Yut Afiffah Kasihandari/Animal Production. 27 (2): 133-143, 2025
Accredited by Kemenristek Dikti No 32a/E/KPT/2017. ISSN 1411-2027

Energy Utilization and Performance of Madura Cattle Fed with Two Kinds of Rice Straw Processing and Concentrate Supplemented Teak Leaf Flour (*Tectona grandiss*)

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Abstract. This study aims to investigate the effect of the interaction between the type of rice straw processing and the concentration of teak leaf flour supplementation on energy intake and performance of Madura cattle. A total of 18 Madura cattle with an average weight of 246.5 ± 10.29 kg were placed in individual pens and randomly assigned to either ammoniated or non-ammoniated rice straw processing and concentrate with different supplementations of teak leaf flour (TLF): 0% (T1), 0.21% (T2), and 0.42% (T3) of dry matter. This study used a completely randomized design with a 2 x 3 factorial and Tukey's range test or orthogonal polynomials. The observed variables were dry matter intake (DMI), energy intake (EI), digested energy (DE), retained energy (RE), RE:EI efficiency, RE:DE efficiency, average daily gain (ADG), feed conversion (FC), and slaughter weight. The results showed no interaction between the type of rice straw and the concentration of TLF on all variables ($p > 0.05$). The type of rice straw processing did not significantly affect all variables ($p > 0.05$). TLF supplementation had a quadratic effect on EI, DMI, and slaughter weight. Madura cattle fattening fed with either ammoniated or non-ammoniated rice straw combined with concentrate supplemented with TLF resulted in an increase in feed intake and final body weight.

Keywords: rice straw, teak leaf, flavonoid, energy, performance

Abstrak. Penelitian ini bertujuan untuk mengkaji pengaruh interaksi jenis pengolahan jerami padi dan taraf suplementasi tepung daun Jati terhadap penggunaan energi dan performa sapi Madura. Delapan belas ekor sapi Madura dengan berat rata-rata 246,5±10,29 kg digunakan pada penelitian ini. Sapi tersebut ditempatkan pada kandang individu dan diacak secara sempurna untuk menerima perlakuan 2 jenis pengolahan jerami padi (amoniasi dan nonamoniasi) dan taraf tepung daun Jati (TDJ) dalam konsentrat yang disuplementasikan sebanyak 0% (T1), 0,21% (T2), dan 0,42% (T2) dari bahan kering konsentrat. Penelitian menggunakan Rancangan acak lengkap (RAL) berpola faktorial 2x3 dengan uji lanjut BNJ atau orthogonal polinomial. Peubah yang diamati dan diukur adalah konsumsi BK (KBK), konsumsi energi (KE), energi tercerna (ET), energi teretensi (RE), efisiensi RE:KE, efisiensi RE:ET, pertambahan bobot badan harian (PBBH), konversi pakan (KP) dan bobot potong. Hasil penelitian menunjukan tidak terdapat interaksi ($P>0.05$) antara jenis jerami padi dan taraf TDJ terhadap semua peubah. Jenis pengolahan jerami padi tidak berpengaruh nyata ($p>0,05$) terhadap semua peubah yang diukur. Suplementasi TDJ secara kuadratik berpengaruh terhadap KE, KBK dan bobot potong. Penggemukan sapi Madura yang diberi pakan jerami padi baik tanpa amoniasi maupun dengan amoniasi dikombinasikan konsentrat disuplementasi TDJ meningkatkan konsumsi pakan dan bobot badan akhir.

Kata kunci: jerami padi, daun jati, flavonoid, energi, performa

Introduction

Local cattle are comprised of a multitude of breeds that exhibit superior characteristics as meat producers. Their high adaptability to the environment in Indonesia lends itself to their potential to be fattened within the framework of animal husbandry operations (Romjali, 2018). Local breeds represent the primary source of domestic meat production, yet they exhibit low levels of productivity and quality in their meat. The productivity and quality of local cattle are improved by means of manipulation of their feed (Okumura et al., 2007). Madura cattle represent one of Indonesia's local cattle breeds, which have the potential for a greater efficiency in feed intake. The estimated nutrient requirements for the maintenance of Madura cattle are higher than those of Java cattle (Kearl, 1982). Increasing the body weight of Madura cattle with a body weight of 200 kg requires 5.2 kg DM/kg BW according to Umar et al. (2015) or 5.6 kg DM/kg BW according to Kearl (1982).

In the feedlot industry, metabolic acidosis can become an issue, especially when cattle feed consists of 90% concentrate (Yanza et al., 2022). A low crude fiber content in the feed can lead to rumen acidosis, resulting in an acidic rumen pH. This condition reduces the rumen's microbial population and hampers fermentation and nutrient absorption (Hernández et al., 2014). The fermentation process in the rumen significantly impacts the metabolic processes, which in turn affects livestock performance. According to González et al. (2012), subacute acidosis may not show obvious signs of illness in livestock but is accompanied by decreased feed intake and performance. If not addressed quickly, this issue can be detrimental to farmers.

In the feedlot sector, rice straw is an important and economical source of fiber. However, its crude protein digestibility and mineral content are relatively low. Rice straw contains hemicellulose (31.42%), cellulose (33.35%), crude protein (0.12%), calcium (0.53%), phosphorus (0.12%), magnesium (0.24%), and ash (12.10%). The lack of lignase enzymes in the rumen limits the breakdown of rice straw, and even when partially degraded, livestock struggle to obtain adequate energy from it (Sarnklong et al., 2010). Therefore, ammoniation is recommended prior to feeding, as in vitro studies have shown that ammonia treatment significantly increases the production of acetate, butyrate, and volatile fatty acids (VFA) (Ma et al., 2020). According to McDonald et al. (2020), using urea as a non-protein nitrogen source enables rapid dissolution and hydrolysis into ammonia, which supports microbial protein synthesis. However, simply mixing rice straw with other feed or non-feed additives is not sufficient to achieve optimal productivity in ruminants.

Feed additives can help balance pH levels and address metabolic disorders in the rumen (Hernández et al., 2014). Plant extracts rich in flavonoids have been shown to stabilize rumen pH, increase propionate levels, and promote the growth of lactate-utilizing bacteria in cattle fed high-concentrate diets. Supplementing with flavonoids may enhance the efficiency of rumen fermentation and lower the risk of acidosis by boosting the population of lactate-utilizing bacteria (Balcells et al., 2012). Flavonoids contribute to rumen management by preventing pH drops and reducing inflammatory responses in cattle on high-concentrate diets. Additionally, they effectively decrease methane production and alter the ratio of acetate to propionate. Improved livestock feed efficiency stems from changes in the fermentation process that enhance digestibility and energy metabolism (Olagaray & Bradford, 2019). Beyond regulating rumen production, which affects volatile fatty acid (VFA) production, flavonoids can also lower methane and ammonia levels in the rumen, ultimately improving livestock performance (Kalantar, 2018).

Dried teak leaves (*Tectona grandis*), processed into flour, contain flavonoids. An extraction study reported a flavonoid content of 3.15 mg/g when extracted with ethanol (Daramola, 2022). The use of teak leaves as animal feed has been well studied. Replacing 30% of elephant grass with teak leaves resulted in the highest dry matter and organic matter digestibility, along with increased VFA concentrations, in an in vitro study using sheep rumen fluid (Wahyudi et al., 2022). Research by Lamid et al. (2013) showed that fermenting teak leaves with *Actinobacillus* sp. improved their quality by increasing crude protein and reducing crude fiber. However, there are no existing reports on the use of teak leaves as a feed additive for local beef cattle.

Flavonoids can significantly influence rumen fermentation by raising pH levels, increasing lactate-utilizing bacteria populations, and enhancing propionate concentrations while reducing methane and ammonia levels in the rumen. These effects indirectly influence the fermentation process, which in turn affects energy intake in livestock. Moreover, flavonoids can manipulate the rumen environment to decrease methane gas production and improve energy efficiency. This study aims to explore the effects of supplementing teak leaf flour in the diet of Madura cattle.

Materials and Methods

Materials and Experimental Design

This study was conducted at UD Amanah Farm in Banyumas Regency, involving 18 Madura cattle with an average weight of 246.5 ± 10.29 kg. The cattle were housed in individual pens and randomly assigned to receive either ammoniated or non-ammoniated rice straw and varying amounts of teak leaf flour (TLF)—0% (T1), 0.21% (T2), and 0.42% (T3) of the dry matter. We used a completely randomized design with a 2 x 3 factorial arrangement and analyzed the results using Tukey's range test or orthogonal polynomial test

Observed Variables

The observed and measured variables were dry matter intake (DMI), energy intake (EI), digested energy (DE), retained energy (RE), RE:EI efficiency, RE:DE efficiency, average daily gain (ADG), feed conversion (FC), and slaughter weight. Table 1 provides the nutrient content of the feed and teak leaf flour.

Methods

The study began with the preparation of teak leaf flour, following the methods described by Daramola (2022). We then determined the flavonoid content according to Zhishen et al. (1999). The ammoniation of rice straw was carried out using urea as an additive and tapioca starch waste as a carbohydrate source, as outlined by Bata et al. (2016).

This research spanned 104 days, which included a 14-day preliminary investigation and a 90-day maintenance period. During the 90-day feeding phase, the cattle received rice straw (RS), ammoniated rice straw (ARS), and concentrate at different times. RS and ARS were offered ad libitum two hours after the concentrate at 7 a.m. and 2 p.m. The cattle had ad libitum access to drinking water. Digestibility data were collected from days 52 to 57 of the maintenance period, using the total collection method as described by Cole & Ronning (1974). We determined the initial weight of the cattle at the start of the feeding trial and subsequently weighed them monthly to track the amount of feed provided. At the end of the maintenance period, we weighed the cattle again to assess their final weight and calculate the average daily gain.

Chemical Analysis

The samples of feed, feed residue, and feces were analyzed for proximate and moisture content using the methods specified by AOAC (1990). Additionally, we employed a bomb calorimeter for analysis as indicated by (Dittmann et al., 2014).

Table 1. Chemical Composition of the Feed

Feed	Chemical Composition (% DM)					
	DM	%				
		CP	CFa	CFi	Ash	EMWN
Concentrate	84.51	14.87	2.42	15.78	5.85	66.93
Rice Straw	51.02	6.44	0.86	21.12	17.77	71.58
Ammoniated Rice Straw	25.50	7.71	1.04	24.63	21.63	66.62
Teak Leaf Flour	89.99	15.18	2.74	27.79	9.9	44.39

Description: DM = dry matter, CP = crude protein, CFa = crude fat, CFi = crude fiber, EMWN = extracted material without nitrogen

Data Analysis

We analyzed the data of DMI, energy intake, digested energy, retained energy, dry matter digestibility coefficient, energy digestibility coefficient, RE:EI efficiency, RE:DE efficiency, and feed conversion using analysis of variance (ANOVA). Given the significant effect of teak leaf flour, we further analyzed DMI, energy intake, and feed conversion using orthogonal polynomials. Finally, we used analysis of covariance (ANCOVA) to analyze final weight and ADG, with initial weight included as a covariate, as per Steel & Torrie (1993).

Results and Discussion

Table 2 shows the average dry matter intake (DMI), energy intake (EI), digested energy (DE), retained energy (RE), dry matter digestibility coefficient (DMDC), energy digestibility coefficient (EDC), and the efficiencies of RE:EI and RE:DE for Madura cattle fed processed rice straw and teak leaf flour. The energy intake data was collected using the total collection method during the second month of the maintenance period, when the cattle averaged 291.56 ± 18.87 kg. ANOVA results revealed no interaction between the type of rice straw processing and the concentrate supplemented with teak leaf flour regarding EI, DE, RE, RE:EI, and RE:DE ($p > 0.05$). Additionally, the processing of rice straw did not influence EI, DE, RE, DMDC, EDC, RE:EI, or RE:DE ($p > 0.05$). While the concentrate with teak leaf flour had no significant effect on DE, RE, DMDC, EDC, RE:EI, or RE:DE, it showed significant quadratic effect on EI & DMI ($p<0.05$).

The interaction between the method of processing rice straw and the concentration of teak leaf flour in the concentrate did not affect DMI, EI, DE, RE, RE:EI efficiency, or RE:DE for the Madura cattle ($p > 0.05$). The type of rice straw processing also had no significant impact on EI and DMI. According to Table 2, the average intake of rice straw and concentrate was nearly the same in both the RS and ARS treatments. Data collection occurred when the cattle reached an average weight of 291.56 kg, and the average dry matter intake for the Madura cattle was 2.56% of their body weight. In the RS treatment group, the average intake of rice straw was 2.19 kg DM, while the average concentrate intake was 5.35 kg DM, resulting in a 71:29 ratio. Conversely, the ARS treatment group had an average rice straw intake of 2.06 kg DM and a concentrate intake of 5.28 kg DM, with a 72:28 ratio. These results align with a study by Silitonga et al. (2013), which found that the feeding of concentrate and rice straw, whether mechanically, chemically, or biologically processed, did not significantly affect the intake and digestibility in local male sheep. This phenomenon can be attributed to the similar palatability of both ammoniated and unprocessed rice straw for Madura cattle, along with the greater proportion of concentrate intake compared to rice straw. Consequently, the nutritional needs of the Madura cattle were primarily met through concentrate intake, minimizing the impact of the relatively lower nutrient contribution from RS and ARS on DMI and EI. In contrast, Partama et al. (2019) reported that Bali cattle receiving a rice straw-based diet and complete feed up to 1.5% of their body weight showed higher energy intake in the ammoniated rice straw group compared to the non-ammoniated group.

This study found that the energy intake of Madura cattle ranged from 24.6 to 28.26 Mcal per day. This value is lower than the energy intake reported in a study by Utami et al. (2021), which indicated that Madura cattle weighing 300.3 kg and fed rice straw and concentrate consumed 139.52 MJ per day, equivalent to 33.32 Mcal. This difference is understandable, as the Madura cattle in this study had a lower body weight than those in the previous research. According to NRC (2000), variations in energy requirements are influenced by factors such as body weight, genotype, sex, age, season, environmental temperature, physiological status, and nutritional content of the feed.

Table 2. The Average of Dry Matter Intake, Energy Intake, Digested Energy, Retained Energy, RE: EI Efficiency, RE:DE Efficiency, ADG, and Feed Conversion of Madura Cattle Treated with Rice Straw and Teak Leaf Flour Supplementation

Variable	Treatment						Significance		
	RS			ARS			RS	TLF	RS x TLF
	T0	T1	T2	T0	T1	T2			
Energy Balance									
Intake									
DM (kg)	7.31 ± 0.38	7.68 ± 0.21	7.65 ± 0.48	6.98 ± 0.07	7.93 ± 0.69	7.11 ± 0.35	0.311	0.050	0.266
Energy (Mcal/d)	24.6 ± 1.68	27.4 ± 0.16	26.8 ± 1.53	25.5 ± 0.18	28.3 ± 2.49	26.4 ± 1.58	0.533	0.027	0.702
Excretion									
Feces (Mcal/d)	7.28 ± 0.50	8.99 ± 1.24	7.92 ± 1.30	7.17 ± 0.92	8.22 ± 1.66	7.61 ± 1.80	0.532	0.230	0.905
Urine (Mcal/d)	1.69 ± 0.21	2.59 ± 0.47	2.71 ± 0.84	1.47 ± 0.56	1.96 ± 0.30	2.15 ± 0.71	0.105	0.050	0.800
DE (Mcal/d)	17.3 ± 1.39	18.4 ± 1.16	18.9 ± 2.53	18.3 ± 1.08	20.0 ± 1.54	18.8 ± 2.66	0.340	0.431	0.709
RE (Mcal/d)	15.6 ± 1.58	15.8 ± 0.69	16.1 ± 3.18	16.9 ± 1.50	18.1 ± 1.85	16.6 ± 2.42	0.190	0.823	0.738
ED (%)	71.3 ± 1.69	67.1 ± 4.45	70.2 ± 6.23	71.9 ± 3.79	71.1 ± 3.79	71.0 ± 7.49	0.401	0.773	0.854
DMD (%)	66.7 ± 2.16	62.3 ± 4.21	66.6 ± 7.14	64.9 ± 4.33	64.1 ± 6.05	63.9 ± 8.38	0.748	0.717	0.775
RE:EI Eff (%)	63.5 ± 2.78	57.7 ± 2.74	60.0 ± 9.59	66.1 ± 5.58	64.0 ± 4.33	62.8 ± 5.92	0.168	0.456	0.814
RE:DE Eff (%)	90.2 ± 1.95	86.0 ± 1.75	85.1 ± 6.33	91.9 ± 3.51	90.1 ± 2.22	88.6 ± 3.40	0.090	0.154	0.833
Performance									
IW (kg/head)	249 ± 25.0	265 ± 4.73	266 ± 11.27	253 ± 10.1	269 ± 16.3	256 ± 8.50	-	-	-
FW (kg/head)	320 ± 15.3	334 ± 4.36	346 ± 21.66	317 ± 14.2	349 ± 12.2	332 ± 11.7	0.644	0.039	0.362
ADG (kg)	0.79 ± 0.16	0.76 ± 0.05	0.89 ± 0.13	0.71 ± 0.17	0.89 ± 0.04	0.84 ± 0.06	0.743	0.175	0.185
FC	9.03 ± 1.83	9.89 ± 0.80	8.20 ± 1.41	9.77 ± 1.93	8.86 ± 1.05	8.75 ± 0.19	0.925	0.407	0.448

Note: Significant at a p-value of less than 0.05

ANOVA results indicated that concentrate supplemented with teak leaf flour significantly affected dry matter intake (DMI) and energy intake (EI) ($p < 0.05$). This aligns with findings from Utami et al. (2020), which suggested that hibiscus leaf flour, rich in flavonoids and saponins, positively impacted the crude fiber intake of local sheep fed with ammoniated rice straw. Conversely, Setiadi et al. (2020) found that supplementing dairy cattle with Javanese turmeric (Curcuma zanthorrhiza) flour, up to 1% of dry matter feed requirements, had no significant effect on crude protein intake. This discrepancy may be due to the fact that Javanese turmeric contains not only flavonoids but also curcumin and essential oils when given to livestock that consume a mix of 50% elephant grass and 50% corn waste.

Orthogonal polynomial testing revealed that concentrate supplemented with teak leaf flour had a quadratic effect on both DMI and EI in Madura cattle. For DMI, the relationship can be described by the equation y, with an R^2 value of 0.325 and optimal supplementation at 0.23%. Similarly, for energy consumption (EC), the quadratic effect can be represented by the equation y, with an R^2 value of 0.428 and optimal supplementation at 0.25%. An increase in both DMI and EI was observed at T1 (0.21%), while a higher concentration at T2 (0.42%) led to a decrease.

Different findings emerged from a study by Utami et al. (2020), which revealed that adding hibiscus leaf flour had a quadratic effect on crude fiber intake. The lowest intake was noted at 0.22%, with higher concentrations leading to increased intake. Although the flavonoid content was similar, their effects on intake varied. This difference can be attributed to the higher saponin content in hibiscus leaves compared to the higher tannin levels in teak leaves. The reduced dry matter intake (DMI) at T2 is linked to the high tannin content of the teak leaves, as indicated in Table 2. The average tannin intake for Madura cattle in the T1 treatment was 0.49 g/day, while in the T2 treatment, it rose to 0.94 g/day. This aligns with findings from a study by Utama et al. (2024), which indicated that tannin intake ranging from 0.77 to 1.56 g/day from powdered tea was associated with a decrease in dry matter intake in sheep. Besharati et al. (2022) also noted that excessive tannin in feed can reduce voluntary feed intake. In ruminants, voluntary feed intake is influenced by the palatability and digestibility of the feed. Tannins interact with glycoproteins in saliva, altering taste and leading to decreased feed intake.

Additionally, the processing of rice straw did not significantly affect digestible energy (DE) and energy digestibility (ED) ($p > 0.05$). According to Table 2, the DE and ED values for Madura cattle in this study ranged from 17.32 to 20.04 Mcal/d and from 67.15% to 71.86%, respectively. Similar results were reported in a study by Gultom et al. (2001), which found no difference in the dry matter digestibility of local male sheep fed concentrate and fermented rice straw with varying urea concentrations (0% to 0.08% per 100 kg of rice straw) and starbio (0 to 0.8 kg). In contrast, Zain et al. (2005) discovered that ammoniating oil palm fiber with 4% urea could enhance in vitro digestibility. This discrepancy may be due to the study being conducted in vitro with oil palm fiber making up to 50% of the content.

The concentrate supplemented with teak leaf flour did not significantly impact dry matter digestibility (DMDC) or energy digestibility (EDC) ($p > 0.05$). While it did affect energy intake (EI), a decrease in intake was noted at higher concentrations, particularly in the T2 treatment. However, this decrease did not influence overall digestibility. Similar results were observed in a study examining the digestibility of rations in vitro, which included 40% forage and 60% concentrate supplemented with moringa leaves—known for their bioactive compounds like flavonoids and tannins. Supplementation with moringa leaf extract up to 20% produced digestibility rates between 53.52% and 56.82%

(Zahera et al., 2022). These findings align with a study by Bata et al. (2016), which indicated that adding hibiscus leaf flour did not significantly affect the digestibility of dry matter and organic matter in ammoniated rice straw and concentrate at 35:65 and 30:70 ratios. Conversely, Ichwani et al. (2013) found that increasing the concentration of hibiscus leaf supplementation in a 45:55 ratio of ammoniated rice straws and concentrates enhanced the digestibility of Ongole cattle. This discrepancy may stem from the different bioactive compounds present in the two types of leaves, despite the similar flavonoid content in both hibiscus and teak leaves. Preliminary research suggests that teak leaves contain flavonoids, phenols, and tannins, but not saponins. The tannin level of 41.75 mg/ml in teak leaves might influence energy digestibility in the rumen. Flavonoids in teak leaves could help maintain a favorable pH for microbial growth in the rumen, though this effect wasn't seen in dry matter or energy digestibility.

The energy retention (RE) value indicates the amount of energy available for livestock use. Neither the rice straw treatment nor the teak leaf flour supplementation significantly affected the energy retention (RE) value ($p > 0.05$). Variations in the energy excreted through urine did not influence the energy retention (RE) value across all treatments. In this study, the RE value for Madura cattle was found to range from 15.58 to 18.08 Mcal/d. This range is similar to that reported by Umam (2023), who found that Madura cattle fed ammoniated rice straw and concentrate supplemented with hibiscus leaf flour up to 0.48% achieved an RE value of 15.203 Mcal/d.

Rice straw processing and the addition of teak leaf flour did not have a significant impact on the ratio of energy available to energy intake (RE:EI), with p-values greater than 0.05. RE:EI represents the percentage of energy available in the body compared to the energy consumed, and in this study, values ranged from 57.69% to 66.08%. Similarly, there was no significant effect on the ratio of energy available to digested energy (RE:DE) from rice straw processing and teak leaf flour supplementation ($p > 0.05$). However, the RE:DE efficiency showed a tendency to increase in the rice straw treatment, with a significance value of 0.090. This variation could be due to higher energy values and lower energy excretion in urine from the rice straw treatment compared to the alternative treatment, even though the difference was not statistically significant. The RE:DE values in this study were between 85.98% and 90.16%. These results contrast with those from Utami et al. (2021), who reported RE:EI and RE:DE values of 70.56% and 98.75%, respectively. The discrepancies may stem from variations in energy intake, digested energy, and energy lost in feces and urine.

To assess livestock growth rates and production efficiency, it's essential to measure average daily gain (ADG) and feed conversion rates. Table 2 illustrates the initial weight, final weight, ADG, and feed conversion rates of Madura cattle receiving a mix of processed rice straw and teak leaf flour. ANCOVA results, adjusted for the initial weight of the cattle, revealed no interaction between the type of rice straw processing and the concentration of teak leaf flour on final weight, ADG, or feed conversion ($p > 0.05$). The type of rice straw processing did not significantly affect final weight, ADG, or feed conversion rates ($p > 0.05$). While the concentration of teak leaf flour supplementation did not significantly influence ADG or feed conversion ($p > 0.05$), it did have a significant effect on final weight.

Neither rice straw processing nor teak leaf supplementation affected ADG. The growth rate of livestock is typically measured by body weight gain, represented as ADG, according to Yusriani, et al. (2020). In this study, ADG values ranged from 0.71 to 0.89 kg/day, which is higher than the 0.64 kg/day reported by Rab, et al. (2016) for Madura cattle fed a diet consisting of 30%

soybean pod skin and 70% concentrate. This difference can be attributed to the lower nutrient content and dry matter intake in the current study compared to previous research. Additionally, a study on Bali cattle found that while the provision of fermented ammoniated rice straw in varying proportions did not significantly affect ADG, there was a tendency for ADG to decrease as the proportion of ammoniated fermented rice straw in the diet increased (Amin, et al., 2018).

Teak leaf flour supplementation at levels up to 0.42% in the concentrate did not hinder the growth of Madura cattle. In this study, the average daily gain (ADG) ranged from 0.71 to 0.89 kg/day, which is comparable to findings from Umam (2023), where Madura cattle fed ammoniated rice straw and a concentrate supplemented with 0.48% hibiscus leaf flour achieved an ADG of 0.767 kg/day. Similarly, (Balcells et al., 2012), reported that flavonoid supplementation in high-concentrate feed had no impact on the ADG of female dairy cattle. According to Table 2, RST2 and ARST1 both produced an ADG of 0.89 kg/day, suggesting that the combination of 0.42% TLF supplementation and rice straw was effective.

Feed conversion rate is a useful measure of the efficiency of Madura cattle in terms of feed intake. A lower feed conversion value indicates greater efficiency. Factors influencing feed conversion include body weight gain, dry matter (DM) intake, and feed quality (Damayanti, et al., 2018). The type of rice straw processing did not significantly affect feed conversion ($p > 0.05$). In this study, the feed conversion values ranged from 8.20 to 9.89, showing that Madura cattle were more efficient than those in a study by Nurnaningsih (2021), which reported a feed conversion value of 16.39 for cattle fed on concentrate and rice straw. Conversely, Partama et al. (2019) found that the type of rice straw processing as a basal feed did impact the feed conversion of Bali cattle, with the lowest feed conversion value for those fed ammoniated rice straw being 13.4. However, the feed conversion rates in our study were better than those reported by Partama et al. (2019), likely due to the limitation of rice straw to 30% of total intake, while that study used rice straw as a basal feed.

Teak leaf flour supplementation did not have a significant effect on feed conversion ($p > 0.05$). This aligns with findings from Bata et al. (2016) which indicated that hibiscus leaf flour supplementation did not affect ADG or feed efficiency in dairy cattle fed with ARS and concentrates in 35:65 and 30:70 ratios. In cattle consuming high-concentrate feeds, plant extracts with flavonoids did not affect ADG or feed efficiency but served as buffers and enhanced the fermentation process in the rumen (Balcells et al., 2012).

The results of the ANCOVA, adjusted for initial weight, showed that the type of rice straw processing did not significantly affect slaughter weight ($p > 0.05$). Orthogonal polynomial testing indicated that supplementing with teak leaf flour had a quadratic effect on slaughter weight, as described by a specific equation with an R^2 value of 0.380. The optimal weight was reached with teak leaf flour supplementation at 0.29% of dry matter (DM) concentrate. In this study, the slaughter weight of Madura cattle ranged from 317.33 to 349.67 kg. This final weight aligns with findings from Nurnaningsih (2021), where Madura cattle maintained for 101 days achieved a final weight of 337.38 kg. Notably, there was an interaction among final weight, average daily gain (ADG), and feed conversion rates. Additionally, the treatment that resulted in the lowest feed conversion value also produced the highest ADG and final weight.

Supplementing the concentrate with teak leaf flour had a quadratic effect on dry matter intake (DMI), energy intake (EI), and final weight, with the most effective supplementation seen in treatment T2. The best DMI, EI, and final weight were associated with teak leaf flour concentrations of 0.23%, 0.25%, and 0.29%, respectively. While teak leaf flour influenced

DMI and energy efficiency (KE) quadratically, it did not affect the digestibility of Madura cattle, as there were no significant differences in digestible energy (DE), dry matter digestibility coefficient (DMDC), energy digestibility coefficient (EDC), and the ratios of retained energy to energy intake (RE:EI) and retained energy to digestible energy (RE:ED) across all treatments. The consistent digestibility levels but varying feed intakes led to different final weights. According to Olagaray dan Bradford (2019), flavonoids can serve as buffers to mitigate acidosis in livestock consuming high-concentrate feed and may also help reduce inflammation caused by subacute acidosis in the rumen. This suggests that flavonoids could enhance livestock health, reflected in the observed body weight gains.

In conclusion, teak leaf flour supplementation exhibited a quadratic effect on slaughter weight. However, there was a noticeable trend of increasing final weight with rising concentrations of teak leaf flour, as seen in the RS treatment. This likely stems from an increase in teak leaf flour concentration, which corresponded with a higher concentrate intake ratio and a lower rice straw intake. The concentrate to rice straw intake ratios for treatments T0, T1, and T2 were 70.64:29.36, 71.47:28.43, and 72.28:27.72, respectively. Among these, treatment T1 with teak leaf flour supplementation at 0.21% produced the best final weight.

Conclusions

Madura cattle fattening fed with either ammoniated or non-ammoniated rice straw combined with concentrate supplemented with teak leaf flour resulted in an increase in feed intake and final body weight.

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