P-ISSN: 2304-3075; E-ISSN: 2305-4360
International Journal of Veterinary Science
www.ijvets.com; editor@ijvets.com
Research Article https://doi.org/10.47278/journal.ijvs/2022.216

Metabolic Response and Meat Quality of Goats Fed *Artocarpus heterophyllus* and *Moringa oleifera*

Angelia Utari[1], Lili Warly[2*], Hermon[2], Suyitman[2] and Evitayani[2]

[1]Doctoral Program, Department of Animal Nutrition and Feed Technology, Faculty of Animal Science, Andalas University
[2]Department of Animal Nutrition and Feed Technology, Faculty of Animal Science, Andalas University, Limau Manis Campus, Padang, West Sumatera, Indonesia
***Corresponding author:** lwarly@ansci.unand.ac.id

Article History: 22-728 Received: 18-Oct-22 Revised: 22-Nov-22 Accepted: 24-Nov-22

ABSTRACT

The availability of feed in the tropics generally depends on the season, low quality, and unstable continuity. One way to overcome the problem, use alternative feed ingredients that can come from forages, such as Jackfruit leaves (*Artocarpus heterophyllus*) and moringa leaves (*Moringa oleifera*). The main objective of this research is to develop the preparation of rations with optimal levels of utilization of jackfruit leaves (JAL) and moringa leaves (MOL) on metabolic responses and meat quality. The study used a Latin square design with four treatments and four replications; this research used goats aged about 8-10 months with a weight ranging from 10 to 15kg, four goats. Treatments were arranged as follows A (40% JAL+field grass 60%), B (Concentrate 40%+JAL 7.5%+MOL 7.5%+field grass 45%), C (Concentrate 40%+JAL 10%+MOL 10%+field grass 40%), and D (JAL 15%+MOL 15%+field grass 70%). The use of JAL and MOL in the diet from treatment D increased body weight gain, ration efficiency, metabolic responses from blood, lower cholesterol, and improved meat quality. Body weight gain (79.29%) and feed efficiency (18.22%) were significantly (P<0.05) higher in treatment D and significantly (P<0.05) lower triglycerides (19.80mg/dL), creatinine (0.62mg/dL), and cholesterol (63.20mg/dL) with the treatment D. With treatment D, cooking losses, pH, total meat proteins, meat cholesterol and meat tenderness were 33.54%, 6.71, 6.92%, 68.61%, 140.90mg/dL, and 3.04kg/cm^2, respectively. This study concluded that special feeding of JAL 15% forage with 15% MOL mixed with 70% field grass gave the best results, cheap and easy to obtain, lower cholesterol with cost-effective feed that was useful for the community/farmer in South Tapanuli.

Key words: Jackfruit Leaves, Moringa Leaves, Metabolic Responses, Meat Quality.

INTRODUCTION

The pandemic Covid-19 caused by the coronavirus has been spreading since 2019 in the world. Covid-19 spreads very fast (WHO 2020). The government has designated Covid-19 as a non-natural disaster. In Indonesia, the implementation of Social Restrictions Large-Scale in the long term led to a food crisis and potentially triggered household social and economic conflicts (Nina et al. 2021). Fluctuation in the community's economy has decreased due to the COVID-19 pandemic, which has resulted in the inability to cope with their own territorial needs (Agung 2020). Rising prices affect people's understanding of the importance of nutritious food, especially meat consumption. This consumption decreased by 2.6% from March 2020, further decreasing in March 2021 to 0.039kg/capita/month in Indonesia. Livestock, particularly small ruminants, production in the industrialized world, and increasingly in developing countries, is characterized by its intensive nature. Initially driven by post-pandemic government policies to increase production and lower costs, consumers now demand cheap food (Karen et al. 2022). The contribution of the livestock business is directly or indirectly affected by the pandemic, thereby reducing the potential for income and adequate profits of farmers, resulting in the provision of quality feed ingredients that cannot be available as in the past and the impact on livestock growth is slow (Olaniyi and Evas 2020).

Indonesia, especially in South Tapanuli, actually has many potential natural food sources that grow wild or intentionally planted but are not utilized optimally by

Cite This Article as: Utari A, Warly L, Hermon, Suyitman and Evitayani, xxxx. Metabolic response and meat quality of goats fed *Artocarpus heterophyllus* and *Moringa oleifera*. International Journal of Veterinary Science x(x): xxxx. https://doi.org/10.47278/journal.ijvs/2022.216

farmers to spur the growth of their livestock, especially in the dry season, which is a period when conventional forage types are difficult to obtain (Kongmanila and Ledin 2009). There are several types of leaves in question, e.g., jackfruit (*Artocarpus heterophyllus*), kelor (*Moringa oleifera*), and avocado (Ravindran 2016). JAL and MOL have the advantage of protein contents, essential amino acids, vitamins, and minerals needed by the livestock body (Makkar and Becker 1996). Based on the research that has been done, the results obtained from MOL and JAL, each level of 2.5% tannin *in vitro* rations, have crude protein digestibility of 84.01% (Goel et al. 2008). Additionally, JAL and MOL positively affected microbial protein synthesis and decreased methane gas. However, it was still not optimal in the level of *in vivo* administration of JAL and MOL on metabolic responses and production performance (Afid 2016). Giving a combination of rations added with JAL and MOL to livestock is a benchmark for assessing the palatability of feed ingredients that is one of the potential feed ingredients for ruminants because it has a high carbohydrate and protein source. JAL and MOL have nitrogen-free extract contents of 20 and 32.83% and crude protein of 12.52 and 26.43%, respectively (Nisa et al. 2017). Whether the feed ingredients are palatable can be checked at the feed consumption level (Suwignyo et al. 2016).

Consumption of rations affects the digestibility of food substances, the quality of the meat produced, body weight gain, and ration efficiency value that aims to gain profit. During the current project, whether the use of JAL and MOL in ruminants can stimulate metabolic responses and aspects of meat quality with optimal levels or not has been addressed.

MATERIALS AND METHODS

Animals

The four goats of about 8-10 months, having a weight range of 10-15kg, were used. Wooden cages (100x130cm) were used, which were further divided into two, a place to eat, a place to drink, a means of collecting feces and urine, and scales for weighing.

Treatment

The study used a Latin square design with four treatments and four replications. The analyses performed were metabolic responses and aspects of meat quality. The treatments are: Treatment A=40% JAL+field grass60%; Treatment B=Concentrate 40%+JAL 7.5%+ MOL 7.5%+field grass 45%; Treatment C=Concentrate 40%+JAL 10%+MOL 10%+field grass 40%, and Treatment D=JAL 15%+MOL 15%+field grass 70%.

Collections carried out during *in vivo* analysis include a collection of leftover feed, feces, and urine. Leftover feed was weighed to know the everyday feed consumption data. In each period, initial and final body weight was recorded to determine body weight gain and ration consumption.

Sampling and Parameters

The termination parameters were weight gain, serum metabolite levels, biochemical blood levels, pH, cooking loss, water-holding capacity, cholesterol, and meat tenderness.

Chemical Analysis

Each sample (Table 1) was analyzed using proximate analysis to determine the dry matter, organic matter, crude protein, crude fiber, extract ether, and ash (AOAC 2005).

Body Weight Gain and Feed Efficiency

Body weight determination was carried out for one month by weighing the body weight of the livestock every week; body weight gain was calculated by reducing body weight before treatment with body weight after treatment: BWT= (Final weight – Initial weight) / Research duration (days).

$$\text{Feed efficiency} = \frac{\text{Weight Gain}}{\text{Consumption of dry ingredients}} \times 100\%$$

Metabolic Responses

Blood samples were collected from the jugular vein at the end of the treatment period (end of the 8th week) and the end of the feed treatment period (end 12th week) before the animal acquired morning feed (7-8 am). Serum was separated for blood biochemistry for the determination of cholesterol, triglycerides, total protein, glucose, creatinine, albumin, globulin, sodium (Na), potassium (K), chloride (Cl), and calcium (Ca) using Microlab 300 at a wavelength of 505nm.

Meat quality

Variables measured were pH value, tenderness, shrinkage value of cooking loss of meat, total proteins, fat and cholesterol contents, and the water-holding capacity of meat. The degree's acidity or pH of fresh meat was determined by using a pH meter. Took 25g of meat sample, crushed, and diluted with 25 mL distilled water. Then the pH measurement was carried out after calibrating with buffer solution to standard 7. The meat sample (20g) was placed in a polypropylene plastic bag

Table 1: Feed ingredient and nutrient (% dry matter)

Ingredient (% dry matter)	Treatment			
	A	B	C	D
Concentrate	40	40	40	0
Jackfruit leaves	0	7.5	10	15
Moringa leaves	0	7.5	10	15
Field grass	60	45	40	70
Total	100	100	100	100
Nutrient (%)*				
Dry Matter	42.69	46.08	45.90	45.99
Organic Matter	92.96	92.88	92.58	92.73
Crude Protein	12.62	12.86	13.68	13.27
Crude Fiber	25.20	24.60	24.15	24.37
Extract Enter	4.08	4.12	4.22	4.17
Extract Enter Non-Nitrogen	51.06	51.30	50.53	50.92
Total Digestible Nutrient	62.27	63.15	63.21	63.18

*Data is provided from the total calculation results of the chemical composition of research ration materials with the arrangement of *in vitro* treatment rations. A: 40% JAL+60% Field Grass, B: Concentrate 40%+JAL 7.5%+MOL 7.5%+Field Grass 45%, C: Concentrate 40%+JAL 10%+MOL 10%+Field Grass 40%, D: JAL 15%+MOL 15%+ Field Grass 70%.

(0.5mm) and cooked in bath water for one hour at 80°C. At cooking, the meat was cooled in tap water for 30min, the meat was removed from the bag, and the liquid was wiped, dried with tissue paper, and weighed to measure weight lost during cooking.

Cholesterol levels were analyzed according to the "Liebermann-Burchard" test. In this test, cholesterol esters react with acetic anhydride and concentrated sulfuric acid to form a green color. A slice of mashed meat (0.5g) was stirred with alcohol ether (10mL) until homogeneous (0.5h), then centrifuged at 3000rpm for 10min; the supernatant was heated until the water was dried. The extract was dissolved in chloroform and added acetic anhydride (2mL) and concentrated sulfuric acid (0.1mL) and the solution was homogenized and stored (15min), then spectrophotometer readings were carried out at 420nm.

Statistical analysis

All data were subjected to analyses of variance of completely randomized design using SPSS software version 25.0 (SPSS 2017). IBM SPSS Statistics for Windows, version 21.0. Armonk, NY: IBM Corp. The results were presented as the mean values and standard error of the means. Differences between treatment mean were determined by Duncan's multiple range test. The significance level was at P<0.05 (Harsojuwono et al. 2021).

RESULTS

Effect of Treatment on Body Weight Gain and Ration Efficiency

Daily body weight gain with the treatment of JAL and MOL was between 70.36-79.29%. Daily body weight gain was significant (P<0.05), the highest in treatment D (79.29%), and the lowest in treatment A (70.36%). Furthermore, the efficiency of the ration was significant (P<0.05), the highest in treatment D (18.22%), while the lowest was in treatment B at 15.34% (Table 2).

Utilization of Jackfruit and Moringa Leaves on Metabolic Responses

The JAL and MOL as additional feed were given to determine the concentration of metabolite and blood biochemical responses in goats. The results showed goats' average serum metabolic levels (Table 3) and biochemical blood levels (Table 4).

The average blood glucose levels (12.93mg/dL) were found in goats using JAL and MOL. The glucose levels were lower in treatment D (1.2mg/dL) than in treatment A (without JAL and MOL) (Table 3). The creatinine levels associated with increased body weight in goats have increased fat and protein compaction. The lowest creatinine levels were present in treatment D (0.62mg/dL) compared to treatment A (1.19mg/dL). Furthermore, the total proteins in goats were relatively normal, with an average of 6.76g/dL. The cholesterol levels varied significantly (P<0.05) between 63.20 mg/dL (treatment D) to 76.40mg/dL (treatment A). Feeding of JAL and MOL did not affect albumin, globulin (Table 3), calcium, potassium, sodium, and chloride (Table 4).

Aspects of The Quality Meat

The results on the average quality parameters of meat, such as water contents, cooking losses, pH, meat tenderness and protein, fat, and cholesterol contents, have been shown in Table 5.

Table 2: The effect of using JAL and MOL on body weight gain and ration efficiency in goats

Parameters	Treatment				SE
	A	B	C	D	
ABWT (g/head/day)	70.36a	69.64c	74.82d	79.29d	1.27
Feed Efficiency (%)	15.42a	15.34a	18.03b	18.22d	0.47

Values (Mean±SE) with different alphabets in the same row are significantly (P<0.05) different. ABWT: Average Body Weight Gain.

Table 3: Effect of utilization of JAL and MOL on metabolic responses in goats

Parameters	Units	Levels of treatment in serum				SE
		A	B	C	D	
Cholesterol	mg/dL	73.30	76.40	75.50	63.20	1.25
Triglycerides	mg/dL	21.50	26.10	23.00	19.80	2.38
Glucose	mg/dL	24.90	13.10	12.50	1.20	1.80
Creatinine	mg/dL	1.19	0.70	0.68	0.62	0.45
Total Proteins	g/dL	6.08	7.29	6.65	7.03	1.30
Albumin	g/dL	3.60	3.84	3.58	4.25	0.98
Globulin	g/dL	2.42	3.45	3.07	2.78	0.86

Values (Mean±SE) with different alphabets in the same row are significantly (P<0.05) different.

Table 4: Effect of utilization of JAL and MOL on biochemical parameters in goats

Parameters	Units	Levels of treatment in serum				SE
		A	B	C	D	
Calcium	mg/dL	1.65	1.34	1.52	1.41	0.61
Potassium	mg/dL	0.23	0.27	0.21	0.22	0.24
Sodium	mg/dL	1.28	1.37	1.29	1.45	0.58
Chloride	mg/dL	3.28	3.51	3.62	3.22	0.92

Values (Mean±SE) with different alphabets in the same row are significantly (P<0.05) different.

Table 5: The effect of the use of JAL and MOL on the quality aspect of meat

Parameters	Units	Treatments				SE
		A	B	C	D	
Cooking Losses	%	35.26b	33.82b	34.17b	33.54c	0.89
pH		5.62a	5.97a	6.23c	6.71a	0.23
Fat Contents	%	8.67a	8.45a	7.12b	6.92c	0.39
Proteins Contents	%	56.23b	66.92a	67.36b	68.61b	0.24
Water Holding Capacity	%	79.67a	79.23a	78.31b	77.60c	0.44
Total Cholesterol	mg/Dl	145.92b	144.34a	141.27a	140.90a	0.98
Meat Tenderness	kg/cm^2	4.35a	4.21b	3.19b	3.04a	0.96

Values (Mean±SE) with different alphabets in the same row are significantly (P<0.05) different.

Table 5 shows that JAL and MOL treatment significantly (P<0.05) on cooking losses as being minimum in treatment D (33.54%). The average pH value of meat was 6.13. The fat contents of goat meat with the ration were significantly (P<0.05) different between treatment A (control) of 8.67% and treatment D (6.92%). Furthermore, the highest protein contents in meat were present in treatment D (68.61%) compared to the control group (56.23%). The cholesterol levels showed significant (P<0.05) the lowest values with treatment D (140.90 mg/dL), while the highest were in treatment A (145.92mg/dL). The tenderness of the meat showed significant (P<0.05) the lowest values with treatment D (3.04kg/cm^2) while the highest yield with treatment A (4.35kg/cm^2).

DISCUSSION

In the present study, results showed that the addition of JAL and MOL as functional feed has a significant (P<0.05) effect on average body weight and feed efficiency (Table 2). This could be due to the high body weight in the treatment D due to the high consumption and digestibility, and the low body weight in the treatment B with the utilization level of JAL and MOL of 7.5%, and the growth of body weight was not optimal, could be due to low palatability. Compared to other treatments, besides that JAL and MOL have antinutritional substances in the form of tannins and saponins (Makkar and Becker 1996), so if animals consume continuously in large quantities, it can reduce the growth of the goats (Jayanegara et al. 2015).

It is suspected that the use of JAL and MOL causes competition for the use of nutrients for rumen microbial growth, so it is likely that some rumen microbes do not get enough nutrients for their growth. This assumption is clarified by the increased temperature and humidity of the environment, which can cause a decrease in feed consumption, so the higher the temperature and humidity in a place tend to reduce livestock productivity (Bhatta et al. 2000). Slow body weight may be caused by the inefficient use of energy for growth because some energy is widely used to increase physiological body parameters (Dosom et al. 2018). It has been stated that body weight is influenced by several factors, including the total proteins obtained every day, type of livestock, age, genetic conditions, environment, condition of each individual, and livestock health (Harmoko and Padang 2019). As a result, the fleshy muscles enlarge slowly, and the body's resistance decreases (Ana et al. 2018).

Daily body weight gain in treatment D in the present study was considered significantly higher when compared with the control group that did not receive treatment of JAC and MOL. This makes it clearer that the availability of nitrogen sources by microbes to build body cells and feed that reaches the abomasum and intestines can be maximally digested and absorbed to meet the basic needs of life and production (Ragni et al. 2014). Based on the value of the efficiency of the study ration ranged from 15.42 to 18.22%, it can be seen that the effect of the ration treatments was significantly (P<0.05) different from the use of jackfruit leaves and moringa leaves. Consumption of DM rations that are not matched by the daily body weight a ration will be more efficiently used if the ration is consumed in small quantities and can provide a large body weight (Suwignyo et al. 2016). This verdict is also supported by results reported by Munir et al. (2015), who stated that feed conversion is the ratio of the amount of feed consumed (kg) and body weight (kg), because the smaller the feed conversion value, the more efficient the feed consumed.

Furthermore, the study's results in Table 3 are based on the value of blood glucose levels obtained from feed carbohydrates, both in the form of crude fiber and nitrogen-free extract, which affected the increase in blood glucose (Agung et al. 2020). Rumen bacteria digest crude fiber and nitrogen-free extract into volatile fatty acids (VFA) and simple sugars, eventually converting into liver blood glucose (Warly et al. 2017). Propionic acid supplies the body's glucose needs as much as 30%. The activity of the hormone insulin causes changes in levels to stabilize blood glucose levels by pushing blood glucose into the liver and muscle glycogen (Suwasono 2013).

The results of creatinine levels were associated with increased body weight in goats in the current study, present in the form of increased fat and protein compaction. This possibility was considered based on the tendency to decrease creatinine levels in goat blood. In this study, the lowest result of treatment D was 0.62g/dL compared to treatment A was 1.19mg/dL. Creatinine levels were still within normal limits, ranging from 0.9-1.8mg/dL for goats (Wahjuni and Bijanti 2006). It is suspected that blood is part of the extracellular fluid that takes oxygen from the lungs, nutrients from the gastrointestinal tract, and transports hormones from the endocrine glands. These materials are transported throughout cells and tissues. These materials will diffuse from the capillaries to the interstitial tissue, enter the cells, and then be used for all cell activities (Sticker et al. 1996). The creatine synthesis process uses essential amino acids as precursors of creatinine, namely arginine and glycine, and these essential amino acids are contained in jackfruit leaves and moringa leaves, so the influence of the amount of feed consumption also affects creatinine levels (Afid 2016).

Total proteins were 6.08-7.29g/dL with the treatments carried out in the present study with significant (P<0.05) difference between treatments. The difference in total protein concentration in this study may be related to the interval of additional feeding levels of JAL and MOL. It contains antinutritional substances in jackfruit leaves and moringa leaves, namely tannins, which have two properties in animal feed. Tannins have sound biological effects, which are positive or negative when consumed by livestock. At the right concentration, protein protection by tannins alters a number of rumen degradable proteins (RDP) to rumen undegradable protein (RUP), which then increases metabolizable protein (MP), the protein that can be digested and absorbed in the intestine fine (Putri et al. 2021). This is one of the reasons an increase in total plasma protein by giving 15% JAL and 15% MOL is suspected to be appropriate supplementation to the amount of tannins available and can increase the total protein blood plasma (Anugrah et al. 2019).

The concentration of cholesterol levels in this study had a significantly different effect (P<0.05) after receiving additional feed treatment of JAL and MOL. This is because it contains good natural antioxidants and various antioxidant compounds such as ascorbic acid, flavonoids, phenolics, and carotenoids, high concentrations of ascorbic acid, protein, and especially essential amino acids, especially methionine, cysteine, tryptophan. The combination of jackfruit leaves with low levels of ammonia (NH_3) with moringa leaves will potentially increase nutrient digestibility and control cholesterol levels in goat blood (Zvonko et al. 2020). These results indicated that the goats did not have electrolyte balance disturbances (Na, K, and Cl) and body acid-base or protein catabolism. This is different from the findings in wildebeest and deer, which showed a change/decrease in serum protein and electrolyte levels of potassium and blood acidity (pH) under conditions of lack/decrease in feed intake (Soppela et al. 2008).

In this research about meat quality, the cooking loss value of meat varies between 1.5-54.5%. pH, the length of the muscle fiber sarcomere, the length of the muscle fiber cut, the state of myofibril contraction, the size and weight of the meat samples, and the cross-section of the meat all affect the amount of cooking loss (Sriyani et al. 2015). pH value of meat average is 6.13. In general, the ultimate pH range of fresh meat is 5.4-6.8 (Snezana et al. 2014), indicating that the pH value of the goat meat that was slaughtered for each treatment was still normal in or ultimate range.

The results showed that there was a significant difference ($P<0.05$) in the protein content of the meat, the highest result was found in treatment D at 68.61%, and the lowest was found in treatment A (control) at 56.23%. It is suspected that the provision of JAL and MOL in the ration affects the protein content of goat meat. Jackfruit leaves and moringa leaves are potential feed ingredients for ruminants because they have a fairly high source of carbohydrates and protein, have a nitrogen-free extract content of 42.56%, and CP of 29.36% (Wahyono et al. 2017). The addition of JAL and MOL has a positive effect on tannins, namely increasing the efficiency of the use of ration protein, faster livestock growth, the lower the protein content of the meat produced, the higher the fat content of goat meat (Purnami and Purbowati 2021).

Furthermore, the results of goat meat cholesterol levels ranged from 140.90-145.92mg/dL. The lowest treatment was found in treatment D, while the highest was in treatment A. This could be because, apart from giving different treatments, the level of ration consumption and age of goats can cause meat cholesterol levels to increase; with increasing age, the percentage of carcass fat will increase. Fat consumed is the basic ingredient, although the cholesterol intake of feed varies. Cholesterol from feed can inhibit the formation of cholesterol in the body (Imam et al. 2013).

The tenderness of the meat in all treatments showed significantly different values of 3.04-4.35kg/cm^2. The difference could be that the ration with the addition of JAL and MOL at different levels given to each goat contained nutrients to meet the additional basic life needs. Tenderness criteria based on trained panelists stated that very tender meat had a breaking power of WB (Warner Blatzler) <4.15kg/cm^2, tender meat 4.15<5.86kg/cm^2, slightly tender meat 5.86-<7.56kg/cm^2, slightly tough meat 7.56-<9.27 kg/cm^2, tough meat 9.2-<10.97kg/cm^2, very tough meat 10.97kg/cm^2. The results of the average tenderness of ruminant meat for all treatments showed a value of tenderness (±4.4) (Ana et al. 2018).

Conclusion

The addition of 15% each of JAL and MOL (treatment D) provides significantly ($P<0.05$) best results in terms of body weight gain (79.29%), feed efficiency (18.22%), metabolic responses, and blood biochemical parameters. This study concludes that it can improve the body proteins in the goat body tissues and thus can increase body weight and reduce meat cholesterol. Even the metabolic responses are not disturbed in goat blood.

Conflict of Interest

The authors confirm that there is no conflict of interest regarding this manuscript.

Acknowledgement

The authors are grateful to the Directorate General of Higher Education, The Ministry of Education and Culture for funding this research under the scheme of Doctoral Research of Dissertation with contract number: T/73/UN.16.17/PT.01.03/PPS-PDD Pangan/2022. This research was carried out well with technical assistance from the staff of the Livestock Technology Laboratory, Faculty of Animal Husbandry, Biochemical Laboratory, Faculty of Medical, Andalas University, Limau Manis Campus, Pauh Districts, Padang City, West Sumatera, Indonesia.

Author's Contribution

Lili Warly and Angelia Utari supervised the experiment. Hermon and Suyitman conducted the experiment and data analysis. A Evitayani and Angelia Utari prepared tables and finalized the draft. The final version of the manuscript was read and approved by all authors.

REFERENCES

Afid M, 2016. Effects of goat meat consumption on blood pressure. Public health journal 10: 85-90. http://dx.doi.org/10.12928/kesmas.v10i1.5209

Agung IM, 2020. Understanding the Covid-19 pandemic in the perspective of social psychology. Psikobuletin Journal 1: 68–84. http://dx.doi.org/10.24014/pib.v1i2.9616

Agung P, Jauhari, Nellita M, Yusmadi, Tongku NS, Juli M, Budianto P and Nuzul Asmili, 2020. Aceh cow blood biochemistry profileat different estrus intensity. Jurnal Veteriner 21: 470-475. http://dx.doi.org/10.19087/jveteriner.2020.21.3.470

Ana G, María DMC, José LO and Carlos S, 2018. Carcass and meat quality in goat. In book: Goat Science. http://dx.doi.org/10.5772/intechopen.72095

Anugrah RM, Maryanto, Tjahjono and Kartasurya, 2019. Red guava juice Psidium Guajava L reduce oxidative stress of toll gate collector. Journal Agritech 39: 333-337. https://dx.doi.org/10.22146/agritech.23030

Bhatta R, Krishnamoorthy U, and Mohammed F, 2000. Effect of feeding tamarind (Tamarindus indica) seed husk as a source of tannin on dry matter intake, digestibility of nutrient and production performance of crossbred dairy cows in midlactation. Animal Feed Science and Technology 83: 67-74. https://doi.org/10.1016/S0377-8401(99)00118-2

Dosom YN, Suarsana IN and Setiasih NLE, 2018. The effect adding moringa leaf flour to feed on creatinine and urea levels in wistar rats. Buletin Veteriner Udayana 10: 190-195**.** https://doi.org/10.24843/bulvet.2018.v10.i02.p13

Goel G, Makkar HPS and Becker K, 2008. Effects of *Sesbania sesban* and *Carduus pycnocephalus* leaves and Fenugreek (*Trigonella foenum-graecum* L.) seeds and their extracts on partitioning of nutrients from roughage and concentrate-based feeds to methane. Animal Feed Science Journal 147: 72-89. https://dx.doi.org/10.1016/j.anifeedsci.2007.09.010

Harmoko and Padang, 2019. Performance conditions and physiological status of peanut goats with feeding castor leaf flour (*Jatropha gossypifolia*) fermentation. Jurnal Peternakan Indonesia 21: 183-191. http://dx.doi.org/10.25077/jpi.21.3.183-191.2019

Imam K, Purbowati E and Adiwinarti R, 2013. Chemical composition of goat meat male beans that are feeded with different quality. Animal Agriculture Journal 2: 23-30. https://ejournal3.undip.ac.id/index.php/aaj/issue/view/412

Jayanegara A, Goel G, Makkar HPS and Becker K, 2015. Divergence between purified hydrolysable and condensed tannin effects on methane emission, rumen fermentation and microbial population in vitro. Animal Feed Science and Technology Journal 209: 60–68.

Karen T, Carlos ALD, Luis ESI, Alfonso JCC, Manuel GR and Einar VBP, 2022. A brief update on the challenges and prospects for goat production in mexico. Commentary Animals 837: 2-14. https://doi.org/10.3390/ani12070837

Kongmanila D and Ledin I, 2009.Chemical composition of some tropical foliage species and their intake and digestibility by goats.Asian-Australasian Journal of Animal Sciences 22: 803–811. https://doi.org/10.5713/ajas.2009.80589

Makkar HPS and Becker K, 1996. Nutrional value and antinutritional components of whole and ethanol extracted Moringa oleifera leaves. Animal Feed Science and Technology Journal 63: 211-228. https://doi.org/10.1016/S0377-8401(96)01023-1

Munir MI and Kardiyanto, 2015. Increasing the body weight of local sheep in banten province through the addition of bran and grass. Balai Pengkajian Teknologi Pertanian Banten. Prosiding Seminar Nasional Teknologi Peternakan dan Veteriner. A603-RKNu. https://.doi.org/10.13140/RG.2.2.35658.16327

Nina RP, Reny S and Ema HM, 2021. The Impact of Covid-19 on the decline of sales volume and income of broiler meat traders. Journal of Agricultural Sciences and Veteriner 09: 158-165. https://doi.org/10.31949/agrivet.v9i2.1359

Nisa D, Achmadi J, Wahyono F and Diponegoro U, 2017. Degradability of organic matter and production of total Vollatile Fatty Acids (VFA) in Moringa (Moringa oleifera) leaves in vitro. Ilmu-ilmu Peternakan 27: 12–17. https://doi.org/10.21776/ub.jiip.2017.027.01.02

Olaniyi and Evas, 2020. Socio ecconomi Impacts Of novel coronavirus: The policy solutions, bizecons quartely, strides educational foundation. Econ Paper 7.312. https://econpapers.repec.org/article/risbuecqu/0013.htm

Purnami NA, and Purbowati E, 2021. Meat production of young and adult Kejobong goats fed diets with different protein concentration. Jurnal Ilmu-ilmu Peternakan 31: 52–59. https://doi.org/10.21776/ub.jiip.2021.031.01.0

Putri EM, Mardiati Z, Lili W and Hermon, 2021. Effects of rumen degradable to undegradable protein ratio in ruminant diet on in vitro digestibility, rumen fermentation, and microbial protein synthesis. Veterinary World 14: 640-648. https://doi.org/10.14202/vetworld.2021.640-648

Ragni M, Vicenti A, Melodia L and Marsico G, 2014. Use of grape seed flour in feed for lambs and effects on performance and meat quality. Procedia-Social and Behavioral Sciences 8: 59-64. https://doi.org/10.1016/j.apcbee.2014.03.001

Ravindran V, 2016. Feed-induced specific ileal endogenous amino acid losses: Measurement and significance in the protein nutrition of monogastric animals. Animal Feed Science and Technology 221: 304–313. https://doi.org/10.1016/j.anifeedsci.2016.05.013

Snezana DI, Zoran MS, Ksenija DN, Boris PP, Milan ŽB, Jovanka VPR and Jelena MD, 2014. Effect of goat breed on the meat quality. Hemijska Industrija 68: 801-807. http://dx.doi.org/10.2298/HEMIND131201006I

Sriyani NLP, Tirta AIN, Lindawatati SA and Miwada INS, 2015. Study of physical quality of goat meat cut in denpasar city traditional RPH. Majalah Ilmu Peternakan 18: 48-51. https://doi.org/10.24843/MIP.2015.v18.i02.p03

Suwignyo B, Wijaya UA, Indriani R and Kurniawati A, 2016. Intake, nutrient digestibility, body weight gain and physiology response status on feed restriction of male bligon goat. Jurnal Sain Veteriner 34: 210-219. https://dx.doi.org/10.22146/jsv.27560

Suwasono, 2013. Hematocrit, glucose and blood urea levels of Java cattle fed concentrate feed with different levels. Animal Agriculture Journal 2: 37-44.

Sticker LS, Thompson Jr DL, Bunting LD and Fernandez JM, 1996. Dietary protein and energy restriction in mares: rapid changes in plasma metabolite and hormone concentrations during dietary alteration. Journal Animal Science 74(6): 1326-1335. https://dx.doi.org/%2010.2527/1996.7461326x

Soppela P, Saarela S, Heiskari U and Nieminen M, 2008. The effects of wintertime undernutrition on plasma leptin and insulin levels in an arctic ruminant, the reindeer. Comparative Biochemistry and Physiology 149: 613-621. https://dx.doi.org/10.1016/j.cbpb.2007.12.008

Wahyono T, Sasongko WT, Sholihah M, and Pikoli MR, 2017. Effect of addition of tannins in jackfruit (*Artocarpus heterophyllus*) leaves on biological values of moringa (*Moringa oleifera*) and green bean straw (Vigna radiata) leaves In vitro. Buletin Peternakan 4: 15-25. https://doi.org/10.21059/buletinpeternak.v41i1.2245

Wahjuni RS and Bijanti R, 2006. Side effects test of compli feed formula on liver and kidney function of holstein friesian cattle. Jurnal Kedokteran Hewan 22: 174-178.

Warly L, Suyitman, Evitayani and Fariani A, 2017. Nutrient digestibility and apparent bioavailability of minerals in beef cattle fed with different levels of concentrate and oil-palm fronds. Pakistan Journal Nutrition 16(3): 131-135. https://doi.org/10.3923/pjn.2017.131.135

WHO, 2020. WHO Timeline COVID-19. World Health Organization

Zvonko A, Katja N, Željka K, Vatroslav Š, Boro M, Marcela Š, Mario R and Josip N, 2020. Blood metabolic profile and acid-base status of Istrian goats a critically endangered Croatian goat in relation to age. Veterinarski Arhiv 90: 27-38. http://dx.doi.org/10.24099/vet.arhiv.0780