153

#### Statistical Analysis

1. A completely randomized design (Model) (Steel and Torrie 1991) was used to analyze
2. intake, feed digestibility, production, and milk quality. The data were analyzed with the study
3. concludes that of variance using the Excel 2019 program at a significance level of @=0.05.
4. Duncan's Advanced Multiple range tests were used to test the differences between treatments.
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|  |  |
| --- | --- |
| 160 | **RESULTS** |
| 161 |  |
| 162 | **Milk Production of Etawa Crossbreed Dairy Goats Treatment** |
| 163 | Replacement of company forages with a mixture of cassava and tithonia and replacement |
| 164 | of company concentrate with PKCC were not significantly different (P>0.05) in increasing |
| 165 | milk production. Using cassava leaves, tithonia, and PKCC is expected to increase milk |
| 166 | production. The average daily milk production results from replacing company forages with a |
| 167 | mixture of cassava leaves and tithonia and replacing company concentrate with PKCC in |

1. various percentages are presented in Table 3. The study concludes that of the variance of the
2. highest milk production after being converted to 4% FCM was in treatment D, and the lowest
3. was in treatment A (control).
4. 171

#### Milk Quality of Etawa Crossbreed dairy Goat Treatment

1. The results of statistical analysis showed that there was no significant difference (P>0.05)
2. in all milk quality parameters. Replacing the company forages with a mixture of cassava and
3. tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The
4. average milk quality results from replacing company forages with a mixture of cassava leaves
5. and tithonia and replacing company concentrate with PKCC in various percentages are
6. presented in Table 4.

#### Feed Intake of Etawa Crossbreed dairy Goats Treatment

1. The study concludes that results of dry matter intake, organic matter intake, and crude
2. protein intake by replacing company concentrate with PKCC and replacing company forages
3. with tithonia and cassava leaves are presented in Table 5. Replacing company concentrate
4. with PKCC and replacing company forages with tithonia and cassava leaves in the ration
5. gave no significant difference (P>0.05) in each treatment on the value of dry matter intake,
6. organic matter intake, and crude protein intake.

#### Digestibility of Etawa Crossbreed Dairy Goats Treatment

1. The study concludes that results of dry matter digestibility (DMD), organic matter
2. digestibility (OMD), and crude protein digestibility (CPD) by replacing company concentrate
3. with PKCC and replacing company forages with tithonia, and cassava leaves are presented in
4. Table 6. Table 6 shows that the treatment of replacing company concentrate with PKCC and
5. replacing company forages with a mixture of cassava leaves and tithonia had no significant
6. effect (P>0.05) on DMD, OMD, and CPD.
7. 193

#### DISCUSSION

1. 195

#### Milk Production of Etawa Crossbreed Dairy Goats Treatment

1. Replacement of company forages with a mixture of cassava and tithonia and replacement
2. of company concentrate with PKCC were not significantly different (P>0.05) in increasing
3. milk production. Milk production in dairy goats is strongly influenced by feed quality. Good
4. quality feed will increase milk production. Using cassava leaves, tithonia, and PKCC is
5. expected to increase milk production.
6. The study concludes that of the variance of the highest milk production after being
7. converted to 4% FCM was in treatment D, and the lowest was in treatment A (control). The
8. insignificant difference between treatments A, B, C, and D could be caused by the feed
9. quality. The prepared rations had a crude protein that was not much different between A

206 (21.35%) rations, B (22.07%), C (21.69%), and D (21.31%) rations (Table 2). The intake of

1. feed protein also influences milk production. Saskia (2022) stated that feed protein plays a
2. role in forming lactose. Lactose is water-binding, so the more lactose is formed, the more
3. milk will be produced. In the research conducted, the lactose content obtained in each

210 treatment was A=4.52%, B=4.44%, C=3.91%, and D= 5.29% (Table 4)

1. Good dairy goats have a high amount of milk production and are standardized at 4% FCM
2. (Christi & Rohayati 2018). From the average value of 4% FCM milk production, it can be
3. seen that the highest production was in treatment D (1.32kg/head/day). This indicates that
4. after being standardized to 4% FCM, it turns out that treatment D has a high milk fat content,
5. which affects the production of 4% FCM milk. Based on the results of the study, it was found
6. that the milk fat content in each treatment was: A=4.52%, B=4.44%, C=3.91%, and D=5.29%
7. (Table 4), with the highest increase in milk fat content in treatment D was thought to be
8. because the fat from the D ration was higher from other rations (Table 2), causing high milk
9. production as well. Milk production of 4% FCM is carried out to equalize the energy level in
10. the milk content.

#### Quality of Etawa Crossbreed dairy Goat's Milk Treatment

1. Nutrient components in feed significantly affect the quality of milk. Good quality milk
2. meets milk quality standards. The results of statistical analysis showed that there was no
3. significant difference (P>0.05) in all milk quality parameters. Replacing the company forages
4. with a mixture of cassava and tithonia and replacing the company's concentrate with PKCC
5. did not affect milk quality. The quality of milk produced in treatments A, B, C, and D was
6. within the normal range based on Thai Agricultural Standards (2008). This value indicates
7. that the response of ECDG to rations containing PKCC concentrate and forages of cassava
8. leaves and tithonia is quite good.
9. The feed quality factors (TDN and CP), which were almost the same between treatments,
10. were thought to be the reason the milk quality did not differ between treatments (P>0.05).
11. Arief et al. (2018a) strengthened this study, stated that the sort of feed influences the milk
12. produced. The good feed also improve animal metabolism by increasing the supply of
13. electricity and vitamins for the synthesis of milk components (Arief et al. 2018b). In addition,
14. the same intake of dry matter, organic matter, and crude protein among treatments also
15. caused no difference in the milk quality. The intake and digestibility of the same feed do not
16. affect the final fermented product in the rumen. Volatile fatty acid (VFA) is a product of
17. rumen fermentation. VFA manufacturing offers enough strength for rumen bacteria to
18. develop and grow (Jamarun et al. 2019) and the supply of uncooked substances for milk
19. synthesis (Jamarun et al. 2020). This results are similar with the study from Pazla et al.
20. (2022). They also found no difference in milk quality in ECDG given a mixture of tithonia
21. forage with elephant grass with the addition of a concentrate consisting of corn, rice bran,
22. tofu dregs, and palm kernel cake. Marques et al. (2022) also found the same quality of goat's
23. milk when given forage with a combination of cassava and alfalfa.

#### Feed Intake of Etawa Crossbreed Dairy Goats Treatment

1. Intake of dry matter can produce energy for milk production because it contains food
2. substances consisting of organic materials such as protein, fat, and carbohydrates (Jamarun et
3. al. 2021). The study concludes that results of DMI, OMI, and CPI by replacing company
4. concentrate with PKCC and replacing company forages with tithonia and cassava leaves are
5. presented in Table 5. Replacing company concentrate with PKCC and replacing company
6. forages with tithonia and cassava leaves in the ration showed no significant difference
7. (P>0.05) in each treatment on the value of DMI, OMI, and CPI. The insignificant difference
8. in each treatment could be caused by the type of ration given. In replacing the company's
9. concentrate with PKCC and company forages with tithonia and cassava leaves, it is necessary
10. to pay attention to the dry matter content of each feed ingredient. The dry matter content of
11. the company's concentrate is 23.81%, while the dry matter content of PKCC is 93.24%
12. (Table 1). Meanwhile, the dry matter content of company forages with tithonia and cassava
13. did not differ much. Of course, the difference in the substituted ingredients changed the form
14. of an increase in the dry matter content of the ration (ration A 24.91%, ration B 31.10%,
15. ration C 38.04%, and ration D 44.98%) (Table 2). However, there was an increase in the dry
16. matter content of the ration, and it had no significant difference against intake. This is
17. supported by Pazla et al. (2018b) that the amount of nutrient intake depends on the amount of
18. dry matter in the feed consumed and the nutrient content of the feed given. In the research
19. conducted, it was also observed that livestock have the ability to eat high feed, which is also
20. influenced by the needs of the livestock themselves, following the opinion of Arief et al.
21. (2021b), which states that the volume of feed needed by livestock, especially goats, depends
22. on their ability to eat feed and total weight body. The results obtained were higher than that
23. of Setyaningsih et al. (2013), whose average dry matter intake was 1.55-1.66 kg/e/day with
24. an average body weight of 43 kg. This is presumably because the capacity of the livestock
25. rumen influences dry matter intake.
26. Another factor that plays a role in dry matter intake is the level of palatability or livestock
27. preference on the feed given. In this study, it was found that the level of palatability of
28. tithonia, cassava leaves, and PKCC in its administration was favored by dairy goats. This is
29. under the opinion of Pazla et al. (2021c) that the palatability of feed directly affects interest
30. and causes appetite in livestock. Flavor, texture, smell, and taste significantly affect
31. palatability. Based on the observations made during the study, it was found that Tithonia,
32. cassava leaves, and PKCC have a flavor. The intake of organic matter is in line with the
33. intake of dry matter because organic matter is part of dry matter, which has been reduced by
34. inorganic matter. The pattern of increasing and decreasing organic matter intake is strongly
35. influenced by the components contained in dry matter (Kamalidin et al. 2012). This is also
36. supported by Febrina et al. (2017) that organic matter is carefully associated with dry matter
37. since organic matter is a part of dry matter; if the intake of dry matter from livestock is low, it
38. will be followed by a low level of intake of organic matter as well. Intake of organic matter is
39. also primarily determined by the constituent components of the organic material itself,
40. namely crude protein, extract ether, and crude fiber.
41. High intake of dry matter is a factor that causes a high intake of organic matter, but the
42. factor that increases intake of organic matter is not only feed; livestock is also one of the
43. factors that can increase intake of organic matter. The ability of livestock to eat feed and the
44. level of preference is also a factor in increasing the intake of organic matter. Murni et al.
45. (2012) stated that other factors influencing intake are animal body weight, feed digestibility,
46. palatability, feed quality, and the age of livestock. Intake of crude protein that did not differ
47. between treatments (P>0.05) was due to the protein content of the ration between treatments

293 that were not much different (A=21.35%, B=22.07%, C=21.69%, D=21.31%) (Table 2). The

1. intake of crude protein feed is directly proportional to dry and organic matter intake. Pazla et
2. al. (2021c) stated that feed protein positively correlated with dry matter, protein, and energy
3. intake. The amount of feed consumed affects other nutrients consumed. Martawidjaja et al.
4. (1999) stated that the factors influencing feed protein intake are dry matter intake and protein
5. content. Intake of crude protein in this study was higher than Marwah et al. (2010), who
6. received crude protein intake of ECDG of 0.34 Kg/head/day by feeding *Calliandra*
7. *calothyrsus* and concentrate, and Krisnan et al. (2015), who reported 0.24 kg/head/day by
8. feeding *Pennisetum purpupoides*, *Leucaena leucocephala* and concentrates.
9. 302

#### Digestibility of Etawa Crossbreed Dairy Goats Treatment

1. Table 6 shows that the treatment of replacing company concentrate with PKCC and
2. replacing company forages with a mixture of cassava leaves and tithonia had no significant
3. effect (P>0.05) on DMD, OMD, and CPD. The non-significant difference between treatments
4. was due to the lignin content of the A, B, C, and D rations not being much different. The
5. difference in the lignin content of the ration is only 2.83%. In addition, the lignin content of
6. tithonia and cassava is lower than that of the company forages. In contrast, the lignin content
7. of PKCC is not much different from that of the firm concentrate. High lignin content in
8. livestock rations reduces digestibility because lignin is a timber substance that cannot be
9. digested using rumen microbes (Pazla et al. 2020; Pazla et al. 2021d).
10. The chemical composition of the ration also influences the digestibility of dry matter,
11. organic matter, and crude protein. The chemical composition of rations A, B, C, and D is
12. almost identical. The rations of this study were prepared with a TDN content of 62-64%. In
13. digesting feed ingredients, sufficient and balanced protein and energy are needed for rumen
14. microbial activity to digest food substances, including dry matter, organic matter, and crude
15. protein. Crude protein undergos fermentation in the rumen, which produces ammonia (NH3)
16. (Suyitman et al. 2021). NH3 increases the rumen's microbial population (Putri et al. 2019;
17. Putri et al. 2021). TDN derived from the diet acts as an energy source for rumen microbes.
18. The large population of rumen microbes affects the digestibility of food substances. The same
19. protein and TDN composition in the treatment rations causes the digestibility of dry matter,
20. organic matter, and crude protein to be relatively the same (P>0.05). This follows the opinion
21. of Jamarun et al. (2017), which states that feed digestibility is influenced by the ration
22. composition and the activity of microorganisms.
23. 326

#### Conclusion

1. Replacement of company forages with a mixture of cassava and tithonia and replacement of
2. company concentrate with PKCC did not affect the intake, digestibility, production, and
3. quality of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and tithonia)

331 + 10% company concentrate + 40% PKCC was able to maintain the intake, digestibility,

332 production, and quality of Etawa crossbreed dairy goat milk.

333

#### Author Contributions

1. Conceptualization: Arief and Roni Pazla, Data Curation: Roni Pazla. Formal analysis: Roni
2. Pazla and Rizqan. Funding acquisition: Arief and Novirman Jamarun. Methodology: Arief,
3. Roni Pazla, and Novirman JAmarun. Project administration: Rizqan. Supervision: Arief and
4. Novirman Jamarun. Validation: Roni Pazla. Writing-original draft: Roni Pazla and Arif.
5. Writing-review and editing: Rizqan.
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8. concludes that of feed ingredients, feces, and milk.
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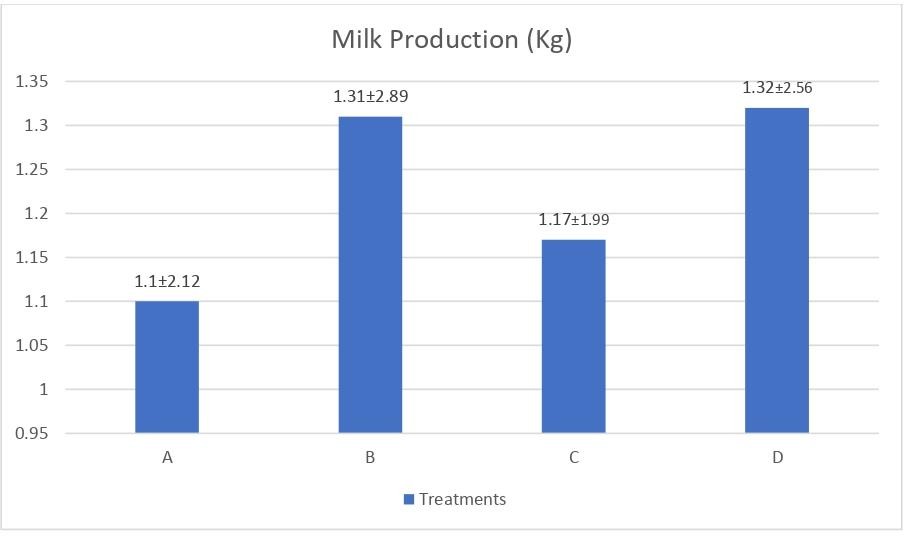
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10. **Table 1:** Chemical composition of feed ingredients

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Nutrients (%) |  |  |  |  | Feed stuff | | |  |  |  |  |
| Company  forages | T | CL | JS | Rice  bran | Tofu  waste | PKC | Corn | PKCC | Skinless  cassava | Company  Concentrate |
| DM | 26.03 | 23.13 | 26.21 | 13.01 | 87.8 | 28.4 | 91.83 | 85.8 | 93.24 | 29.04 | 23.81 |
| OM | 87.93 | 84.65 | 86.33 | 95.02 | 90.8 | 97.67 | 91.41 | 99.1 | 90.23 | 98.78 | 96.92 |
| CP | 25.43 | 25.07 | 30.18 | 12.06 | 10.72 | 20.11 | 12.36 | 7.70 | 13.46 | 11.66 | 17.27 |
| CF | 28.02 | 22.62 | 19.92 | 28.01 | 11.6 | 19 | 26.68 | 2.44 | 18.33 | 4.28 | 20.98 |
| NDF | 48.27 | 55.03 | 56.13 | 71.54 | 55.13 | 59.28 | 66.7 | 49.96 | 62.84 | 37.38 | 61.86 |
| Cfat | 2.73 | 1.62 | 3.10 | 4.00 | 8.73 | 1.25 | 8.23 | 3.50 | 4.96 | 1.13 | 2.07 |
| TDN | 54.53 | 53.54 | 56.44 | 68.8 | 66.63 | 74.61 | 65.4 | 81.9 | 66.36 | 86.53 | 73.46 |
| NFE | 31.75 | 35.34 | 33.13 | 50.93 | 59.75 | 57.31 | 44.14 | 85.46 | 53.48 | 81.71 | 56.62 |
| ASH | 12.07 | 15.35 | 13.67 | 5.00 | 9.2 | 2.33 | 8.59 | 0.90 | 9.77 | 1.22 | 3.08 |
| ADF | 36.45 | 34.2 | 33.69 | 58.55 | 29.35 | 26.65 | 46.10 | 36.76 | 36.02 | 8.92 | 35.33 |
| Hemi | 11.82 | 20.83 | 22.44 | 12.99 | 25.78 | 32.63 | 20.60 | 13.20 | 26.82 | 28.46 | 26.53 |
| Lignin | 11.72 | 5.81 | 6.87 | 8.54 | 06.90 | 2.3 | 17.29 | 07.50 | 3.92 | 6.49 | 4.38 |
| Cellulose | 24.4 | 27.54 | 28.48 | 24.46 | 15.52 | 22.93 | 43.25 | 29.52 | 16.97 | 14.07 | 22.95 |

1. Dry matter (DM), Organic matter (OM), Crude protein (CP), Crude fiber (CF), Neutral
2. detergent fiber, Crude fat (Cfat), Total digestible nutrient (TDN), Nitrogen free extract
3. (NFE), Acid detergent fiber (ADF), Hemicellulose (Hemi), *Tithonia diversifolia* (T). Cassava
4. leaves (CL), Jackfruit skin (JS), Palm kernel cake (PKC), Palm kernel cake concentrate
5. (PKCC)
6. 514
7. 515
8. **Table 2:** Composition of ration and nutritional content of treatment ration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Feedstuff |  | Treatments | |  |
| A | B | C | D |
| Company Forages | 50 | 0 | 0 | 0 |
| *Tithonia diversifolia* | - | 25 | 25 | 25 |
| Cassava Leaves | - | 25 | 25 | 25 |
| PKCC | - | 10 | 20 | 30 |
| Company Concentrate | 50 | 40 | 30 | 20 |
| Total | 100 | 100 | 100 | 100 |
| Nutrient Composition |  |  |  |  |
| Dry Matter | 24.91 | 31.10 | 38.04 | 44.98 |
| Organic Matter | 92.43 | 90.54 | 89.87 | 89.20 |
| Crude Protein | 21.35 | 22.07 | 21.69 | 21.31 |
| Crude Fiber | 24.49 | 20.85 | 20.59 | 20.33 |
| NDF | 55.07 | 58.82 | 58.92 | 59.01 |
| Crude Fat | 2.40 | 2.50 | 2.79 | 3.08 |
| TDN | 64.00 | 63.52 | 62.81 | 62.10 |
| NFE | 44.18 | 45.11 | 44.80 | 44.48 |
| Ash | 7.57 | 9.46 | 10.13 | 10.80 |
| Lignin | 8.05 | 5.31 | 5.27 | 5.22 |

1. Neutral detergent fiber, Total digestible nutrient (TDN), Nitrogen free extract (NFE), Palm
2. kernel cake concentrate (PKCC)
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1. 530
2. **Fig.** 1. Milk Production of Etawa Crossbreed Dairy Goats Treatment
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4. 533
5. **Table 3:** Quality of Etawa Crossbreed Dairy Goat's Milk Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter |  | Goat milk | |  |
| A | B | C | D |
| pH | 6.23±0.05 | 6.32±0.06 | 6.36±0.05 | 6.52±0.07 |
| Fat Level (%) | 4.52±2.27 | 4.44±1.26 | 3.91±2.29 | 5.29±1.21 |
| Lactose (%) | 4.52±0.19 | 4.44±0.31 | 3.91±1.23 | 5.29±1.35 |
| SNF (%) | 9.53±2.27 | 9.46±1.26 | 9.01±2.29 | 8.99±1.21 |
| Protein (%) | 3.46±0.05 | 3.44±0.07 | 3.28±0.07 | 3.26±0.09 |
| Specific Gravity | 1.033±0.07 | 1.032±0.11 | 1.031±0.13 | 1.030±0.07 |
| Phosphorus (%) | 3.17±0.25 | 3.40±0.37 | 3.19±0.49 | 2.92±1.45 |
| Calcium (%) | 2.51±0.12 | 2.46±0.17 | 2.32±0.21 | 2.90±0.51 |
| Water Content (%) | 14.05±1.72 | 13.89±2.57 | 12.91±1.98 | 14.28±1.81 |
| Dry Matter (%) | 85.95±1.72 | 86.11±2.57 | 87.09±1.98 | 85.73±1.81 |

1. Solid non-fat (SNF); There is no significant between treatments (P>0.05)
2. **Table 4:** Ration Intake of Etawa Crossbreed Dairy Goats Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Intake  (kg/e/day) |  | Treatment | |  |
| A | B | C | D |
| Dry Matter | 2.44±3.21 | 2.51±2.47 | 2.48±3.11 | 2.46±2.68 |
| Organic Matter | 2.20±3.09 | 2.27±2.13 | 2.25±3.26 | 2.21±2.39 |

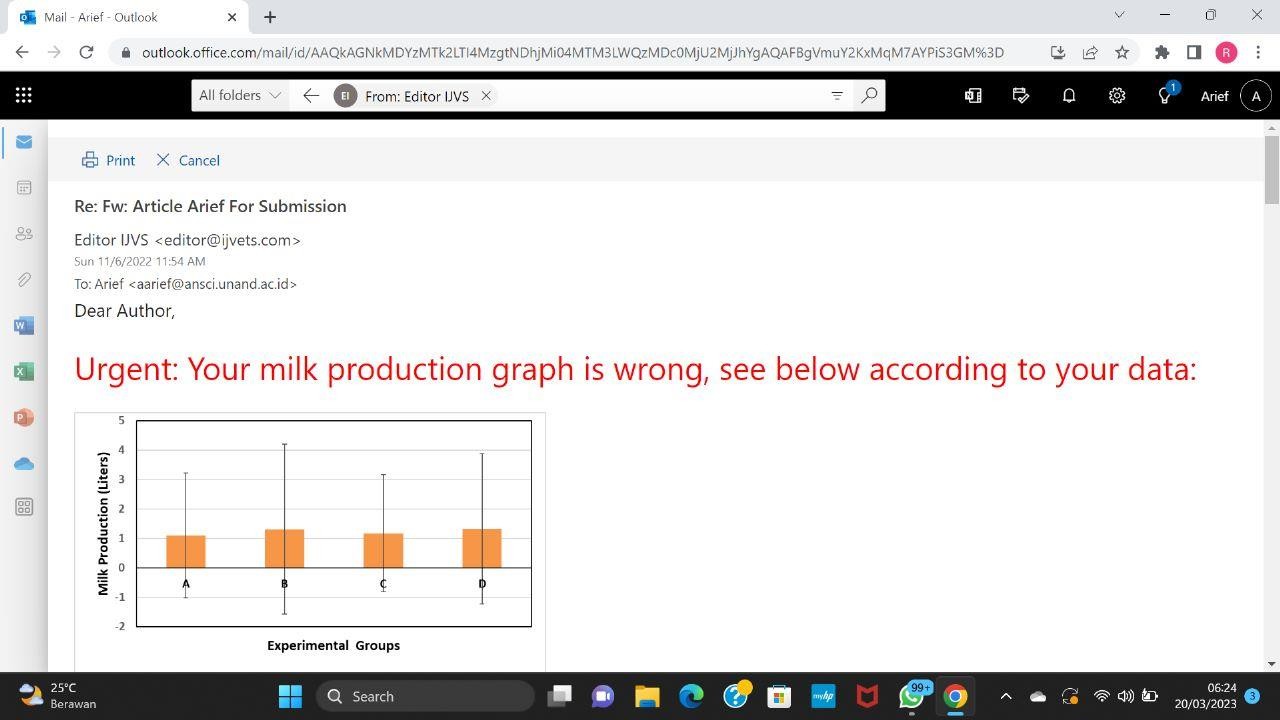
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Crude Protein | 0.60±1.91 | 0.65±1.87 | 0.62±1.37 | 0.61±1.49 |

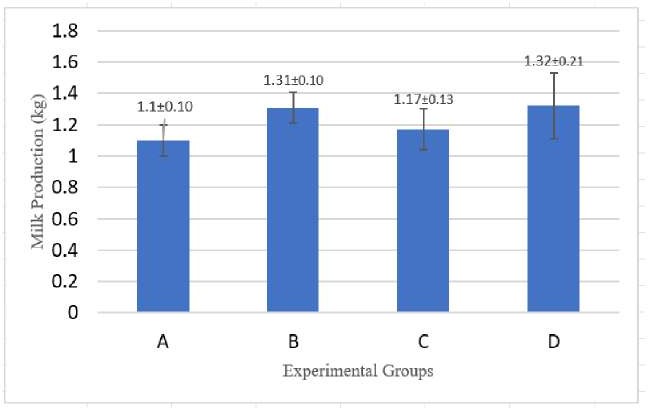
1. There is no significant between treatments (P>0.05)
2. 538
3. **Table 5:** Digestibility of Etawa Crossbreed Dairy Goats Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Digestibility  (%) |  | Treatment | |  |
| A | B | C | D |
| Dry Matter | 65.85±1.19 | 66.17±1.89 | 67.23±1.78 | 67.98±1.55 |
| Organic Matter | 67.76±1.17 | 68.02±1.76 | 68.88±1.63 | 69.32±1.48 |
| Crude Protein | 69.56±1.03 | 70.34±1.11 | 71.38±1.24 | 71.97±1.41 |

1. There is no significant between treatments (P>0.05)

#### Urgent (perbaikan grafik pada revisi 2)





* 1. **Revisi ke 3**

#### Production Performance, Feed Intake and Nutrient Digestibility of Etawa Crosbreed

* 1. **Dairy Goats Fed Tithonia (*Tithonia diversifolia*), Cassava Leaves and Palm Kernel Cake**

#### Concentrate

5

#### 6 13-Oct-22; 29-Oct-22;

7 **ABSTRACT**

8

1. This research aimed at the intake, digestibility, production, and milk quality of Etawa
2. crossbreeds dairy goat (ECDG) fed conventional mixed forage; tithonia (*Tithonia*
3. *diversifolia*) (T) and cassava leaves (CL) with palm kernel cake concentrate (PKCC). A
4. completely randomized design (four treatments and four replications) was used in this study.
5. The treatments consisted of followings: A was company rations (50% company forages +
6. 50% company concentrate(CC)), B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL)

15 + 30% CC + 20% PKCC), D (50% (T+CL)+ 20% CC + 30% PKCC). The variables analyzed

1. were as follows; milk production, milk quality (total solid, lactose, protein, fat, solid non-fat,
2. water content, specific gravity, pH, Ca and P minerals), dry matter intake (DMI), organic
3. matter intake (OMI), crude protein intake (CPI), dry matter digestibility (DMD), organic
4. matter digestibility (OMD), crude protein digestibility (CPD). Data analysis used analysis of
5. variance—a further test to determine differences between treatments using Duncan's multiple
6. ranges. The Analysis showed that the treatment had no significant effect (P>0.05) on feed
7. intake, digestibility, production, and milk quality. Using palm kernel cake concentrate and a
8. mixture of tithonia and cassava leaves was able to maintain the feed intake, feed digestibility,
9. production, and milk quality of ECDG. Replacement of company forages with a mixture of
10. cassava and tithonia and replacement of company concentrate with PKCC did not affect the
11. intake, digestibility, production, and quality of Etawa crossbreed dairy goat's milk. The
12. combination of 50% (cassava and tithonia) + 10% company concentrate + 40% PKCC was
13. able to maintain the intake, digestibility, production, and quality of Etawa crossbreed dairy
14. goat milk.

30

1. **Keywords**: cassava leaves, Etawa crossbreed dairy goat, milk production, palm kernel cake
2. concentrate, *Tithonia diversifolia*.

33

#### 34 INTRODUCTION

35

1. The availability of forage and the high price of concentrate are severe problems in
2. developing the Etawa crossbreed dairy goat (ECDG) farming. The increase in residential
3. areas impacts reducing forage for animal feed. At the same time, the price of concentrate is
4. getting more expensive day by day. Arief et al. (2018a) stated that alternative feed
5. exploration is very urgent to increase productivity and efficiency of livestock business. So, it
6. is necessary to find alternative sources of forage and concentrates with high production and
7. good nutritional quality.
8. Tithonia (*Tithonia diversifolia*) is a forage with good nutritional content (Pazla et al.
9. 2021a). The crude protein content is 22.89%, and organic matter is 84.01% (Pazla et al.
10. 2018a). Tithonia is also rich in P mineral, which can potentially increase the number of
11. rumen bacterial populations (Fasuyi et al. 2010; Adrizal et al. 2021; Pazla et al. 2021b).
12. Oluwasola and Dairo (2016) reported that tithonia plants are also rich in amino acids. The
13. mixture of tithonia with elephant grass as a fiber source in ECDG ration can optimize intake,
14. digestibility, and milk production (Pazla et al. 2022).
15. Cassava leaves contain Branched Chain Amino Acids (BCAA) such as isoleucine, valine,
16. and leucine 4.4, 8.43, and 8.75%, respectively (Suyitman et al. 2017a). BCAAs increase
17. nutrient digestibility like dry matter, organic matter, and acid detergent fiber through the
18. growth of cellulolytic bacteria (Zain et al. 2002). Supplementation of cassava leaves on
19. ammoniated palm stems increased rumen microbial growth and digestibility of DM, ADF,
20. and neutral detergent fiber (NDF) (Nurhaita and ningrat 2011). Suyitman et al. (2020)
21. reported that supplementing cassava leaves in Simmental cattle rations improved digestibility
22. and production performance.
23. Palm kernel cake concentrate (PKCC) is made from a mixture of feed ingredients that
24. have good nutrition for livestock growth and production, such as rice bran, corn, palm kernel
25. cake, and minerals. Energy (total digestible nutrient) and crude protein (CP) of PKCC are 60-
26. 64 and 14-16%, respectively (Arief et al. 2020). This research aims to determine the impact
27. of replacing company forages with a mixture of cassava and tithonia and replacing company
28. concentrate with PKCC on intake, digestibility, production, and quality of ECDG.

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#### MATERIALS AND METHODS

1. **Animal Ethics**
2. This research has referred to the ethics of research using livestock based on the law of the
3. government of the Republic of Indonesia Number 18 of 2009 article 66, which discusses
4. animal maintenance, killing, treatment, and reasonable care.

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#### 71 Experimental Site

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1. This study was carried out on Toni Farm company, Payakumbuh, West Sumatra,
2. Indonesia (-0.2330638,100.6268024, and 516 m asl); this area has two seasons (dry and
3. rainy). The rainy season is from September to February, and summer is from March to
4. August. This research was conducted in May – June 2022. The temperature of this area at the
5. time of the study was in the range of 22-35°C.

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#### Animal Experiment and Feeding Formulation

1. The livestock used in the study were 16 ECDG with an average body weight of 60±1.23
2. Kg and were in the second lactation, distributed in a completely randomized design with four
3. treatments (ration formulation) and four replicates. The treatments consisted of followings:
4. A was company ration as control (50% company forages + 50% company concentrate(CC)),

85 B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC + 20% PKCC), D

1. (50% (T+CL)+ 20% CC + 30% PKCC). The ratio of tithonia with cassava was 1:1
2. PKCC concentrate was made by formulating the following feed ingredients, namely 37%
3. rice bran + 40% palm kernel cake + 22% corn, and 1% minerals. All materials were mixed
4. homogeneously and stored in plastic at less than 12% moisture content.
5. The company forage was bush and native grass. The company's concentrate was made by
6. formulating feed ingredients along with tofu dregs, jackfruit skin, and skinless cassava. All
7. ingredients were stirred evenly and given in a fresh state. Meanwhile, forage company
8. forages, cassava leaves, and tithonia were given three times a day: in the morning at 08.00, at
9. noon at 13.00, and in the afternoon at 18.00. The concentrate was given twice daily, in the
10. morning at 07.00 and noon.
11. The experimental ration was formulated based on the NRC (2007) to fulfill the nutrition of
12. dairy goats weighing 60 kg and having the capacity to produce 2-3kg of milk with 4% fat
13. content per day. The chemical composition of each feed ingredient used is presented in Table
14. 1. The composition of the feed ingredients in the treatment ration and the nutritional
15. composition of the treatment ration are presented in Table 2.
16. Proximate analysis (dry matter, ash, crude protein, extract ether, and crude fiber) of
17. research feed ingredients was carried out based on AOAC international (1995). Fiber
18. fractions (cellulose, lignin, ADF, and NDF) were analyzed according to the technique
19. described by Van Soest (1982). TDN was calculated based on Moran (2005). The nitrogen-
20. free extract was calculated according to Jamarun et al. (2021).

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| --- | --- | --- |
| 106 |  | |
| 107 |  | TDN (%) = 5.31 +1.444 Cfat + 0.412 CP + 0.937 NFE + 0.249 CF |
| 108 |  | NFE= 100 - (ash+ CP+Cfat+CF) |
| 109 | Note: |  |
| 110 |  | TDN= Total digestible nutrient |
| 111 |  | CP= Crude protein |
| 112 |  | CF= Crude fiber |
| 113 |  | Cfat= Crude fat |
| 114 |  | NFE= Nitrogen-free extract. |
| 115 |  |  |

1. The study lasted 45 days, divided into three periods: the adaptation period of 25 days, the
2. preliminary period of 15 days, and the 5-day collection period. The fresh ration intake was
3. calculated by calculating the difference between the amount of ration and the rest of the
4. ration.
5. DMI (Kg/h/day) = Fresh Intake \* DMCR
6. OMI (Kg/h/day) = DMI \* OMCR
7. CPI (Kg/h/day) = DMI \* CPCR
8. 123
9. Note:
10. DMI= Dry matter intake
11. OMI= Organic matter intake
12. CPI= Crude protein intake
13. DMCR= Dry matter content of the ration
14. OMCR= Organic matter content of the ration
15. CPCR= Crude protein content of the ration
16. 131
17. Feces were collected at 6am. All fresh feces were weighed, 10% was taken for each
18. treatment, then dried in the sun. The dried feces were then ground into a fine powder for
19. analysis of chemical composition samples. The difference between ration intake and fecal
20. production calculates feed digestibility. The formula used is:
21. DMD (%) = (DMI- Feces)/ DMI \* 100%)
22. OMD (%) = (OMI- Feces)/ OMI \* 100%)
23. CPD = (CPI- Feces)/ CPI \* 100%)
24. 139
25. Goats were milked twice a day, in the morning and evening, using a mechanical milking
26. machine. Milk production was calculated for five days during the collection period in liters
27. and converted to Kg and FCM (Fat Corrected Milk) 4% based on the formula of Mavrogenis
28. and Papachristoforou (1988):
29. 144

145 4%FCM (Kg)= M (0.144+ 0.1444F)

1. Note:
2. M = Milk production in Kg
3. F= Fat content in %
4. 149
5. During the collection period, 250ml of milk samples was taken for each treatment. The
6. components for the milk quality test (total solid (milk dry matter), protein, fat, lactose, solid
7. non-fat, specific gravity, and pH) were tested using Lactoscan Pro 202.
8. 153

#### Statistical Analysis

1. A completely randomized design (Model) (Steel and Torrie 1991) was used to analyze
2. intake, feed digestibility, production, and milk quality. The data were analyzed with the study
3. concludes that of variance using the Excel 2019 program at a significance level of @=0.05.
4. Duncan's Advanced Multiple range tests were used to test the differences between treatments.
5. 159

|  |  |
| --- | --- |
| 160 | **RESULTS** |
| 161 |  |
| 162 | **Milk Production of Etawa Crossbreed Dairy Goats Treatment** |
| 163 | Replacement of company forages with a mixture of cassava and tithonia and replacement |
| 164 | of company concentrate with PKCC were not significantly different (P>0.05) in increasing |
| 165 | milk production. Using cassava leaves, tithonia, and PKCC is expected to increase milk |
| 166 | production. The average daily milk production results from replacing company forages with a |
| 167 | mixture of cassava leaves and tithonia and replacing company concentrate with PKCC in |

1. various percentages are presented in Table 3. The study concludes that of the variance of the
2. highest milk production after being converted to 4% FCM was in treatment D, and the lowest
3. was in treatment A (control).
4. 171

#### Milk Quality of Etawa Crossbreed dairy Goat Treatment

1. The results of statistical analysis showed that there was no significant difference (P>0.05)
2. in all milk quality parameters. Replacing the company forages with a mixture of cassava and
3. tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The
4. average milk quality results from replacing company forages with a mixture of cassava leaves
5. and tithonia and replacing company concentrate with PKCC in various percentages are
6. presented in Table 4.

#### Feed Intake of Etawa Crossbreed dairy Goats Treatment

1. The study concludes that results of dry matter intake, organic matter intake, and crude
2. protein intake by replacing company concentrate with PKCC and replacing company forages
3. with tithonia and cassava leaves are presented in Table 5. Replacing company concentrate
4. with PKCC and replacing company forages with tithonia and cassava leaves in the ration
5. gave no significant difference (P>0.05) in each treatment on the value of dry matter intake,
6. organic matter intake, and crude protein intake.

#### Digestibility of Etawa Crossbreed Dairy Goats Treatment

1. The study concludes that results of dry matter digestibility (DMD), organic matter
2. digestibility (OMD), and crude protein digestibility (CPD) by replacing company concentrate
3. with PKCC and replacing company forages with tithonia, and cassava leaves are presented in
4. Table 6. Table 6 shows that the treatment of replacing company concentrate with PKCC and
5. replacing company forages with a mixture of cassava leaves and tithonia had no significant
6. effect (P>0.05) on DMD, OMD, and CPD.
7. 193

#### DISCUSSION

1. 195

#### Milk Production of Etawa Crossbreed Dairy Goats Treatment

1. Replacement of company forages with a mixture of cassava and tithonia and replacement
2. of company concentrate with PKCC were not significantly different (P>0.05) in increasing
3. milk production. Milk production in dairy goats is strongly influenced by feed quality. Good
4. quality feed will increase milk production. Using cassava leaves, tithonia, and PKCC is
5. expected to increase milk production.
6. The study concludes that of the variance of the highest milk production after being
7. converted to 4% FCM was in treatment D, and the lowest was in treatment A (control). The
8. insignificant difference between treatments A, B, C, and D could be caused by the feed
9. quality. The prepared rations had a crude protein that was not much different between A

206 (21.35%) rations, B (22.07%), C (21.69%), and D (21.31%) rations (Table 2). The intake of

1. feed protein also influences milk production. Saskia (2022) stated that feed protein plays a
2. role in forming lactose. Lactose is water-binding, so the more lactose is formed, the more
3. milk will be produced. In the research conducted, the lactose content obtained in each

210 treatment was A=4.52%, B=4.44%, C=3.91%, and D= 5.29% (Table 4)

1. Good dairy goats have a high amount of milk production and are standardized at 4% FCM
2. (Christi & Rohayati 2018). From the average value of 4% FCM milk production, it can be
3. seen that the highest production was in treatment D (1.32kg/head/day). This indicates that
4. after being standardized to 4% FCM, it turns out that treatment D has a high milk fat content,
5. which affects the production of 4% FCM milk. Based on the results of the study, it was found
6. that the milk fat content in each treatment was: A=4.52%, B=4.44%, C=3.91%, and D=5.29%
7. (Table 4), with the highest increase in milk fat content in treatment D was thought to be
8. because the fat from the D ration was higher from other rations (Table 2), causing high milk
9. production as well. Milk production of 4% FCM is carried out to equalize the energy level in
10. the milk content.

#### Quality of Etawa Crossbreed dairy Goat's Milk Treatment

1. Nutrient components in feed significantly affect the quality of milk. Good quality milk
2. meets milk quality standards. The results of statistical analysis showed that there was no
3. significant difference (P>0.05) in all milk quality parameters. Replacing the company forages
4. with a mixture of cassava and tithonia and replacing the company's concentrate with PKCC
5. did not affect milk quality. The quality of milk produced in treatments A, B, C, and D was
6. within the normal range based on Thai Agricultural Standards (2008). This value indicates
7. that the response of ECDG to rations containing PKCC concentrate and forages of cassava
8. leaves and tithonia is quite good.
9. The feed quality factors (TDN and CP), which were almost the same between treatments,
10. were thought to be the reason the milk quality did not differ between treatments (P>0.05).
11. Arief et al. (2018a) strengthened this study, stated that the sort of feed influences the milk
12. produced. The good feed also improve animal metabolism by increasing the supply of
13. electricity and vitamins for the synthesis of milk components (Arief et al. 2018b). In addition,
14. the same intake of dry matter, organic matter, and crude protein among treatments also
15. caused no difference in the milk quality. The intake and digestibility of the same feed do not
16. affect the final fermented product in the rumen. Volatile fatty acid (VFA) is a product of
17. rumen fermentation. VFA manufacturing offers enough strength for rumen bacteria to
18. develop and grow (Jamarun et al. 2019) and the supply of uncooked substances for milk
19. synthesis (Jamarun et al. 2020). This results are similar with the study from Pazla et al.
20. (2022). They also found no difference in milk quality in ECDG given a mixture of tithonia
21. forage with elephant grass with the addition of a concentrate consisting of corn, rice bran,
22. tofu dregs, and palm kernel cake. Marques et al. (2022) also found the same quality of goat's
23. milk when given forage with a combination of cassava and alfalfa.

#### Feed Intake of Etawa Crossbreed Dairy Goats Treatment

1. Intake of dry matter can produce energy for milk production because it contains food
2. substances consisting of organic materials such as protein, fat, and carbohydrates (Jamarun et
3. al. 2021). The study concludes that results of DMI, OMI, and CPI by replacing company
4. concentrate with PKCC and replacing company forages with tithonia and cassava leaves are
5. presented in Table 5. Replacing company concentrate with PKCC and replacing company
6. forages with tithonia and cassava leaves in the ration showed no significant difference
7. (P>0.05) in each treatment on the value of DMI, OMI, and CPI. The insignificant difference
8. in each treatment could be caused by the type of ration given. In replacing the company's
9. concentrate with PKCC and company forages with tithonia and cassava leaves, it is necessary
10. to pay attention to the dry matter content of each feed ingredient. The dry matter content of
11. the company's concentrate is 23.81%, while the dry matter content of PKCC is 93.24%
12. (Table 1). Meanwhile, the dry matter content of company forages with tithonia and cassava
13. did not differ much. Of course, the difference in the substituted ingredients changed the form
14. of an increase in the dry matter content of the ration (ration A 24.91%, ration B 31.10%,
15. ration C 38.04%, and ration D 44.98%) (Table 2). However, there was an increase in the dry
16. matter content of the ration, and it had no significant difference against intake. This is
17. supported by Pazla et al. (2018b) that the amount of nutrient intake depends on the amount of
18. dry matter in the feed consumed and the nutrient content of the feed given. In the research
19. conducted, it was also observed that livestock have the ability to eat high feed, which is also
20. influenced by the needs of the livestock themselves, following the opinion of Arief et al.
21. (2021b), which states that the volume of feed needed by livestock, especially goats, depends
22. on their ability to eat feed and total weight body. The results obtained were higher than that
23. of Setyaningsih et al. (2013), whose average dry matter intake was 1.55-1.66 kg/e/day with
24. an average body weight of 43 kg. This is presumably because the capacity of the livestock
25. rumen influences dry matter intake.
26. Another factor that plays a role in dry matter intake is the level of palatability or livestock
27. preference on the feed given. In this study, it was found that the level of palatability of
28. tithonia, cassava leaves, and PKCC in its administration was favored by dairy goats. This is
29. under the opinion of Pazla et al. (2021c) that the palatability of feed directly affects interest
30. and causes appetite in livestock. Flavor, texture, smell, and taste significantly affect
31. palatability. Based on the observations made during the study, it was found that Tithonia,
32. cassava leaves, and PKCC have a flavor. The intake of organic matter is in line with the
33. intake of dry matter because organic matter is part of dry matter, which has been reduced by
34. inorganic matter. The pattern of increasing and decreasing organic matter intake is strongly
35. influenced by the components contained in dry matter (Kamalidin et al. 2012). This is also
36. supported by Febrina et al. (2017) that organic matter is carefully associated with dry matter
37. since organic matter is a part of dry matter; if the intake of dry matter from livestock is low, it
38. will be followed by a low level of intake of organic matter as well. Intake of organic matter is
39. also primarily determined by the constituent components of the organic material itself,
40. namely crude protein, extract ether, and crude fiber.
41. High intake of dry matter is a factor that causes a high intake of organic matter, but the
42. factor that increases intake of organic matter is not only feed; livestock is also one of the
43. factors that can increase intake of organic matter. The ability of livestock to eat feed and the
44. level of preference is also a factor in increasing the intake of organic matter. Murni et al.
45. (2012) stated that other factors influencing intake are animal body weight, feed digestibility,
46. palatability, feed quality, and the age of livestock. Intake of crude protein that did not differ
47. between treatments (P>0.05) was due to the protein content of the ration between treatments

293 that were not much different (A=21.35%, B=22.07%, C=21.69%, D=21.31%) (Table 2). The

1. intake of crude protein feed is directly proportional to dry and organic matter intake. Pazla et
2. al. (2021c) stated that feed protein positively correlated with dry matter, protein, and energy
3. intake. The amount of feed consumed affects other nutrients consumed. Martawidjaja et al.
4. (1999) stated that the factors influencing feed protein intake are dry matter intake and protein
5. content. Intake of crude protein in this study was higher than Marwah et al. (2010), who
6. received crude protein intake of ECDG of 0.34 Kg/head/day by feeding *Calliandra*
7. *calothyrsus* and concentrate, and Krisnan et al. (2015), who reported 0.24 kg/head/day by
8. feeding *Pennisetum purpupoides*, *Leucaena leucocephala* and concentrates.
9. 302

#### Digestibility of Etawa Crossbreed Dairy Goats Treatment

1. Table 6 shows that the treatment of replacing company concentrate with PKCC and
2. replacing company forages with a mixture of cassava leaves and tithonia had no significant
3. effect (P>0.05) on DMD, OMD, and CPD. The non-significant difference between treatments
4. was due to the lignin content of the A, B, C, and D rations not being much different. The
5. difference in the lignin content of the ration is only 2.83%. In addition, the lignin content of
6. tithonia and cassava is lower than that of the company forages. In contrast, the lignin content
7. of PKCC is not much different from that of the firm concentrate. High lignin content in
8. livestock rations reduces digestibility because lignin is a timber substance that cannot be
9. digested using rumen microbes (Pazla et al. 2020; Pazla et al. 2021d).
10. The chemical composition of the ration also influences the digestibility of dry matter,
11. organic matter, and crude protein. The chemical composition of rations A, B, C, and D is
12. almost identical. The rations of this study were prepared with a TDN content of 62-64%. In
13. digesting feed ingredients, sufficient and balanced protein and energy are needed for rumen
14. microbial activity to digest food substances, including dry matter, organic matter, and crude
15. protein. Crude protein undergos fermentation in the rumen, which produces ammonia (NH3)
16. (Suyitman et al. 2021). NH3 increases the rumen's microbial population (Putri et al. 2019;
17. Putri et al. 2021). TDN derived from the diet acts as an energy source for rumen microbes.
18. The large population of rumen microbes affects the digestibility of food substances. The same
19. protein and TDN composition in the treatment rations causes the digestibility of dry matter,
20. organic matter, and crude protein to be relatively the same (P>0.05). This follows the opinion
21. of Jamarun et al. (2017), which states that feed digestibility is influenced by the ration
22. composition and the activity of microorganisms.
23. 326

#### Conclusion

1. Replacement of company forages with a mixture of cassava and tithonia and replacement of
2. company concentrate with PKCC did not affect the intake, digestibility, production, and
3. quality of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and tithonia)

331 + 10% company concentrate + 40% PKCC was able to maintain the intake, digestibility,

332 production, and quality of Etawa crossbreed dairy goat milk.

333

#### Author Contributions

1. Conceptualization: Arief and Roni Pazla, Data Curation: Roni Pazla. Formal analysis: Roni
2. Pazla and Rizqan. Funding acquisition: Arief and Novirman Jamarun. Methodology: Arief,
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6. 340
7. 341

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8. concludes that of feed ingredients, feces, and milk.
9. 351

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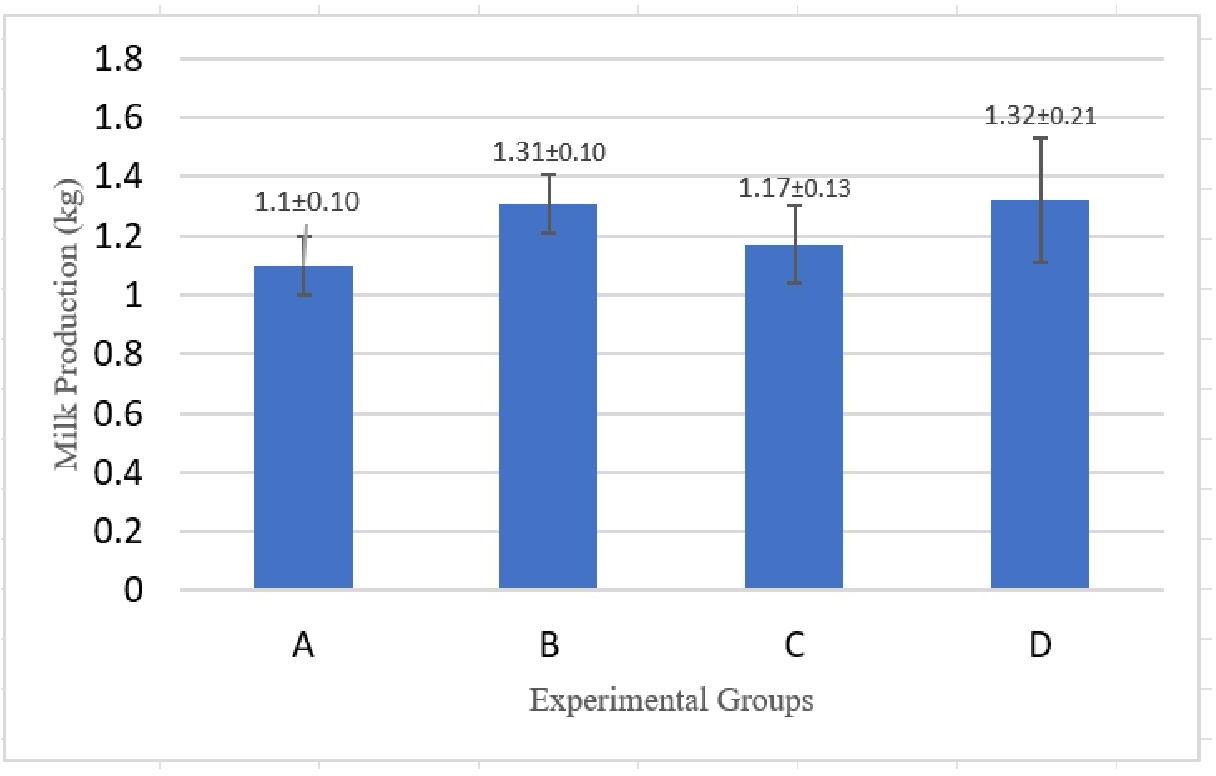
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6. 497
7. 498
8. 499
9. **Table 1:** Chemical composition of feed ingredients

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Nutrients (%) |  |  |  |  | Feed stuff | | |  |  |  |  |
| Company  forages | T | CL | JS | Rice  bran | Tofu  waste | PKC | Corn | PKCC | Skinless  cassava | Company  Concentrate |
| DM | 26.03 | 23.13 | 26.21 | 13.01 | 87.8 | 28.4 | 91.83 | 85.8 | 93.24 | 29.04 | 23.81 |
| OM | 87.93 | 84.65 | 86.33 | 95.02 | 90.8 | 97.67 | 91.41 | 99.1 | 90.23 | 98.78 | 96.92 |
| CP | 25.43 | 25.07 | 30.18 | 12.06 | 10.72 | 20.11 | 12.36 | 7.70 | 13.46 | 11.66 | 17.27 |
| CF | 28.02 | 22.62 | 19.92 | 28.01 | 11.6 | 19 | 26.68 | 2.44 | 18.33 | 4.28 | 20.98 |
| NDF | 48.27 | 55.03 | 56.13 | 71.54 | 55.13 | 59.28 | 66.7 | 49.96 | 62.84 | 37.38 | 61.86 |
| Cfat | 2.73 | 1.62 | 3.10 | 4.00 | 8.73 | 1.25 | 8.23 | 3.50 | 4.96 | 1.13 | 2.07 |
| TDN | 54.53 | 53.54 | 56.44 | 68.8 | 66.63 | 74.61 | 65.4 | 81.9 | 66.36 | 86.53 | 73.46 |
| NFE | 31.75 | 35.34 | 33.13 | 50.93 | 59.75 | 57.31 | 44.14 | 85.46 | 53.48 | 81.71 | 56.62 |
| ASH | 12.07 | 15.35 | 13.67 | 5.00 | 9.2 | 2.33 | 8.59 | 0.90 | 9.77 | 1.22 | 3.08 |
| ADF | 36.45 | 34.2 | 33.69 | 58.55 | 29.35 | 26.65 | 46.10 | 36.76 | 36.02 | 8.92 | 35.33 |
| Hemi | 11.82 | 20.83 | 22.44 | 12.99 | 25.78 | 32.63 | 20.60 | 13.20 | 26.82 | 28.46 | 26.53 |
| Lignin | 11.72 | 5.81 | 6.87 | 8.54 | 06.90 | 2.3 | 17.29 | 07.50 | 3.92 | 6.49 | 4.38 |
| Cellulose | 24.4 | 27.54 | 28.48 | 24.46 | 15.52 | 22.93 | 43.25 | 29.52 | 16.97 | 14.07 | 22.95 |

1. Dry matter (DM), Organic matter (OM), Crude protein (CP), Crude fiber (CF), Neutral
2. detergent fiber, Crude fat (Cfat), Total digestible nutrient (TDN), Nitrogen free extract
3. (NFE), Acid detergent fiber (ADF), Hemicellulose (Hemi), *Tithonia diversifolia* (T). Cassava
4. leaves (CL), Jackfruit skin (JS), Palm kernel cake (PKC), Palm kernel cake concentrate
5. (PKCC)
6. 506
7. 507
8. **Table 2:** Composition of ration and nutritional content of treatment ration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Feedstuff |  | Treatments | |  |
| A | B | C | D |
| Company Forages | 50 | 0 | 0 | 0 |
| *Tithonia diversifolia* | - | 25 | 25 | 25 |
| Cassava Leaves | - | 25 | 25 | 25 |
| PKCC | - | 10 | 20 | 30 |
| Company Concentrate | 50 | 40 | 30 | 20 |
| Total | 100 | 100 | 100 | 100 |
| Nutrient Composition |  |  |  |  |
| Dry Matter | 24.91 | 31.10 | 38.04 | 44.98 |
| Organic Matter | 92.43 | 90.54 | 89.87 | 89.20 |
| Crude Protein | 21.35 | 22.07 | 21.69 | 21.31 |
| Crude Fiber | 24.49 | 20.85 | 20.59 | 20.33 |
| NDF | 55.07 | 58.82 | 58.92 | 59.01 |
| Crude Fat | 2.40 | 2.50 | 2.79 | 3.08 |
| TDN | 64.00 | 63.52 | 62.81 | 62.10 |
| NFE | 44.18 | 45.11 | 44.80 | 44.48 |
| Ash | 7.57 | 9.46 | 10.13 | 10.80 |
| Lignin | 8.05 | 5.31 | 5.27 | 5.22 |

1. Neutral detergent fiber, Total digestible nutrient (TDN), Nitrogen free extract (NFE), Palm
2. kernel cake concentrate (PKCC)
3. 511
4. 512
5. 513
6. 514
7. 515
8. 516
9. 517
10. 518
11. 519
12. 520
13. 521
14. 522
15. **Fig.** 1. Milk Production of Etawa Crossbreed Dairy Goats Treatment
16. 524
17. 525
18. **Table 3:** Quality of Etawa Crossbreed Dairy Goat's Milk Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter |  | Goat milk | |  |
| A | B | C | D |
| pH | 6.23±0.05 | 6.32±0.06 | 6.36±0.05 | 6.52±0.07 |
| Fat Level (%) | 4.52±0.27 | 4.44±0.26 | 3.91±0.29 | 5.29±0.21 |
| Lactose (%) | 4.52±0.19 | 4.44±0.31 | 3.91±0.23 | 5.29±0.35 |
| SNF (%) | 9.53±0.14 | 9.46±0.34 | 9.01±0.63 | 8.99±0.20 |
| Protein (%) | 3.46±0.05 | 3.44±0.13 | 3.28±0.23 | 3.26±0.09 |
| Specific Gravity | 1.033±0.008 | 1.032±0.001 | 1.031±0.001 | 1.030±0.001 |
| Phosphorus (%) | 3.17±0.44 | 3.40±0.08 | 3.19±0.20 | 2.92±0.19 |
| Calcium (%) | 2.51±0.55 | 2.46±0.32 | 2.32±0.26 | 2.90±0.28 |
| Water Content (%) | 14.05±0.38 | 13.89±1.39 | 12.91±1.96 | 14.28±1.37 |
| Dry Matter (%) | 85.95±0.38 | 86.11±1.39 | 87.09±1.96 | 85.73±1.37 |

1. Solid non-fat (SNF); There is no significant between treatments (P>0.05)
2. **Table 4:** Ration Intake of Etawa Crossbreed Dairy Goats Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Intake |  | Treatment | |  |
| (kg/e/day) | A | B | C | D |

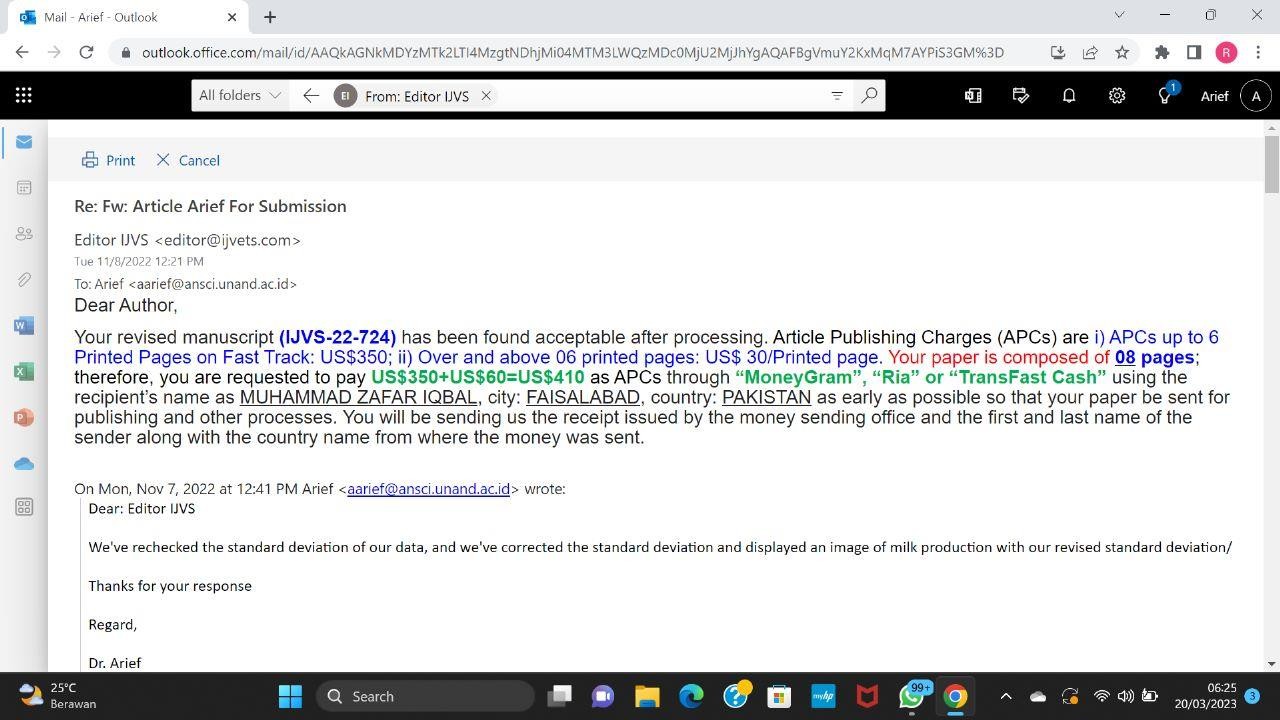
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dry Matter | 2.44±0.21 | 2.51±0.47 | 2.48±0.11 | 2.46±0.68 |
| Organic Matter | 2.20±0.19 | 2.27±0.43 | 2.25±0.10 | 2.21±0.59 |
| Crude Protein | 0.60±0.07 | 0.65±0.08 | 0.62±0.05 | 0.61±0.07 |

1. There is no significant between treatments (P>0.05)
2. 530
3. **Table 5:** Digestibility of Etawa Crossbreed Dairy Goats Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Digestibility  (%) |  | Treatment | |  |
| A | B | C | D |
| Dry Matter | 65.85±1.19 | 66.17±1.89 | 67.23±1.78 | 67.98±1.55 |
| Organic Matter | 67.76±1.17 | 68.02±1.76 | 68.88±1.63 | 69.32±1.48 |
| Crude Protein | 69.56±1.03 | 70.34±1.11 | 71.38±1.24 | 71.97±1.41 |

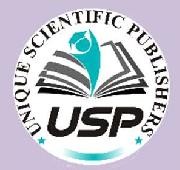
1. There is no significant between treatments (P>0.05)

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**Production Performance, Feed Intake and Nutrient Digestibility of Etawa Crossbreed Dairy Goats Fed Tithonia (*Tithonia diversifolia*), Cassava Leaves and Palm Kernel Cake Concentrate**

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|  |
| --- |
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| **ABSTRACT**  This research aimed at the intake, digestibility, production, and milk quality of Etawa crossbreeds dairy goat (ECDG) fed conventional mixed forage; tithonia (*Tithonia diversifolia*) (T) and cassava leaves (CL) with palm kernel cake concentrate (PKCC). A completely randomized design (four treatments and four replications) was used in this study. The treatments consisted of followings: A was company rations (50% company forages + 50% company concentrate(CC)), B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC + 20% PKCC), D (50%  (T+CL)+ 20% CC + 30% PKCC). The variables analyzed were as follows; milk production, milk quality (total solid, lactose, protein, fat, solid non-fat, water content, specific gravity, pH, Ca and P minerals), dry matter intake (DMI), organic matter intake (OMI), crude protein intake (CPI), dry matter digestibility (DMD), organic matter digestibility (OMD), crude protein digestibility (CPD). Data analysis used analysis of variance—a further test to determine differences between treatments using Duncan's multiple ranges. The Analysis showed that the treatment had no significant effect (P>0.05) on feed intake, digestibility, production, and milk quality. Using palm kernel cake concentrate and a mixture of tithonia and cassava leaves was able to maintain the feed intake, feed digestibility, production, and milk quality of ECDG. Replacement of company forages with a mixture of cassava and tithonia and replacement of company concentrate with PKCC did not affect the intake, digestibility, production, and quality of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and tithonia) + 10% company concentrate + 40% PKCC was able to maintain the intake, digestibility, production, and quality of Etawa crossbreed dairy goat milk. |
| **Key words:** Cassava Leaves, Etawa Crossbreed Dairy Goat, Milk Production, Palm Kernel Cake Concentrate,  Tithonia Diversifolia. |

**INTRODUCTION**

The availability of forage and the high price of concentrate are severe problems in developing the Etawa crossbreed dairy goat (ECDG) farming. The increase in residential areas impacts reducing forage for animal feed. At the same time, the price of concentrate is getting more expensive day by day. Arief et al. (2018a) stated that alternative feed exploration is very urgent to increase productivity and efficiency of livestock business. So, it is necessary to find alternative sources of forage and concentrates with high production and good nutritional quality.

Tithonia (*Tithonia diversifolia*) is a forage with good nutritional content (Pazla et al. 2021a). The crude protein content is 22.89%, and organic matter is 84.01% (Pazla et al. 2018a). Tithonia is also rich in P mineral, which can potentially increase the number of rumen bacterial populations (Fasuyi et al. 2010; Adrizal et al. 2021; Pazla et al. 2021b). Oluwasola and Dairo (2016) reported that tithonia plants are also rich in amino acids. The mixture of tithonia with elephant grass as a fiber source in ECDG ration can optimize intake, digestibility, and milk production (Pazla et al. 2022).

Cassava leaves contain Branched Chain Amino Acids (BCAA) such as isoleucine, valine, and leucine 4.4, 8.43,

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and 8.75%, respectively (Suyitman et al. 2017a). BCAAs increase nutrient digestibility like dry matter, organic matter, and acid detergent fiber through the growth of cellulolytic bacteria (Zain et al. 2002). Supplementation of cassava leaves on ammoniated palm stems increased rumen microbial growth and digestibility of DM, ADF, and neutral detergent fiber (NDF) (Nurhaita and Ningrat 2011). Suyitman et al. (2020) reported that supplementing cassava leaves in Simmental cattle rations improved digestibility and production performance.

Palm kernel cake concentrate (PKCC) is made from a mixture of feed ingredients that have good nutrition for livestock growth and production, such as rice bran, corn, palm kernel cake, and minerals. Energy (total digestible nutrient) and crude protein (CP) of PKCC are 60-64 and 14-16%, respectively (Arief et al. 2020). This research aims to determine the impact of replacing company forages with a mixture of cassava and tithonia and replacing company concentrate with PKCC on intake, digestibility, production, and quality of ECDG.

**MATERIALS AND METHODS**

**Animal Ethics**

This research has referred to the ethics of research using livestock based on the law of the government of the Republic of Indonesia Number 18 of 2009 article 66, which discusses animal maintenance, killing, treatment, and reasonable care.

**Experimental Site**

This study was carried out on Toni Farm company, Payakumbuh, West Sumatra, Indonesia (- 0.2330638,100.6268024, and 516 m asl); this area has two seasons (dry and rainy). The rainy season is from September to February, and summer is from March to August. This research was conducted in May – June 2022. The temperature of this area at the time of the study was in the range of 22-35°C.

**Animal Experiment and Feeding Formulation**

The livestock used in the study were 16 ECDG with an average body weight of 60±1.23kg and were in the second lactation, distributed in a completely randomized design with four treatments (ration formulation) and four replicates. The treatments consisted of followings: A was company ration as control (50% company forages + 50% company concentrate (CC)), B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC + 20% PKCC), D (50% (T+CL)+ 20% CC + 30% PKCC). The ratio of

tithonia with cassava was 1:1

PKCC concentrate was made by formulating the following feed ingredients, namely 37% rice bran + 40% palm kernel cake + 22% corn, and 1% minerals. All materials were mixed homogeneously and stored in plastic at less than 12% moisture content.

The company forage was bush and native grass. The company's concentrate was made by formulating feed ingredients along with tofu dregs, jackfruit skin, and skinless cassava. All ingredients were stirred evenly and given in a fresh state. Meanwhile, forage company forages, cassava leaves, and tithonia were given three

times a day: in the morning at 08.00, at noon at 13.00, and in the afternoon at 18.00. The concentrate was given twice daily, in the morning at 07.00 and noon.

The experimental ration was formulated based on the NRC (2007) to fulfill the nutrition of dairy goats weighing 60 kg and having the capacity to produce 2-3kg of milk with 4% fat content per day. The chemical composition of each feed ingredient used is presented in Table 1. The composition of the feed ingredients in the treatment ration and the nutritional composition of the treatment ration are presented in Table 2.

Proximate analysis (dry matter, ash, crude protein, extract ether, and crude fiber) of research feed ingredients was carried out based on AOAC international (1995). Fiber fractions (cellulose, lignin, ADF, and NDF) were analyzed according to the technique described by Van Soest (1982). TDN was calculated based on Moran (2005). The nitrogen-free extract was calculated according to Jamarun et al. (2021).

TDN (%) = 5.31 +1.444 Cfat + 0.412 CP + 0.937 NFE +

0.249 CF

NFE= 100 - (ash+ CP+Cfat+CF)

Note:

TDN= Total digestible nutrient CP= Crude protein

CF= Crude fiber Cfat= Crude fat

NFE= Nitrogen-free extract.

The study lasted 45 days, divided into three periods: the adaptation period of 25 days, the preliminary period of 15 days, and the 5-day collection period. The fresh ration intake was calculated by calculating the difference between the amount of ration and the rest of the ration.

DMI (kg/h/day) = Fresh Intake \* DMCR OMI (kg/h/day) = DMI \* OMCR

CPI (kg/h/day) = DMI \* CPCR Note:

DMI= Dry matter intake OMI= Organic matter intake CPI= Crude protein intake

DMCR= Dry matter content of the ration OMCR= Organic matter content of the ration CPCR= Crude protein content of the ration

Feces were collected at 6am. All fresh feces were weighed, 10% was taken for each treatment, then dried in the sun. The dried feces were then ground into a fine powder for analysis of chemical composition samples. The difference between ration intake and fecal production calculates feed digestibility. The formula used is:

DMD (%) = (DMI- Feces)/ DMI \* 100%) OMD (%) = (OMI- Feces)/ OMI \* 100%) CPD = (CPI- Feces)/ CPI \* 100%)

Goats were milked twice a day, in the morning and evening, using a mechanical milking machine. Milk production was calculated for five days during the collection period in liters and converted to kg (Fig. 1) and FCM (Fat Corrected Milk) 4% based on the formula of Mavrogenis and Papachristoforou (1988):

4%FCM (kg)= M (0.144+ 0.1444F)

Note:

M = Milk production in kg F= Fat content in %

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**Table 1:** Chemical composition of feed ingredients

Nutrients Feed stuff

Skinless

(%) Company

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | forages |  | bran | waste |  |  | cassava | Concentrate |
| DM | 26.03 | 23.13 26.21 | 13.01 87.8 | 28.4 | 91.83 | 85.8 | 93.24 29.04 | 23.81 |
| OM | 87.93 | 84.65 86.33 | 95.02 90.8 | 97.67 | 91.41 | 99.1 | 90.23 98.78 | 96.92 |
| CP | 25.43 | 25.07 30.18 | 12.06 10.72 | 20.11 | 12.36 | 7.70 | 13.46 11.66 | 17.27 |
| CF | 28.02 | 22.62 19.92 | 28.01 11.6 | 19 | 26.68 | 2.44 | 18.33 4.28 | 20.98 |
| NDF | 48.27 | 55.03 56.13 | 71.54 55.13 | 59.28 | 66.7 | 49.96 | 62.84 37.38 | 61.86 |
| Cfat | 2.73 | 1.62 3.10 | 4.00 8.73 | 1.25 | 8.23 | 3.50 | 4.96 1.13 | 2.07 |
| TDN | 54.53 | 53.54 56.44 | 68.8 66.63 | 74.61 | 65.4 | 81.9 | 66.36 86.53 | 73.46 |
| NFE | 31.75 | 35.34 33.13 | 50.93 59.75 | 57.31 | 44.14 | 85.46 | 53.48 81.71 | 56.62 |
| ASH | 12.07 | 15.35 13.67 | 5.00 9.2 | 2.33 | 8.59 | 0.90 | 9.77 1.22 | 3.08 |
| ADF | 36.45 | 34.2 33.69 | 58.55 29.35 | 26.65 | 46.10 | 36.76 | 36.02 8.92 | 35.33 |
| Hemi | 11.82 | 20.83 22.44 | 12.99 25.78 | 32.63 | 20.60 | 13.20 | 26.82 28.46 | 26.53 |
| Lignin | 11.72 | 5.81 6.87 | 8.54 06.90 | 2.3 | 17.29 | 07.50 | 3.92 6.49 | 4.38 |
| Cellulose | 24.4 | 27.54 28.48 | 24.46 15.52 | 22.93 | 43.25 | 29.52 | 16.97 14.07 | 22.95 |

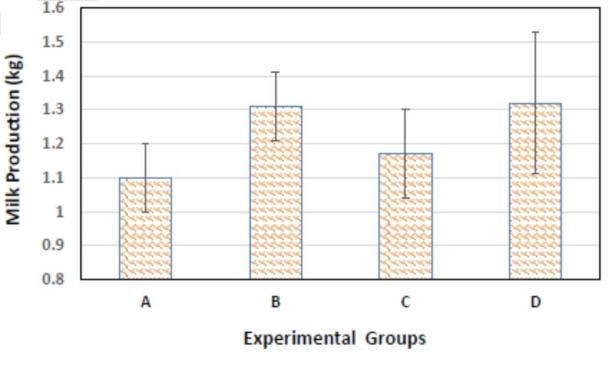
T CL JS Rice

Tofu

PKC Corn PKCC

Company

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* (T). Cassava leaves (CL), Jackfruit skin (JS), Palm kernel cake (PKC), Palm kernel cake concentrate (PKCC)



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

Feedstuff Treatments

A B C D

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company Forages | 50 | 0 | 0 | 0 |
| *Tithonia diversifolia* | - | 25 | 25 | 25 |
| Cassava Leaves | - | 25 | 25 | 25 |
| PKCC | - | 10 | 20 | 30 |
| Company Concentrate | 50 | 40 | 30 | 20 |
| Total | 100 | 100 | 100 | 100 |
| Nutrient Composition |  |  |  |  |
| Dry Matter | 24.91 | 31.10 | 38.04 | 44.98 |
| Organic Matter | 92.43 | 90.54 | 89.87 | 89.20 |
| Crude Protein | 21.35 | 22.07 | 21.69 | 21.31 |
| Crude Fiber | 24.49 | 20.85 | 20.59 | 20.33 |
| NDF | 55.07 | 58.82 | 58.92 | 59.01 |
| Crude Fat | 2.40 | 2.50 | 2.79 | 3.08 |
| TDN | 64.00 | 63.52 | 62.81 | 62.10 |
| NFE | 44.18 | 45.11 | 44.80 | 44.48 |
| Ash | 7.57 | 9.46 | 10.13 | 10.80 |
| Lignin | 8.05 | 5.31 | 5.27 | 5.22 |

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

During the collection period, 250ml of milk samples was taken for each treatment. The components for the milk quality test (total solid (milk dry matter), protein, fat, lactose, solid non-fat, specific gravity, and pH) were tested using Lactoscan Pro 202.

**Statistical Analysis**

A completely randomized design (Model) (Steel and Torrie 1991) was used to analyze intake, feed digestibility, production, and milk quality. The data were analyzed with the study concludes that of variance using the Excel 2019 program at a significance level of @=0.05. Duncan's Advanced Multiple range tests were used to test the differences between treatments.

**RESULTS**

**Milk Production of Etawa Crossbreed Dairy Goats Treatment**

Replacement of company forages with a mixture of cassava and tithonia and replacement of company

concentrate with PKCC were not significantly different (P>0.05) in increasing milk production (Fig. 1). Using cassava leaves, tithonia, and PKCC is expected to increase milk production. The average daily milk production results from replacing company forages with a mixture of cassava leaves and tithonia and replacing company concentrate with PKCC in various percentages are presented in Table 3. The study concludes that of the variance of the highest milk production after being converted to 4% FCM was in treatment D, and the lowest was in treatment A (control).

**Fig. 1:** Milk Production of Etawa crossbreed dairy goat’s treatment.

**Milk Quality of Etawa Crossbreed dairy Goat Treatment**

The results of statistical analysis showed that there was no significant difference (P>0.05) in all milk quality parameters. Replacing the company forages with a mixture of cassava and tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The average milk quality results from replacing company forages with a mixture of cassava leaves and tithonia and replacing company concentrate with PKCC in various percentages are presented in Table 4.

**Feed Intake of Etawa Crossbreed dairy Goats Treatment**

The study concludes that results of dry matter intake, organic matter intake, and crude protein intake by replacing company concentrate with PKCC and replacing

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**Table 3:** Quality of Etawa crossbreed dairy goat's milk with various treatments

Parameters

Goat milk

A B C D

pH 6.23±0.05 6.32±0.06 6.36±0.05 6.52±0.07

Fat Level (%) 4.52±2.27 4.44±1.26 3.91±2.29 5.29±1.21

Lactose (%) 4.52±0.19 4.44±0.31 3.91±1.23 5.29±1.35

SNF (%) 9.53±2.27 9.46±1.26 9.01±2.29 8.99±1.21

Protein (%) 3.46±0.05 3.44±0.07 3.28±0.07 3.26±0.09

Specific Gravity 1.033±0.07 1.032±0.11 1.031±0.13 1.030±0.07

Phosphorus (%) 3.17±0.25 3.40±0.37 3.19±0.49 2.92±1.45

Calcium (%) 2.51±0.12 2.46±0.17 2.32±0.21 2.90±0.51

Water Content (%) 14.05±1.72 13.89±2.57 12.91±1.98 14.28±1.81

Dry Matter (%) 85.95±1.72 86.11±2.57 87.09±1.98 85.73±1.81



Solid non-fat (SNF); There is no significant between treatments (P>0.05). Treatment A= Company ration (50% company forages+50%company concentrate (CC)), B=(50%(T+CL)+40% CC+10% PKCC), C=(50%(T+CL)+30% CC+20%PKCC), and

D=(50%(T+CL)+20% CC + 30% PKCC). *Tithonia diversifolia* (T), Cassava leaves (CL Palm kernel cake), and Palm kernel cake

concentrate (PKCC).

**Table 4:** Ration Intake of Etawa Crossbreed Dairy Goats Treatment

Intake (kg/e/day) Treatment

A B C D

Dry matter 2.44±3.21 2.51±2.47 2.48±3.11 2.46±2.68

Organic matter 2.20±3.09 2.27±2.13 2.25±3.26 2.21±2.39

Crude protein 0.60±1.91 0.65±1.87 0.62±1.37 0.61±1.49

There is no significant between treatments (P>0.05). Treatment A= Company ration (50% company forages+50%company concentrate (CC)), B=(50%(T+CL)+40% CC+10% PKCC), C=(50%(T+CL)+30% CC+20%PKCC), and D=(50%(T+CL)+20% CC + 30%

PKCC). *Tithonia diversifolia* (T), Cassava leaves (CL Palm kernel cake), and Palm kernel cake concentrate (PKCC).

**Table 5:** Digestibility of Etawa crossbreed dairy goats treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Digestibility (%) | A | Treatm  B | ent C | D |
| Dry matter | 65.85±1.19 | 66.17±1.89 | 67.23±1.78 | 67.98±1.55 |
| Organic matter | 67.76±1.17 | 68.02±1.76 | 68.88±1.63 | 69.32±1.48 |
| Crude protein | 69.56±1.03 | 70.34±1.11 | 71.38±1.24 | 71.97±1.41 |
| Footnote is same as that of Table 4. |  |  |  |  |

company forages with tithonia and cassava leaves are presented in Table 5. Replacing company concentrate with PKCC and replacing company forages with tithonia and cassava leaves in the ration gave no significant difference (P>0.05) in each treatment on the value of dry matter intake, organic matter intake, and crude protein intake.

**Digestibility of Etawa Crossbreed Dairy Goats Treatment**

The study concludes that results of dry matter digestibility (DMD), organic matter digestibility (OMD), and crude protein digestibility (CPD) by replacing company concentrate with PKCC and replacing company forages with tithonia, and cassava leaves are presented in Table 5. Table 5 shows that the treatment of replacing company concentrate with PKCC and replacing company forages with a mixture of cassava leaves and tithonia had no significant effect (P>0.05) on DMD, OMD, and CPD.

**DISCUSSION**

**Milk Production of Etawa Crossbreed Dairy Goats Treatment**

Replacement of company forages with a mixture of cassava and tithonia and replacement of company concentrate with PKCC were not significantly different (P>0.05) in increasing milk production. Milk production in dairy goats is strongly influenced by feed quality. Good quality feed will increase milk production. Using cassava

leaves, tithonia, and PKCC is expected to increase milk production.

The study concludes that the variance of the highest milk production after being converted to 4% FCM was in treatment D, and the lowest was in treatment A (control). The insignificant difference between treatments A, B, C, and D could be caused by the feed quality. The prepared rations had a crude protein that was not much different between A (21.35%) rations, B (22.07%), C (21.69%), and D (21.31%) rations (Table 2). The intake of feed protein also influences milk production. Prihatminingsih et al. (2015) stated that feed protein plays a role in forming lactose. Lactose is water-binding, so the more lactose is formed, the more milk will be produced. In the research conducted, the lactose content obtained in each treatment was A=4.52%, B=4.44%, C=3.91%, and D=5.29% (Table 4).

Good dairy goats have a high amount of milk production and are standardized at 4% FCM (Christi and Rohayati 2018). From the average value of 4% FCM milk production, it can be seen that the highest production was in treatment D (1.32kg/head/day). This indicates that after being standardized to 4% FCM, it turns out that treatment D has a high milk fat content, which affects the production of 4% FCM milk. Based on the results of the study, it was found that the milk fat content in each treatment was: A=4.52%, B=4.44%, C=3.91%, and D=5.29% (Table 4), with the highest increase in milk fat content in treatment D was thought to be because the fat from the D ration was higher from other rations (Table 2),

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causing high milk production as well. Milk production of 4% FCM is carried out to equalize the energy level in the milk contents.

**Quality of Etawa Crossbreed dairy Goat's Milk Treatment**

Nutrient components in feed significantly affect the quality of milk. Good quality milk meets milk quality standards. The results of statistical analysis showed that there was no significant difference (P>0.05) in all milk quality parameters. Replacing the company forages with a mixture of cassava and tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The quality of milk produced in treatments A, B, C, and D was within the normal range based on Thai Agricultural Standards (2008). This value indicates that the response of ECDG to rations containing PKCC concentrate and forages of cassava leaves and tithonia is quite good. The feed quality factors (TDN and CP), which were almost the same between treatments, were thought to be the reason the milk quality did not differ between treatments (P>0.05). Arief et al. (2018a) strengthened this study, stated that the sort of feed influences the milk produced. The good feed also improve animal metabolism by increasing the supply of electricity and vitamins for the synthesis of milk components (Arief et al. 2018b). In addition, the same intake of dry matter, organic matter, and crude protein among treatments also caused no difference in the milk quality. The intake and digestibility of the same feed do not affect the final fermented product in the rumen. Volatile fatty acid (VFA) is a product of rumen fermentation. VFA manufacturing offers enough strength for rumen bacteria to develop and grow (Jamarun et al. 2019) and the supply of uncooked substances for milk synthesis (Jamarun et al. 2020). This results are similar with the study from Pazla et al. (2022). They also found no difference in milk quality in ECDG given a mixture of tithonia forage with elephant grass with the addition of a concentrate consisting of corn, rice bran, tofu dregs, and palm kernel cake. Marques et al. (2022) also found the same quality of goat's milk when given forage with a combination of cassava and alfalfa.

**Feed Intake of Etawa Crossbreed Dairy Goats Treatment**

Intake of dry matter can produce energy for milk production because it contains food substances consisting of organic materials such as protein, fat, and carbohydrates (Jamarun et al. 2021). The study concludes that results of DMI, OMI, and CPI by replacing company concentrate with PKCC and replacing company forages with tithonia and cassava leaves are presented in Table 5. Replacing company concentrate with PKCC and replacing company forages with tithonia and cassava leaves in the ration showed no significant difference (P>0.05) in each treatment on the value of DMI, OMI, and CPI. The insignificant difference in each treatment could be caused by the type of ration given. In replacing the company's concentrate with PKCC and company forages with tithonia and cassava leaves, it is necessary to pay attention to the dry matter content of each feed ingredient. The dry matter content of the company's concentrate is 23.81%, while the dry matter content of PKCC is 93.24% (Table

1). Meanwhile, the dry matter content of company forages with tithonia and cassava did not differ much. Of course, the difference in the substituted ingredients changed the form of an increase in the dry matter content of the ration (ration A 24.91%, ration B 31.10%, ration C 38.04%, and ration D 44.98%) (Table 2). However, there was an increase in the dry matter content of the ration, and it had no significant difference against intake. This is supported by Pazla et al. (2018b) that the amount of nutrient intake depends on the amount of dry matter in the feed consumed and the nutrient content of the feed given. In the research conducted, it was also observed that livestock have the ability to eat high feed, which is also influenced by the needs of the livestock themselves, following the opinion of Arief et al. (2021b), which states that the volume of feed needed by livestock, especially goats, depends on their ability to eat feed and total weight body. The results obtained were higher than that of Setyaningsih et al. (2013), whose average dry matter intake was 1.55- 1.66kg/e/day with an average body weight of 43kg. This is presumably because the capacity of the livestock rumen influences dry matter intake.

Another factor that plays a role in dry matter intake is the level of palatability or livestock preference on the feed given. In this study, it was found that the level of palatability of tithonia, cassava leaves, and PKCC in its administration was favored by dairy goats. This is under the opinion of Pazla et al. (2021c) that the palatability of feed directly affects interest and causes appetite in livestock. Flavor, texture, smell, and taste significantly affect palatability. Based on the observations made during the study, it was found that Tithonia, cassava leaves, and PKCC have a flavor. The intake of organic matter is in line with the intake of dry matter because organic matter is part of dry matter, which has been reduced by inorganic matter. The pattern of increasing and decreasing organic matter intake is strongly influenced by the components contained in dry matter (Kamalidin et al. 2012). This is also supported by Febrina et al. (2017) that organic matter is carefully associated with dry matter since organic matter is a part of dry matter; if the intake of dry matter from livestock is low, it will be followed by a low level of intake of organic matter as well. Intake of organic matter is also primarily determined by the constituent components of the organic material itself, namely crude protein, extract ether, and crude fiber.

High intake of dry matter is a factor that causes a

high intake of organic matter, but the factor that increases intake of organic matter is not only feed; livestock is also one of the factors that can increase intake of organic matter. The ability of livestock to eat feed and the level of preference is also a factor in increasing the intake of organic matter. Murni et al. (2012) stated that other factors influencing intake are animal body weight, feed digestibility, palatability, feed quality, and the age of livestock. Intake of crude protein that did not differ between treatments (P>0.05) was due to the protein content of the ration between treatments that were not much different (A=21.35%, B=22.07%, C=21.69%, D=21.31%) (Table 2). The intake of crude protein feed is directly proportional to dry and organic matter intake. Pazla et al. (2021c) stated that feed protein positively correlated with dry matter, protein, and energy intake. The

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amount of feed consumed affects other nutrients consumed. Martawidjaja et al. (1999) stated that the factors influencing feed protein intake are dry matter intake and protein content. Intake of crude protein in this study was higher than Marwah et al. (2010), who received crude protein intake of ECDG of 0.34kg/head/day by feeding *Calliandra calothyrsus* and concentrate, and Krisnan et al. (2015), who reported 0.24kg/head/day by feeding *Pennisetum purpupoides*, *Leucaena leucocephala* and concentrates.

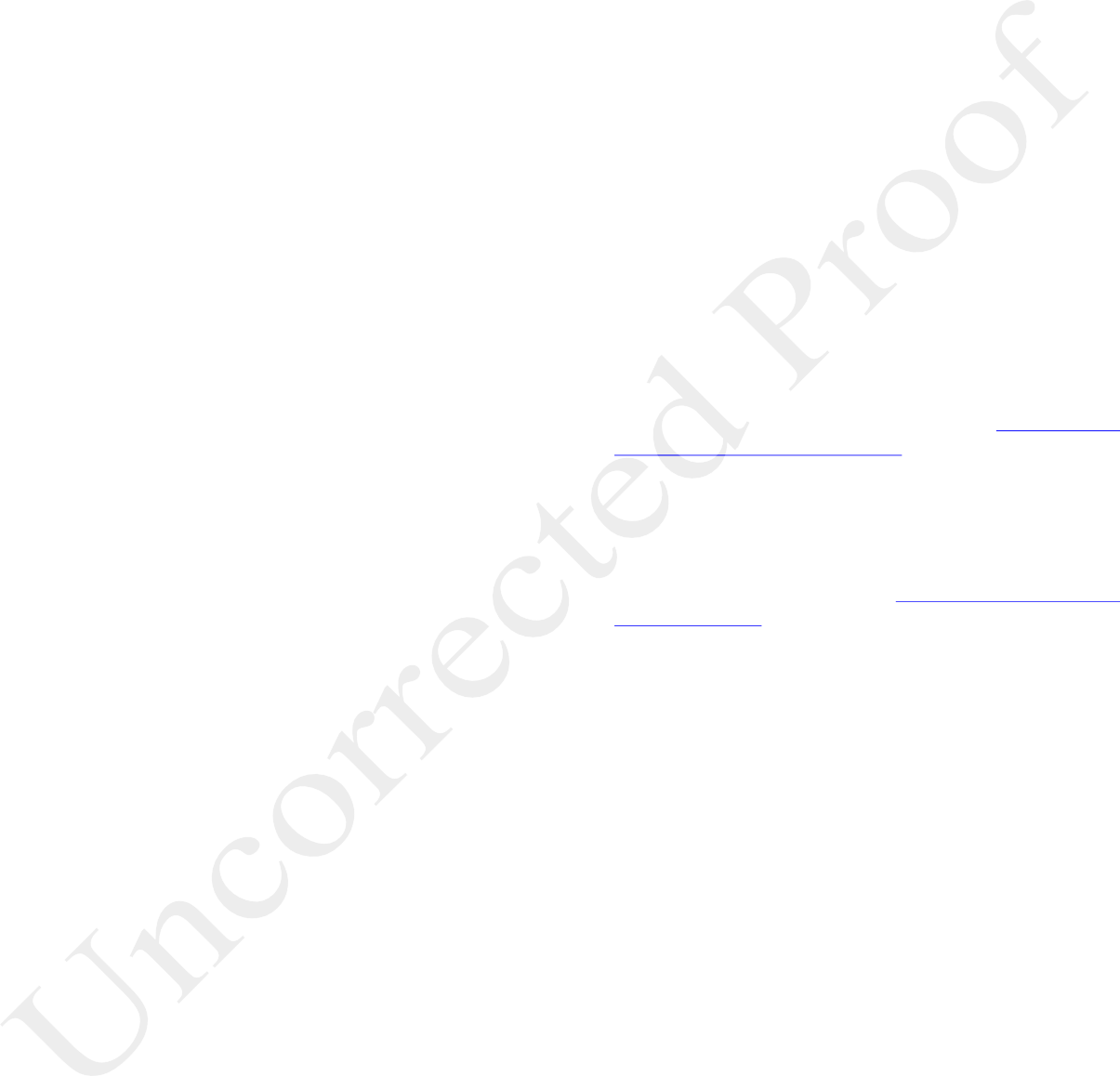
**Digestibility of Etawa Crossbreed Dairy Goats Treatment**

Table 5 shows that the treatment of replacing company concentrate with PKCC and replacing company forages with a mixture of cassava leaves and tithonia had no significant effect (P>0.05) on DMD, OMD, and CPD. The non-significant difference between treatments was due to the lignin content of the A, B, C, and D rations not being much different. The difference in the lignin content of the ration is only 2.83%. In addition, the lignin content of tithonia and cassava is lower than that of the company forages. In contrast, the lignin content of PKCC is not much different from that of the firm concentrate. High lignin content in livestock rations reduces digestibility because lignin is a timber substance that cannot be digested using rumen microbes (Pazla et al. 2020; Pazla et al. 2021d).

The chemical composition of the ration also influences the digestibility of dry matter, organic matter, and crude protein. The chemical composition of rations A, B, C, and D is almost identical. The rations of this study were prepared with a TDN content of 62-64%. In digesting feed ingredients, sufficient and balanced protein and energy are needed for rumen microbial activity to digest food substances, including dry matter, organic matter, and crude protein. Crude protein undergoes fermentation in the rumen, which produces ammonia (NH3) (Suyitman et al. 2021). NH3 increases the rumen's microbial population (Putri et al. 2019; Putri et al. 2021). TDN derived from the diet acts as an energy source for rumen microbes. The large population of rumen microbes affects the digestibility of food substances. The same protein and TDN composition in the treatment rations causes the digestibility of dry matter, organic matter, and crude protein to be relatively the same (P>0.05). This follows the opinion of Jamarun et al. (2017), which states that feed digestibility is influenced by the ration composition and the activity of microorganisms.

**Conclusion**

Replacement of company forages with a mixture of cassava and tithonia and replacement of company concentrate with PKCC did not affect the intake, digestibility, production, and quality of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and tithonia)+10% company concentrate+40% PKCC was able to maintain the intake, digestibility, production, and quality of Etawa crossbreed dairy goat milk.

**Author Contributions**

Conceptualization: Arief and Roni Pazla, Data Curation: Roni Pazla. Formal analysis: Roni Pazla and

Rizqan. Funding acquisition: Arief and Novirman Jamarun. Methodology: Arief, Roni Pazla, and Novirman JAmarun. Project administration: Rizqan. Supervision: Arief and Novirman Jamarun. Validation: Roni Pazla. Writing-original draft: Roni Pazla and Arif. Writing- review and editing: Rizqan.

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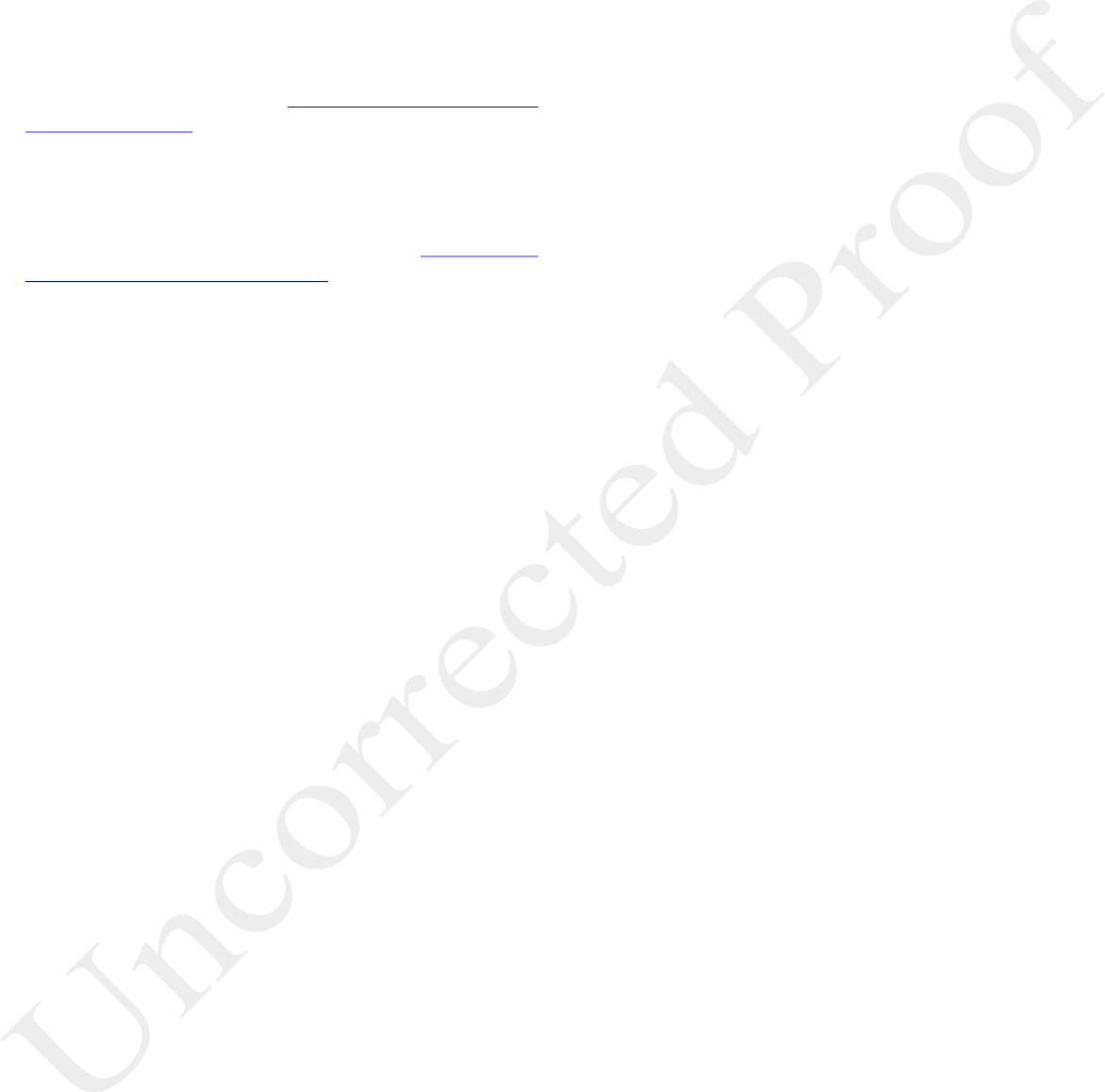
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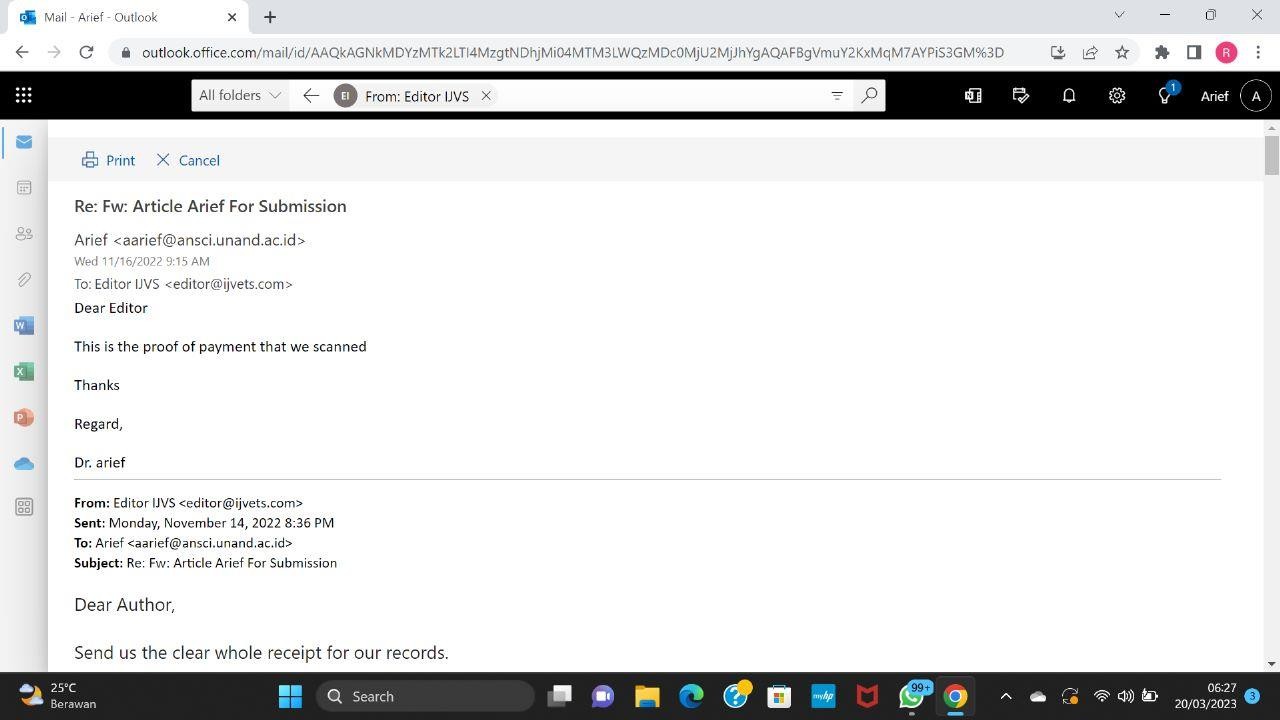
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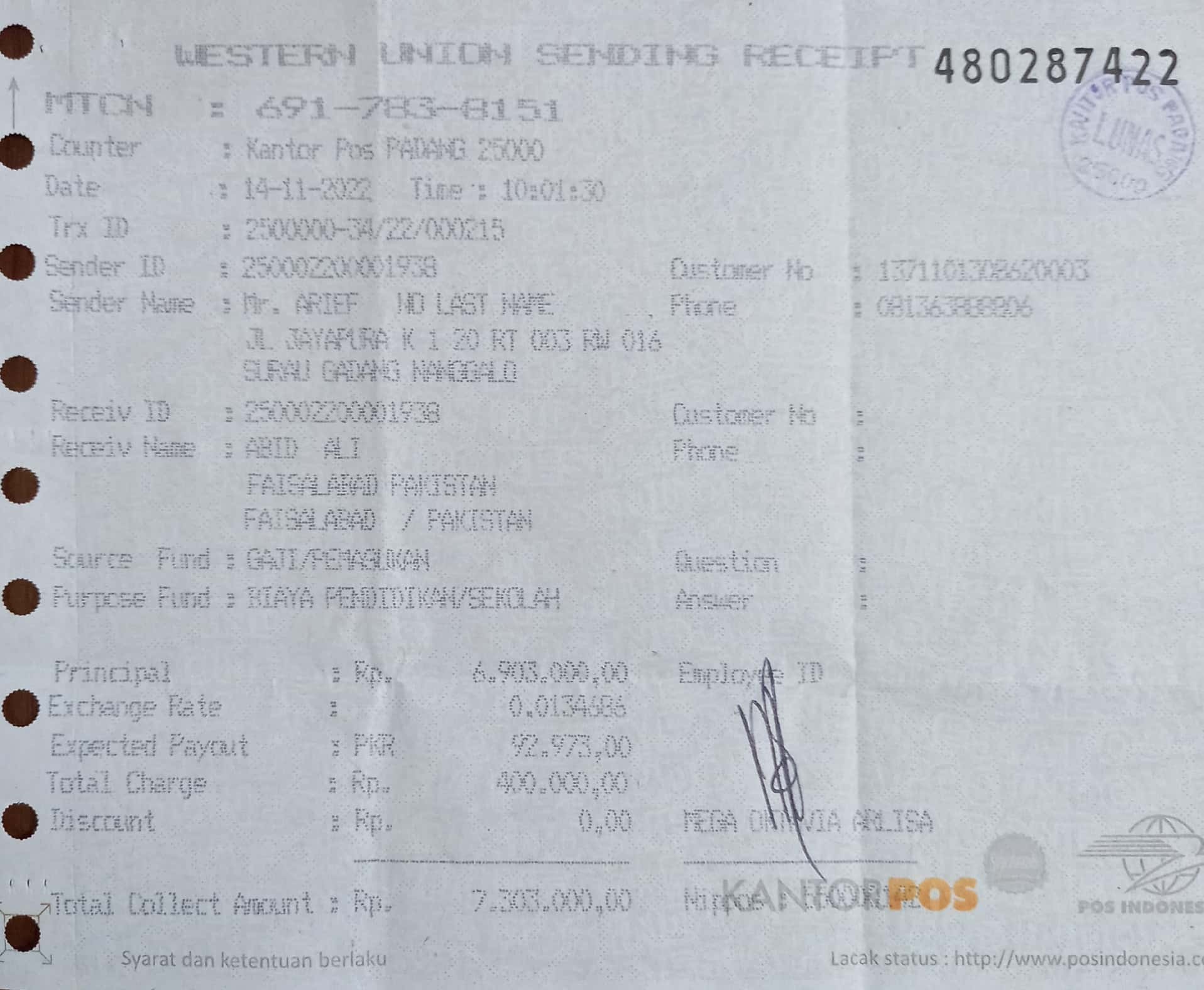
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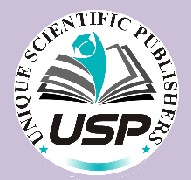
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**Production Performance, Feed Intake and Nutrient Digestibility of Etawa Crossbreed Dairy Goats Fed Tithonia (*Tithonia diversifolia*), Cassava Leaves and Palm Kernel Cake Concentrate**

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| **ABSTRACT**  This research aimed at the intake, digestibility, production, and milk quality of Etawa crossbreeds dairy goat (ECDG) fed conventional mixed forage; tithonia (*Tithonia diversifolia*) (T) and cassava leaves (CL) with palm kernel cake concentrate (PKCC). A completely randomized design (four treatments and four replications) was used in this study. The treatments consisted of followings: A was company rations (50% company forages + 50% company concentrate(CC)), B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC + 20% PKCC), D (50%  (T+CL)+ 20% CC + 30% PKCC). The variables analyzed were as follows; milk production, milk quality (total solid, lactose, protein, fat, solid non-fat, water content, specific gravity, pH, Ca and P minerals), dry matter intake (DMI), organic matter intake (OMI), crude protein intake (CPI), dry matter digestibility (DMD), organic matter digestibility (OMD), crude protein digestibility (CPD). Data analysis used analysis of variance—a further test to determine differences between treatments using Duncan's multiple ranges. The Analysis showed that the treatment had no significant effect (P>0.05) on feed intake, digestibility, production, and milk quality. Using palm kernel cake concentrate and a mixture of tithonia and cassava leaves was able to maintain the feed intake, feed digestibility, production, and milk quality of ECDG. Replacement of company forages with a mixture of cassava and tithonia and replacement of company concentrate with PKCC did not affect the intake, digestibility, production, and quality of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and tithonia) + 10% company concentrate + 40% PKCC was able to maintain the intake, digestibility, production, and quality of Etawa crossbreed dairy goat milk. | | | |
| **Key words:** Cassava Leaves, Etawa Crossbreed Dairy Goat, Milk Production, Palm Kernel Cake Concentrate,  Tithonia Diversifolia. | | | |

**INTRODUCTION**

The availability of forage and the high price of concentrate are severe problems in developing the Etawa crossbreed dairy goat (ECDG) farming. The increase in residential areas impacts reducing forage for animal feed. At the same time, the price of concentrate is getting more expensive day by day. Arief et al. (2018a) stated that alternative feed exploration is very urgent to increase productivity and efficiency of livestock business. So, it is necessary to find alternative sources of forage and concentrates with high production and good nutritional quality.

Tithonia (*Tithonia diversifolia*) is a forage with good nutritional content (Pazla et al. 2021a). The crude protein content is 22.89%, and organic matter is 84.01% (Pazla et al. 2018a). Tithonia is also rich in P mineral, which can potentially increase the number of rumen bacterial populations (Fasuyi et al. 2010; Adrizal et al. 2021; Pazla et al. 2021b). Oluwasola and Dairo (2016) reported that tithonia plants are also rich in amino acids. The mixture of tithonia with elephant grass as a fiber source in ECDG ration can optimize intake, digestibility, and milk production (Pazla et al. 2022).

Cassava leaves contain Branched Chain Amino Acids (BCAA) such as isoleucine, valine, and leucine 4.4, 8.43,

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and 8.75%, respectively (Suyitman et al. 2017a). BCAAs increase nutrient digestibility like dry matter, organic matter, and acid detergent fiber through the growth of cellulolytic bacteria (Zain et al. 2002). Supplementation of cassava leaves on ammoniated palm stems increased rumen microbial growth and digestibility of DM, ADF, and neutral detergent fiber (NDF) (Nurhaita and Ningrat 2011). Suyitman et al. (2020) reported that supplementing cassava leaves in Simmental cattle rations improved digestibility and production performance.

Palm kernel cake concentrate (PKCC) is made from a mixture of feed ingredients that have good nutrition for livestock growth and production, such as rice bran, corn, palm kernel cake, and minerals. Energy (total digestible nutrient) and crude protein (CP) of PKCC are 60-64 and 14-16%, respectively (Arief et al. 2020). This research aims to determine the impact of replacing company forages with a mixture of cassava and tithonia and replacing company concentrate with PKCC on intake, digestibility, production, and quality of ECDG.

**MATERIALS AND METHODS**

**Animal Ethics**

This research has referred to the ethics of research using livestock based on the law of the government of the Republic of Indonesia Number 18 of 2009 article 66, which discusses animal maintenance, killing, treatment, and reasonable care.

**Experimental Site**

This study was carried out on Toni Farm company, Payakumbuh, West Sumatra, Indonesia (- 0.2330638,100.6268024, and 516 m asl); this area has two seasons (dry and rainy). The rainy season is from September to February, and summer is from March to August. This research was conducted in May – June 2022. The temperature of this area at the time of the study was in the range of 22-35°C.

**Animal Experiment and Feeding Formulation**

The livestock used in the study were 16 ECDG with an average body weight of 60±1.23kg and were in the second lactation, distributed in a completely randomized design with four treatments (ration formulation) and four replicates. The treatments consisted of followings: A was company ration as control (50% company forages + 50% company concentrate (CC)), B (50% (T+CL) + 40% CC + 10% PKCC), C (50% (T+CL) + 30% CC + 20% PKCC), D (50% (T+CL)+ 20% CC + 30% PKCC). The ratio of

tithonia with cassava was 1:1

PKCC concentrate was made by formulating the following feed ingredients, namely 37% rice bran + 40% palm kernel cake + 22% corn, and 1% minerals. All materials were mixed homogeneously and stored in plastic at less than 12% moisture content.

The company forage was bush and native grass. The company's concentrate was made by formulating feed ingredients along with tofu dregs, jackfruit skin, and skinless cassava. All ingredients were stirred evenly and given in a fresh state. Meanwhile, forage company forages, cassava leaves, and tithonia were given three

times a day: in the morning at 08.00, at noon at 13.00, and in the afternoon at 18.00. The concentrate was given twice daily, in the morning at 07.00 and noon.

The experimental ration was formulated based on the NRC (2007) to fulfill the nutrition of dairy goats weighing 60 kg and having the capacity to produce 2-3kg of milk with 4% fat content per day. The chemical composition of each feed ingredient used is presented in Table 1. The composition of the feed ingredients in the treatment ration and the nutritional composition of the treatment ration are presented in Table 2.

Proximate analysis (dry matter, ash, crude protein, extract ether, and crude fiber) of research feed ingredients was carried out based on AOAC international (1995). Fiber fractions (cellulose, lignin, ADF, and NDF) were analyzed according to the technique described by Van Soest (1982). TDN was calculated based on Moran (2005). The nitrogen-free extract was calculated according to Jamarun et al. (2021).

TDN (%) = 5.31 +1.444 Cfat + 0.412 CP + 0.937 NFE +

0.249 CF

NFE= 100 - (ash+ CP+Cfat+CF)

Note:

TDN= Total digestible nutrient CP= Crude protein

CF= Crude fiber Cfat= Crude fat

NFE= Nitrogen-free extract.

The study lasted 45 days, divided into three periods: the adaptation period of 25 days, the preliminary period of 15 days, and the 5-day collection period. The fresh ration intake was calculated by calculating the difference between the amount of ration and the rest of the ration.

DMI (kg/h/day) = Fresh Intake \* DMCR OMI (kg/h/day) = DMI \* OMCR

CPI (kg/h/day) = DMI \* CPCR Note:

DMI= Dry matter intake OMI= Organic matter intake CPI= Crude protein intake

DMCR= Dry matter content of the ration OMCR= Organic matter content of the ration CPCR= Crude protein content of the ration

Feces were collected at 6am. All fresh feces were weighed, 10% was taken for each treatment, then dried in the sun. The dried feces were then ground into a fine powder for analysis of chemical composition samples. The difference between ration intake and fecal production calculates feed digestibility. The formula used is:

DMD (%) = (DMI- Feces)/ DMI \* 100%) OMD (%) = (OMI- Feces)/ OMI \* 100%) CPD = (CPI- Feces)/ CPI \* 100%)

Goats were milked twice a day, in the morning and evening, using a mechanical milking machine. Milk production was calculated for five days during the collection period in liters and converted to kg (Fig. 1) and FCM (Fat Corrected Milk) 4% based on the formula of Mavrogenis and Papachristoforou (1988):

4%FCM (kg)= M (0.144+ 0.1444F)

Note:

M = Milk production in kg F= Fat content in %

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**Table 1:** Chemical composition of feed ingredients

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Nutrients (%) |  | Feed stuff | | | | | | | | |  |
| Company forages | T | CL | JS | Rice bran | Tofu waste | PKC | Corn | PKCC | Skinless cassava | Company Concentrate |
| DM | 26.03 | 23.13 | 26.21 | 13.01 | 87.8 | 28.4 | 91.83 | 85.8 | 93.24 | 29.04 | 23.81 |
| OM | 87.93 | 84.65 | 86.33 | 95.02 | 90.8 | 97.67 | 91.41 | 99.1 | 90.23 | 98.78 | 96.92 |
| CP | 25.43 | 25.07 | 30.18 | 12.06 | 10.72 | 20.11 | 12.36 | 7.70 | 13.46 | 11.66 | 17.27 |
| CF | 28.02 | 22.62 | 19.92 | 28.01 | 11.6 | 19 | 26.68 | 2.44 | 18.33 | 4.28 | 20.98 |
| NDF | 48.27 | 55.03 | 56.13 | 71.54 | 55.13 | 59.28 | 66.7 | 49.96 | 62.84 | 37.38 | 61.86 |
| Cfat | 2.73 | 1.62 | 3.10 | 4.00 | 8.73 | 1.25 | 8.23 | 3.50 | 4.96 | 1.13 | 2.07 |
| TDN | 54.53 | 53.54 | 56.44 | 68.8 | 66.63 | 74.61 | 65.4 | 81.9 | 66.36 | 86.53 | 73.46 |
| NFE | 31.75 | 35.34 | 33.13 | 50.93 | 59.75 | 57.31 | 44.14 | 85.46 | 53.48 | 81.71 | 56.62 |
| ASH | 12.07 | 15.35 | 13.67 | 5.00 | 9.2 | 2.33 | 8.59 | 0.90 | 9.77 | 1.22 | 3.08 |
| ADF | 36.45 | 34.2 | 33.69 | 58.55 | 29.35 | 26.65 | 46.10 | 36.76 | 36.02 | 8.92 | 35.33 |
| Hemi | 11.82 | 20.83 | 22.44 | 12.99 | 25.78 | 32.63 | 20.60 | 13.20 | 26.82 | 28.46 | 26.53 |
| Lignin | 11.72 | 5.81 | 6.87 | 8.54 | 06.90 | 2.3 | 17.29 | 07.50 | 3.92 | 6.49 | 4.38 |
| Cellulose | 24.4 | 27.54 | 28.48 | 24.46 | 15.52 | 22.93 | 43.25 | 29.52 | 16.97 | 14.07 | 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* (T). Cassava leaves (CL), Jackfruit skin (JS), Palm kernel cake (PKC), Palm kernel cake concentrate (PKCC)

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Feedstuff |  | Treatments | |  |
| A | B | C | D |
| Company Forages | 50 | 0 | 0 | 0 |
| *Tithonia diversifolia* | - | 25 | 25 | 25 |
| Cassava Leaves | - | 25 | 25 | 25 |
| PKCC | - | 10 | 20 | 30 |
| Company Concentrate | 50 | 40 | 30 | 20 |
| Total | 100 | 100 | 100 | 100 |
| Nutrient Composition |  |  |  |  |
| Dry Matter | 24.91 | 31.10 | 38.04 | 44.98 |
| Organic Matter | 92.43 | 90.54 | 89.87 | 89.20 |
| Crude Protein | 21.35 | 22.07 | 21.69 | 21.31 |
| Crude Fiber | 24.49 | 20.85 | 20.59 | 20.33 |
| NDF | 55.07 | 58.82 | 58.92 | 59.01 |
| Crude Fat | 2.40 | 2.50 | 2.79 | 3.08 |
| TDN | 64.00 | 63.52 | 62.81 | 62.10 |
| NFE | 44.18 | 45.11 | 44.80 | 44.48 |
| Ash | 7.57 | 9.46 | 10.13 | 10.80 |
| Lignin | 8.05 | 5.31 | 5.27 | 5.22 |

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

During the collection period, 250ml of milk samples was taken for each treatment. The components for the milk quality test (total solid (milk dry matter), protein, fat, lactose, solid non-fat, specific gravity, and pH) were tested using Lactoscan Pro 202.

**Statistical Analysis**

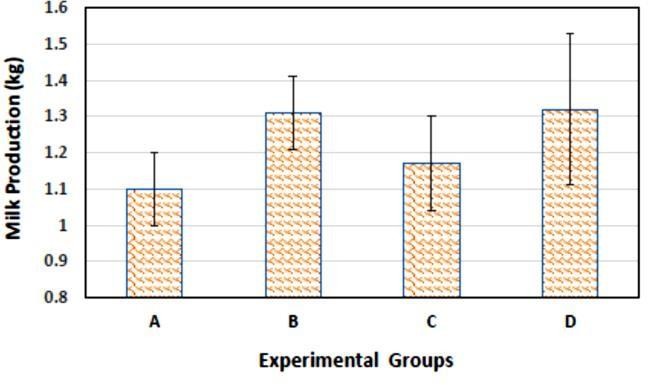
A completely randomized design (Model) (Steel and Torrie 1991) was used to analyze intake, feed digestibility, production, and milk quality. The data were analyzed with the study concludes that of variance using the Excel 2019 program at a significance level of @=0.05. Duncan's Advanced Multiple range tests were used to test the differences between treatments.

**RESULTS**

**Milk Production of Etawa Crossbreed Dairy Goats Treatment**

Replacement of company forages with a mixture of cassava and tithonia and replacement of company

concentrate with PKCC were not significantly different (P>0.05) in increasing milk production (Fig. 1). Using cassava leaves, tithonia, and PKCC is expected to increase milk production. The average daily milk production results from replacing company forages with a mixture of cassava leaves and tithonia and replacing company concentrate with PKCC in various percentages are presented in Table 3. The study concludes that of the variance of the highest milk production after being converted to 4% FCM was in treatment D, and the lowest was in treatment A (control).



**Fig. 1:** Milk Production of Etawa crossbreed dairy goat’s treatment.

**Milk Quality of Etawa Crossbreed dairy Goat Treatment**

The results of statistical analysis showed that there was no significant difference (P>0.05) in all milk quality parameters. Replacing the company forages with a mixture of cassava and tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The average milk quality results from replacing company forages with a mixture of cassava leaves and tithonia and replacing company concentrate with PKCC in various percentages are presented in Table 4.

**Feed Intake of Etawa Crossbreed dairy Goats Treatment**

The study concludes that results of dry matter intake, organic matter intake, and crude protein intake by replacing company concentrate with PKCC and replacing

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**Table 3:** Quality of Etawa crossbreed dairy goat's milk with various treatments

Goat milk

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters |  |  | |  |
| A | B | C | D |
| pH | 6.23±0.05 | 6.32±0.06 | 6.36±0.05 | 6.52±0.07 |
| Fat Level (%) | 4.52±2.27 | 4.44±1.26 | 3.91±2.29 | 5.29±1.21 |
| Lactose (%) | 4.52±0.19 | 4.44±0.31 | 3.91±1.23 | 5.29±1.35 |
| SNF (%) | 9.53±2.27 | 9.46±1.26 | 9.01±2.29 | 8.99±1.21 |
| Protein (%) | 3.46±0.05 | 3.44±0.07 | 3.28±0.07 | 3.26±0.09 |
| Specific Gravity | 1.033±0.07 | 1.032±0.11 | 1.031±0.13 | 1.030±0.07 |
| Phosphorus (%) | 3.17±0.25 | 3.40±0.37 | 3.19±0.49 | 2.92±1.45 |
| Calcium (%) | 2.51±0.12 | 2.46±0.17 | 2.32±0.21 | 2.90±0.51 |
| Water Content (%) | 14.05±1.72 | 13.89±2.57 | 12.91±1.98 | 14.28±1.81 |
| Dry Matter (%) | 85.95±1.72 | 86.11±2.57 | 87.09±1.98 | 85.73±1.81 |

Solid non-fat (SNF); There is no significant between treatments (P>0.05). Treatment A= Company ration (50% company forages+50%company concentrate (CC)), B=(50%(T+CL)+40% CC+10% PKCC), C=(50%(T+CL)+30% CC+20%PKCC), and

D=(50%(T+CL)+20% CC + 30% PKCC). *Tithonia diversifolia* (T), Cassava leaves (CL Palm kernel cake), and Palm kernel cake concentrate (PKCC).

**Table 4:** Ration Intake of Etawa Crossbreed Dairy Goats Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Intake (kg/e/day) | Treatment | | | |
|  | A | B | C | D |
| Dry matter | 2.44±3.21 | 2.51±2.47 | 2.48±3.11 | 2.46±2.68 |
| Organic matter | 2.20±3.09 | 2.27±2.13 | 2.25±3.26 | 2.21±2.39 |
| Crude protein | 0.60±1.91 | 0.65±1.87 | 0.62±1.37 | 0.61±1.49 |

There is no significant between treatments (P>0.05). Treatment A= Company ration (50% company forages+50%company concentrate (CC)), B=(50%(T+CL)+40% CC+10% PKCC), C=(50%(T+CL)+30% CC+20%PKCC), and D=(50%(T+CL)+20% CC + 30%

PKCC). *Tithonia diversifolia* (T), Cassava leaves (CL Palm kernel cake), and Palm kernel cake concentrate (PKCC).

**Table 5:** Digestibility of Etawa crossbreed dairy goats treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Digestibility (%) | Treatment | | | |
|  | A | B | C | D |
| Dry matter | 65.85±1.19 | 66.17±1.89 | 67.23±1.78 | 67.98±1.55 |
| Organic matter | 67.76±1.17 | 68.02±1.76 | 68.88±1.63 | 69.32±1.48 |
| Crude protein | 69.56±1.03 | 70.34±1.11 | 71.38±1.24 | 71.97±1.41 |

Footnote is same as that of Table 4.

company forages with tithonia and cassava leaves are presented in Table 5. Replacing company concentrate with PKCC and replacing company forages with tithonia and cassava leaves in the ration gave no significant difference (P>0.05) in each treatment on the value of dry matter intake, organic matter intake, and crude protein intake.

**Digestibility of Etawa Crossbreed Dairy Goats Treatment**

The study concludes that results of dry matter digestibility (DMD), organic matter digestibility (OMD), and crude protein digestibility (CPD) by replacing company concentrate with PKCC and replacing company forages with tithonia, and cassava leaves are presented in Table 5. Table 5 shows that the treatment of replacing company concentrate with PKCC and replacing company forages with a mixture of cassava leaves and tithonia had no significant effect (P>0.05) on DMD, OMD, and CPD.

**DISCUSSION**

**Milk Production of Etawa Crossbreed Dairy Goats Treatment**

Replacement of company forages with a mixture of cassava and tithonia and replacement of company concentrate with PKCC were not significantly different (P>0.05) in increasing milk production. Milk production in dairy goats is strongly influenced by feed quality. Good quality feed will increase milk production. Using cassava

leaves, tithonia, and PKCC is expected to increase milk production.

The study concludes that the variance of the highest milk production after being converted to 4% FCM was in treatment D, and the lowest was in treatment A (control). The insignificant difference between treatments A, B, C, and D could be caused by the feed quality. The prepared rations had a crude protein that was not much different between A (21.35%) rations, B (22.07%), C (21.69%), and D (21.31%) rations (Table 2). The intake of feed protein also influences milk production. Prihatminingsih et al. (2015) stated that feed protein plays a role in forming lactose. Lactose is water-binding, so the more lactose is formed, the more milk will be produced. In the research conducted, the lactose content obtained in each treatment was A=4.52%, B=4.44%, C=3.91%, and D=5.29% (Table 4).

Good dairy goats have a high amount of milk production and are standardized at 4% FCM (Christi and Rohayati 2018). From the average value of 4% FCM milk production, it can be seen that the highest production was in treatment D (1.32kg/head/day). This indicates that after being standardized to 4% FCM, it turns out that treatment D has a high milk fat content, which affects the production of 4% FCM milk. Based on the results of the study, it was found that the milk fat content in each treatment was: A=4.52%, B=4.44%, C=3.91%, and D=5.29% (Table 4), with the highest increase in milk fat content in treatment D was thought to be because the fat from the D ration was higher from other rations (Table 2),

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causing high milk production as well. Milk production of 4% FCM is carried out to equalize the energy level in the milk contents.

**Quality of Etawa Crossbreed dairy Goat's Milk Treatment**

Nutrient components in feed significantly affect the quality of milk. Good quality milk meets milk quality standards. The results of statistical analysis showed that there was no significant difference (P>0.05) in all milk quality parameters. Replacing the company forages with a mixture of cassava and tithonia and replacing the company's concentrate with PKCC did not affect milk quality. The quality of milk produced in treatments A, B, C, and D was within the normal range based on Thai Agricultural Standards (2008). This value indicates that the response of ECDG to rations containing PKCC concentrate and forages of cassava leaves and tithonia is quite good. The feed quality factors (TDN and CP), which were almost the same between treatments, were thought to be the reason the milk quality did not differ between treatments (P>0.05). Arief et al. (2018a) strengthened this study, stated that the sort of feed influences the milk produced. The good feed also improve animal metabolism by increasing the supply of electricity and vitamins for the synthesis of milk components (Arief et al. 2018b). In addition, the same intake of dry matter, organic matter, and crude protein among treatments also caused no difference in the milk quality. The intake and digestibility of the same feed do not affect the final fermented product in the rumen. Volatile fatty acid (VFA) is a product of rumen fermentation. VFA manufacturing offers enough strength for rumen bacteria to develop and grow (Jamarun et al. 2019) and the supply of uncooked substances for milk synthesis (Jamarun et al. 2020). This results are similar with the study from Pazla et al. (2022). They also found no difference in milk quality in ECDG given a mixture of tithonia forage with elephant grass with the addition of a concentrate consisting of corn, rice bran, tofu dregs, and palm kernel cake. Marques et al. (2022) also found the same quality of goat's milk when given forage with a combination of cassava and alfalfa.

**Feed Intake of Etawa Crossbreed Dairy Goats Treatment**

Intake of dry matter can produce energy for milk production because it contains food substances consisting of organic materials such as protein, fat, and carbohydrates (Jamarun et al. 2021). The study concludes that results of DMI, OMI, and CPI by replacing company concentrate with PKCC and replacing company forages with tithonia and cassava leaves are presented in Table 5. Replacing company concentrate with PKCC and replacing company forages with tithonia and cassava leaves in the ration showed no significant difference (P>0.05) in each treatment on the value of DMI, OMI, and CPI. The insignificant difference in each treatment could be caused by the type of ration given. In replacing the company's concentrate with PKCC and company forages with tithonia and cassava leaves, it is necessary to pay attention to the dry matter content of each feed ingredient. The dry matter content of the company's concentrate is 23.81%, while the dry matter content of PKCC is 93.24% (Table

1). Meanwhile, the dry matter content of company forages with tithonia and cassava did not differ much. Of course, the difference in the substituted ingredients changed the form of an increase in the dry matter content of the ration (ration A 24.91%, ration B 31.10%, ration C 38.04%, and ration D 44.98%) (Table 2). However, there was an increase in the dry matter content of the ration, and it had no significant difference against intake. This is supported by Pazla et al. (2018b) that the amount of nutrient intake depends on the amount of dry matter in the feed consumed and the nutrient content of the feed given. In the research conducted, it was also observed that livestock have the ability to eat high feed, which is also influenced by the needs of the livestock themselves, following the opinion of Arief et al. (2021b), which states that the volume of feed needed by livestock, especially goats, depends on their ability to eat feed and total weight body. The results obtained were higher than that of Setyaningsih et al. (2013), whose average dry matter intake was 1.55- 1.66kg/e/day with an average body weight of 43kg. This is presumably because the capacity of the livestock rumen influences dry matter intake.

Another factor that plays a role in dry matter intake is the level of palatability or livestock preference on the feed given. In this study, it was found that the level of palatability of tithonia, cassava leaves, and PKCC in its administration was favored by dairy goats. This is under the opinion of Pazla et al. (2021c) that the palatability of feed directly affects interest and causes appetite in livestock. Flavor, texture, smell, and taste significantly affect palatability. Based on the observations made during the study, it was found that Tithonia, cassava leaves, and PKCC have a flavor. The intake of organic matter is in line with the intake of dry matter because organic matter is part of dry matter, which has been reduced by inorganic matter. The pattern of increasing and decreasing organic matter intake is strongly influenced by the components contained in dry matter (Kamalidin et al. 2012). This is also supported by Febrina et al. (2017) that organic matter is carefully associated with dry matter since organic matter is a part of dry matter; if the intake of dry matter from livestock is low, it will be followed by a low level of intake of organic matter as well. Intake of organic matter is also primarily determined by the constituent components of the organic material itself, namely crude protein, extract ether, and crude fiber.

High intake of dry matter is a factor that causes a high intake of organic matter, but the factor that increases intake of organic matter is not only feed; livestock is also one of the factors that can increase intake of organic matter. The ability of livestock to eat feed and the level of preference is also a factor in increasing the intake of organic matter. Murni et al. (2012) stated that other factors influencing intake are animal body weight, feed digestibility, palatability, feed quality, and the age of livestock. Intake of crude protein that did not differ between treatments (P>0.05) was due to the protein content of the ration between treatments that were not much different (A=21.35%, B=22.07%, C=21.69%, D=21.31%) (Table 2). The intake of crude protein feed is directly proportional to dry and organic matter intake. Pazla et al. (2021c) stated that feed protein positively correlated with dry matter, protein, and energy intake. The

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amount of feed consumed affects other nutrients consumed. Martawidjaja et al. (1999) stated that the factors influencing feed protein intake are dry matter intake and protein content. Intake of crude protein in this study was higher than Marwah et al. (2010), who received crude protein intake of ECDG of 0.34kg/head/day by feeding *Calliandra calothyrsus* and concentrate, and Krisnan et al. (2015), who reported 0.24kg/head/day by feeding *Pennisetum purpupoides*, *Leucaena leucocephala* and concentrates.

**Digestibility of Etawa Crossbreed Dairy Goats Treatment**

Table 5 shows that the treatment of replacing company concentrate with PKCC and replacing company forages with a mixture of cassava leaves and tithonia had no significant effect (P>0.05) on DMD, OMD, and CPD. The non-significant difference between treatments was due to the lignin content of the A, B, C, and D rations not being much different. The difference in the lignin content of the ration is only 2.83%. In addition, the lignin content of tithonia and cassava is lower than that of the company forages. In contrast, the lignin content of PKCC is not much different from that of the firm concentrate. High lignin content in livestock rations reduces digestibility because lignin is a timber substance that cannot be digested using rumen microbes (Pazla et al. 2020; Pazla et al. 2021d; Ciptaan et al. 2022).

The chemical composition of the ration also influences the digestibility of dry matter, organic matter, and crude protein. The chemical composition of rations A, B, C, and D is almost identical. The rations of this study were prepared with a TDN content of 62-64%. In digesting feed ingredients, sufficient and balanced protein and energy are needed for rumen microbial activity to digest food substances, including dry matter, organic matter, and crude protein. Crude protein undergoes fermentation in the rumen, which produces ammonia (NH3) (Suyitman et al. 2021). NH3 increases the rumen's microbial population (Putri et al. 2019; Putri et al. 2021). TDN derived from the diet acts as an energy source for rumen microbes. The large population of rumen microbes affects the digestibility of food substances. The same protein and TDN composition in the treatment rations causes the digestibility of dry matter, organic matter, and crude protein to be relatively the same (P>0.05). This follows the opinion of Jamarun et al. (2017), which states that feed digestibility is influenced by the ration composition and the activity of microorganisms.

**Conclusion**

Replacement of company forages with a mixture of cassava and tithonia and replacement of company concentrate with PKCC did not affect the intake, digestibility, production, and quality of Etawa crossbreed dairy goat's milk. The combination of 50% (cassava and tithonia)+10% company concentrate+40% PKCC was able to maintain the intake, digestibility, production, and quality of Etawa crossbreed dairy goat milk.

**Author Contributions**

Conceptualization: Arief and Roni Pazla, Data Curation: Roni Pazla. Formal analysis: Roni Pazla and

Rizqan. Funding acquisition: Arief and Novirman Jamarun. Methodology: Arief, Roni Pazla, and Novirman JAmarun. Project administration: Rizqan. Supervision: Arief and Novirman Jamarun. Validation: Roni Pazla. Writing-original draft: Roni Pazla and Arif. Writing- review and editing: Rizqan.

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