Original Article

Effect Of Dragon Fruit Peel Flour (*Hylocereus sp.*) In Complete Feed On Characteristics Of Rumen Fermentation In Goat

Syamsinar Alimuddin[1], Syahriani Syahrir[2], Rohmiyatul Islamiyati[3]

[1]Postgraduate Student of Animal Science and Technology, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia.
[2]Department of Animal Nutrition, Faculty of Animal Science, Hasanuddin University Jalan Perintis Kemerdekaan Km.10, Makassar 90245, Indonesia.
[3]Department of Animal Nutrition, Faculty of Animal Science, Hasanuddin University Jalan Perintis Kemerdekaan Km.10, Makassar 90245, Indonesia
Email: nanisyahrirn9@gmail.com | syamsinaralimuddin96@gmail.com
DOI: 10.47750/pnr.2023.14.S02.136

Abstract

Dragon fruit peel is an agricultural waste that contains potential nutrients so that it can be used as an alternative ingredient for making complete feed. The purpose of this study was to examine the effect of giving complete feed containing dragon fruit peel flour (*Hylocereus sp.*) on rumen fermentation characteristics (pH,N-NH_3,VFA) in goats. This study used 12 male goats based on a randomized block design with 3 treatments and 4 groups. The treatment consisted of complete feed without dragon fruit peel flour (P1), complete feed with 5% dragon fruit peel flour (P2) and complete feed with 10% dragon fruit peel flour (P3). The results showed that complete feed treatment with the addition of dragon fruit peel flour had no significant effect (P>0.05) on rumen fermentation characteristics (pH,N-NH_3,VFA). The mean pH values ranged from 6.80-7.22, N-NH_3 levels ranged from 4.76-7.85 (mM) and VFA levels ranged from 28.46-40.48 (mM). It was concluded that complete feed with the addition of dragon fruit peel flour at a level of 10% produced optimal values for rumen fermentation characteristics based on pH values and ammonia levels (N-NH_3).

Keywords: Dragon Fruit Peel Flour, Complete Feed, Characteristics of Rumen Fermentation, Goat

INTRODUCTION

Goat livestock is a type of ruminant livestock that has great potential to be developed (Pagala et al., 2020). In Indonesia, there are many types of goats that are spread in rural areas. Raising goats aims to be a family savings, source of income, produce meat (beef cattle), milk (dairy livestock) and by-products (Nafiu et al., 2020). Feed is an important factor in supporting the life of livestock, because 60-70% of production costs come from feed (Setyatwan et al., 2018). One of the efforts that can be made to optimize livestock productivity is by using good feed ingredients in the form of feed ingredients as energy sources and protein sources in the complete ration given. Ruminants are highly dependent on forage. On the other hand, the need for forage is increasingly limited, due to dependence on season and land. The increasing population growth has resulted in many grazing areas being converted into settlements, plantation land, agricultural land, so that businesses are narrowing due to the rapid development (Pagala et al., 2020).

Alternative feed substitutes for forages can be made by making complete feeds from agricultural, plantation and industrial waste residues. Agricultural and plantation waste is a promising source, especially for ruminants because it is relatively uncompetitive with humans (Dewi et al., 2018). Where complete feed is composed of mixed ingredients from agro-industrial waste, agricultural waste can be used optimally so that livestock do not need to be given forage

(Fachiroh, 2012). Feeding with a complete feed system will avoid feed selection so that most parts of the feed will be consumed and tend not to be selective when eating (Munawaroh et al., 2015). Provision of agro-industrial waste not only reduces environmental problems caused by waste accumulation and reduces the carbon footprint of livestock production (Gerber et al., 2014) but also increases the antioxidant status of livestock (Tian et al., 2019) due to the presence of bioactive compounds such as phytochemicals and vitamins. .

Studies on the use of dragon fruit peels for ruminants are still lacking. Dragon fruit peel is an example of agricultural waste that is worth trying as a ration mixture because of its various potentials and advantages (Pane & Pakpahan, 2019). The weight percentage of dragon fruit peel reaches 30-35% of the total dragon fruit (Nurliyana et al., 2010). Dragon fruit peel has a fairly good nutrient content, namely 8.79% crude protein, 25.8% crude fiber, 1.32% crude fat, 1.75% calcium, 0.30% phosphorus, and 20.06% ash (Astuti et al., 2016). Dragon fruit peel is a source of minerals, nutrients, antioxidants & pigments such as β-carotene, lycopene, anthocyanins (Wahyuni, 2011; Handayani & Rahmawati, 2012; Rosa et al., 2013). Dragon fruit peel also contains about 8.4% sugar, consisting of 4.15% glucose, 3.37% maltose, and 0.86% fructose (Jamilah et al., 2011). The results of Satria and Marhayani's research (2020) reported that the use of dragon fruit peel flour at a level of 0.25% in concentrate gave local goats a daily body weight gain of 54.21 g/head/day. Based on this description, we are interested in conducting research on the addition of dragon fruit peel flour (*Hylocereus sp.*) in complete feed to determine the characteristics of rumen fermentation in goats.

Methodology

This research was carried out at the ruminant feed experiment unit, Faculty of Animal Science, Hasanuddin University, Makassar and was approved by the Research Ethics Commission, Hasanuddin University Medical Faculty, Makassar with protocol number UH23010009. In vivo studies used 12 male goats with an average age of 1.5 years and a body weight ranging from 11 to 18 kg. This study was arranged using a randomized block design (RBD), 4 groups based on body weight and 3 treatments as follows:

P1: Complete feed without Dragon Fruit Peel Flour

P2: Complete feed with 5% Dragon Fruit Peel Flour

P3: Complete feed with 10% Dragon Fruit Peel Flour

Research Procedure

Complete Feed Manufacturing

Dragon fruit peel is first cut into pieces and then dried in an oven for 48 hours at 65°C then pulverized with a blender. Other feed ingredients are ground to change the particle size and soften the texture of the ingredients to facilitate mixing, each ingredient is weighed according to the composition of each treatment, then mixed evenly. The composition of the ingredients and the chemical composition of the complete feed for each treatment feed ingredient can be seen in Tables 1 and 2.

Table 1 Ingredients Composition in Complete Feed Production

Feed Ingredients	**Treatment (%)**		
	P1	**P2**	**P3**
Corn Tumpi	50	45	40
Dragon Fruit Peel Flour	0	5	10
Fine Yellow Corn	10	10	10
Fine bran	20	20	20
Coconut Meal	5	5	5
Molasses	6	6	6
Rese Flour	5	5	5
Salt	1	1	1
Mineral Mix	2	2	2
Urea	1	1	1
Total	100	100	100
Nutrient Composition	**P1**	**P2**	**P3**
Dry matter (%)*	84.42	84.47	84.52
Crude protein (%)*	14.79	14.81	14.82
Crude fiber (%)*	15.51	15.70	15.89
Crude fat (%)*	3.78	3.82	3.86

*Note: * Calculation results*

Table 2 Chemical Composition of Complete Feed Treatment

Nutrient Composition	P1	P2	P3
Dry matter (%)**	93.05	93.19	93.07
Organic matter(%)**	89.51	88.42	88.32
Crude protein (%)**	17.13	17.14	16.89
Crude fiber (%)**	5.83	12.35	10.78
ADF (%)**	13.26	12.65	13.96
NDF (%)**	39.21	41.29	44.33
NFE**	60.23	53.33	55.30

*Note: **Results of Animal Feed Chemistry Laboratory Analysis, Hasanuddin University*

As for there is Table 3. presented the content of nutritional ingredients in the manufacture of complete feed.

Table 3 Content of Nutrients Ingredients for Making Complete Feed

Feed Ingredients	DM (%)	CP (%)	C.F (%)	CF (%)
Corn Tumpi[a]	87.36	8.65	21.29	0.53
Dragon Fruit Peel Flour[b]	88.32	8.98	25.08	1.32
Fine Yellow Corn[b]	89.47	14.38	4.92	4.76
Fine Bran[c]	91.00	12.90	11.40	13.00
Coconut Meal[c]	88.50	21.50	15.00	2.00
Molasses[d]	77.00	4.2	7.7	0.2
Flour Rese[c]	91.04	45.00	17.59	6.62
Salt	-	-	-	-
Mineral	-	-	-	-
Urea	-	287.00	-	-

Note: DM=Dry Matter, CP=Crude Protein, C.F=Crude Fiber, CF=Crude Fat. Source:) Wahyono and Hardianto (2004), [b]) Animal Feed Chemistry Laboratory, Hasanuddin University (2021),[c]) Anggorodi (1985), [d]) Sukria & Rantan (2009).

Feeding on Livestock

Goats were placed in metabolism cages measuring 110 x 130 x 146 cm (length x width x height) each with 12 plots. Each cage plot has been equipped with a place to eat and drink. Under each cage is attached a plastic ram which functions as feces and urine filtration. Feed is given twice a day at 08.00 and 16.00 with the same proportion. Drinking water is provided ad libitum.

Sampling

Rumen fluid collection is carried out 4 hours after feeding using a vacuum pump, by first laying the cattle down and then inserting the tube through the mouth to the rumen, then pressing the vacuum pump button to suck up 5 to 10 ml of liquid from the rumen. Then, the rumen fluid samples obtained were first measured for pH value using a pH meter and stored in a cold box for further analysis of ammonia ($N\text{-}NH_3$) and VFA levels. Rumen fluid collection was carried out at the end of the study.

Measured Parameters

Rumen Fluid pH

Rumen fluid samples were taken using a stomach tube system (Preston and Leng, 1987). Measurement of rumen fluid pH was measured using a pH meter, the pH meter was first turned on and allowed to stabilize for 15-30 minutes. Standardize with standard buffer solution pH 7. Rinse with distilled water then dry with tissue. Insert the electrode into the tube containing the rumen fluid sample, the pH value is determined by looking at the numbers on the monitor screen.

Ammonia content ($N\text{-}NH_3$)

Ammonia levels ($N\text{-}NH_3$) were determined using the Conway microdiffusion technique (General Laboratory Procedures, 1966). The lips of the Conway cup and the lid are smeared with Vaseline. 1 ml of the supernatant derived

from the fermentation process was taken, then placed at one end of the groove in the Conway cup. 1 ml of saturated NaOH solution was placed at one end of the Conway adjacent to the supernatant. A solution of boric acid with indicator methyl red and bromine cressol green as much as 1 ml is placed in a small cup which is located in the middle of the Conway cup.

The Conway cup that had been smeared with Vaseline was tightly closed so that it was airtight, the NaOH solution was mixed with the supernatant until it was evenly distributed by shaking and tilting the cup. After that it was left for 24 hours at room temperature. After 24 hours at room temperature, the indicator boric acid was titrated with 0.005 N H_2SO_4 until the color changed from black to pink. N-NH_3 production is calculated by the following formula:

$$\text{N-NH}_3 = \frac{\text{V. N. 17}}{1000} \times 100\%$$

Note: V = Volume
N = Normality

Vollatille Fatty Acid (VFA)

VFA production was measured using a steam pressure distillation technique (AOAC, 2000). As much as 5 ml of the supernatant was put into a distillation tube which was heated with water vapor. The tube was immediately closed tightly after adding 1 ml of 15% H_2SO_4. The walls of the tube were rinsed with distilled water and immediately closed with a rubber stopper which was connected to a distillation pipe with a diameter of approximately 0.5 cm. then the other end of the pipe is connected to the Laibig cooler.

The distillation tube is inserted into the boiling flask containing boiling water without touching the surface of the water. The distillation results were collected in a 500 ml Erlenmeyer flask which had been filled with 5 ml of 0.5 N NaOH. The distillation process was finished when the amount of distillate stored reached 300 ml. The collected distillate is added with 2-3 drops of phenophthalein (PP) indicator and titrated with 0.5 N HCL. Dropping ends until a color change from pink to clear or colorless is obtained. VFA levels can be calculated using the following formula:

$$\text{Total VFA} = (VB – VS) \times \text{N-HCl} \times 1000/5\text{mM}$$

Note: B = Volume of blank titrant
S = Sample titrant volume
N = Normality of HCl solution

Data analysis

The data obtained in the form of the average value of rumen fermentation characteristics (pH, N-NH_3,VFA) were analyzed variously with the SPSS Version 16.0 program using a randomized block design (RDB) 3 treatment of 4 groups dan followed by the Duncan Test (Gomez, 2007).

Results and Discussions

Rumen Fermentation Characteristics (pH, N-NH_3, VFA)

The condition of the rumen is very important so that the process of digestion of feed in the rumen can be optimal. This is because the digestive process is inseparable from the role of rumen microbes which are very helpful in the digestive process and the provision of food and energy substances for the ruminants. The characteristics of rumen fermentation (pH, N-NH_3, VFA) in goats fed with complete feed in each treatment can be seen in Table 4.

Table 4 Rumen Fermentation Characteristics (pH, N-NH_3,VFA) in each Treatment

Paramater	Treatment			P-Value
	P1	P2	P3	
pH	7.02 ± 0.15	6.80 ± 0.24	7.22± 0.25	0.099
N-NH_3 (mM)	4.76± 1.64	7.85 ± 2.70	5.02 ± 1.94	0.153
VFA (mM)	40.48 ± 10.73	31.52± 7.28	28.46 ± 8.35	0.136

Note:
P1= Complete feed without dragon fruit peel flour
P2= Complete feed with 5% dragon fruit peel flour
P3= Complete feed with 10% dragon fruit peel flour

pH value

The pH value of the rumen fluid plays a role in regulating the fermentation process including to produce VFA and support the growth of rumen microbes (Hapsari et al., 2018). Analysis of variance showed that the treatment had no significant effect (P> 0.05). The pH value ranged from 6.80 to 7.22. This means that the dragon fruit peel flour is not feared to disturb the environmental balance of rumen microorganisms. The average pH value of the three treatments is still in the optimal pH range, so that it can have a good impact on the feed degradation process in the rumen so that the fermentation process runs in balance. This is supported by the opinion of Dehority and Tirabasso (2001) that the pH value is categorized into the optimal pH, which is in the range of 6-7. This was reinforced by Usman (2013) who stated that the rumen would effectively degrade fiber feed if the pH value was in the range of 6.5 to 7 and the activity of fiber-digesting microbes would slow down if the pH was at a value of 6.2. Appropriate pH conditions indicate that the process of microbial growth and metabolism will not be disturbed so that the ration digestion process will be optimal (Suharti et al., 2018). Stable rumen pH will have an impact on optimal rumen microbial performance in digesting feed (Li et al., 2012).

Ammonia (N-NH_3)

The level of ammonia (N-NH_3) in the rumen is one of the factors that determines the efficiency of feed protein synthesis. Ammonia production is closely related to the amount of use of feed ingredients containing protein in the ration. Analysis of variance showed that the treatment had no significant effect (P>0.05) on the levels of ammonia (N-NH_3). This means that all treatments provide the same ammonia use efficiency. The concentration of ammonia produced from all treatments ranged from 4.76-7.85 mM, indicating that each treatment was able to support microbial protein synthesis in the rumen. This is supported by Paengkoum et al. (2006) that the concentration of N-NH_3 needed by rumen microbes to digest feed optimally is 5-20 mg/dL, equivalent to 3.57-14.28 mM. According to Widiyanti et al. (2020) optimum levels of N-NH_3 result in faster microbial growth and maximum carbohydrate degradation.

Factors that affect N-NH_3 concentrations are feed protein content, protein degradation, and energy sources and the proportion of dissolved carbohydrates into ATP energy (Prayitno et al., 2018). The concentration of N-NH_3 in the feed treatment P2 and P3 was higher than P1 proving that substitution of 5-10% dragon fruit peel flour for corn stubble can increase the availability of N to support the growth of rumen microbes which serve as a source of protein for goats. Isah et al. (2013) stated that the concentration of N-NH_3 in the rumen depends on the quantity and level of solubility of the protein contained in the feed.

Total VFA

Volatile Fatty Acids (VFA) are one of the products of carbohydrate fermentation in the rumen consisting of acetic acid, propionate, butyrate and long chain fatty acids. Analysis of variance showed that treatment had no significant effect (P>0.05) on VFA levels. The average values of VFA levels produced by research at P1, P2 and P3 were 40.48 mM, 31.52 mM and 28.46 mM. This value has not yet reached the optimum range for microbial growth, where the VFA concentration needed by an animal to support optimal growth of the rumen according to Waldron et al. (2002) ranged from 80–160 mM.

This phenomenon is thought to be due to the peak of VFA fermentation which occurred earlier so that when taking rumen fluid 4 hours after feeding the peak of fermentation has passed, we suspect this is due to differences in the characteristics and nutrient solubility of each feed ingredient, where the complete feed ingredients that we use tend to towards non-structural carbohydrate types, namely sugar and starch where these types of carbohydrates are fermented more quickly. Susilo et al. (2019) also stated that VFA can give an idea of how high the level of solubility of carbohydrates in the feed during the fermentation process in the rumen.

Apart from being influenced by the nutrient content of crude fiber, the VFA concentration is also influenced by the nutrient content of the nitrogen free extract (NFE). The content of NFE in P1 is higher than in P2 and P3 (Table 2). This causes the VFA concentration at P1 to be higher than the other treatments. The higher the NFE content, the higher the VFA concentration, because NFE has compounds that are easily fermented by rumen microbes (Muslimah et al., 2020). High VFA concentrations indicate more effective fermentation and if the VFA concentration is too high it can have an impact on rumen balance (Rahayu et al., 2018).

Conclusion

Based on the results of the research conducted, it can be concluded that complete feed with dragon fruit peel flour at a level of 10% is able to produce optimal values for rumen fermentation characteristics based on pH values and ammonia levels (N-NH_3) in goats.

Conflict of Interest

The author declares that there is no conflict of interest with financial, personal or other relationships with other people or organizations related to the material discussed in this manuscript.

Acknowledgement

The author would like to thank profusely to all parties involved, especially my research partner Mariam, S. Pt, M. Si, Supervisor Dr.Ir. Syahriani Syahrir, M. Si, Dr. Ir. Rohmiyatul Islamiyati, MP, Laboratory Assistant for Feed Chemistry, Faculty of Animal Husbandry, Hasanuddin University. Acknowledgments also go to Ahmad Jafar Shodiq, S.Pt and Mushandri, S.Pt for their assistance in handling research experimental cattle.

References

1. Anggorodi, R. (1985). *General Animal Feed Science*. Jakarta: PT Gramedia
2. AOAC. (2000). Association of Official Analytical Chemists, Official Methods of Analysis. 15th ed. USA: Washington, D.C.
3. Astuti, I, I. M. Mastika, & Dewi. G. A. M. K. (2016). Performance of broilers fed rations containing dragon fruit peel flour without and with fermented *Aspergillus niger*. *Animal Science Magazine 19*(2):65-70.
4. Dehority, B. A., & Tirabasso, P. A. (2001). Effect of feeding frequency on bacterial and fungal concentrations, pH, and other parameters in the rumen. *Journal of animal science*, *79*(11), 2908-2912. https://doi.org/10.2527/2001.79112908x
5. Dewi, S. P., Ridla, M., Laconi, E. B., & Jayanegara, A. (2018). Increasing the quality of agricultural and plantation residues using combination of fiber cracking technology and urea for ruminant feeds. *Tropical Animal Science Journal*, *41*(2), 137-146. https://doi.org/10.5398/tasj.2018.41.2.137
6. Fachiroh, L., Prasetiyono B. W. H. E. & Subrata., A. (2012). Protein and blood urea levels of cross-breed Etawa goats fed complete feed wafers based on agro-industrial waste with protective proteiner supplementation. *Animal Agriculture Journal, 1*(1). 443–451.
7. General Laboratory Procedures. (1966). Department of Dairy Science. University of Wisconsin. Madison.
8. Gerber, P. J., Uwizeye, A., Schulte, R. P., Opio, C. I., & De Boer, I. J. M. (2014). Nutrient use efficiency: a valuable approach to benchmark the sustainability of nutrient use in global livestock production?. *Current opinion in environmental sustainability*, *9*, 122-130. https://doi.org/10.1016/j.cosust.2014.09.00
9. Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research*. John wiley & sons.
10. Handayani, P. A. & Rahmawati. A. (2012). Utilization of Dragon Fruit Skin (dragon fruit) as Natural Dyes Substitute Synthetic Dyes. *Journal of Renewable Natural Materials. 1*(2): 19-24.
11. Hapsari, N. S., Harjanti, D. W., & Muktiani, A. (2018). Fermentability of Feed with Additions of Babadotan Leaf Extract (*Ageratum conyzoides*) and Ginger (*Zingiber officinale*) in Dairy Cattle In Vitro. *Journal of agripet.18*(1):1-9. https://doi.org/10.17969/agripet.v18i1.9672
12. Isah, O. A., Oguntuyo, S. A., Dawodu, R. O., Diya, O. O., Afolabi, M. O., & Omoniyi, L. A. (2013). Feed utilization, rumen parameters, and microbial profile of goats fed different tropical browse plants with Pennisetum purpureum as basal diet. *The Pacific Journal of Science and Technology*, *14*(1), 397-405.
13. Jamilah, B., C. E. Shu, M. Kharidah, M. A. Dzulkify, & A. Noranizan. 2011. Physico-chemical characteristics of red pitaya (*Hylocereus polyrhizus*) peel. International Food Research Journal.18:279-286.
14. Li, S., Gozho, G. N., Gakhar, N., Khafipour, E., Krause, D. O., & Plaizier, J. C. (2012). Evaluation of diagnostic measures for subacute ruminal acidosis in dairy cows. *Canadian Journal of Animal Science*, *92*(3), 353-364.
15. Munawaroh, L. L., Budisatria, I. G. S., & Suwignyo, B. (2015). Pengaruh pemberian fermentasi complete feed berbasis pakan lokal terhadap konsumsi, konversi pakan, dan feed cost kambing Bligon jantan. *Buletin Peternakan*, *39*(3), 167-173.
16. Muslimah, A. P., R. Istiwati, A. Budiman, B. Ayuningsih, & I. Hernaman. (2020). In vitro study of beef cattle rations containing tengkawang cake on fermentability and digestibility. *Integrated Animal Husbandry Scientific Journal 8*(1):21-26. https://doi.org/10.23960/jipt.v8i1.p21-26.
17. Nafiu, L. O., Pagala, M. A. & Mogiye, S. L. (2020). Production Characteristics of Etawa and Kacang Goats under Different Rearing Systems in Toari District, Kolaka Regency. *Journal of Production Science and Technology of Livestock Products. Faculty of Animal Husbandry, University of Halu Oleo Kendari. 8* (92) : 91-96.
18. Nurliyana, R., Syed Zahir, I., Mustapha Suleiman, K., Aisyah, M. R., & Kamarul Rahim, K. (2010). Antioxidant study of pulps and peels of dragon fruits: a comparative study. *International Food research journal*, *17*(2).
19. Paengkoum, P., Liang, J. B., Jelan, Z. A., & Basery, M. (2006). Utilization of steam-treated oil palm fronds in growing saanen goats: II. Supplementation with energy and urea. *Asian-australasian journal of animal sciences*, *19*(11), 1623-1631.
20. Pagala, M. A., Zulkarnain, D., & Kasmin, M. O. (2021). Analysis of The Carrying Capacity of Food Crop Follow-up As a Source of Ruminant Animal Feed In Kolaka Regency. *Chalaza Journal of Animal Husbandry*, *6*(1), 12-20.
21. Pagala, M. A., Zulkarnain, D., & Munadi, L. O. M. (2020). Carrying Capacity of Forage Animal Feed and By-products of Oil Palm Plantation in Tanggetada District, Kolaka Regency. *Jurnal Sosio Agribisnis*, *5*(2), 70-76.
22. Pane, D., & Pakpahan, R. (2019). Effect of Dragon Fruit Peel Fermentation With Neurospora Crassa Mold on Crude Fat, Calcium, (Ca) and Phosphorus (P) Content. *Journal of Animal Husbandry.10*(2).50-54.
23. Prayitno, R., S., F. Wahyono, & Pangestu. E. (2018). Effect of supplementation of legume forage protein sources on production of ammonia and ruminal total protein in vitro. *Indonesian Animal Husbandry Journal. 20*(2):116-123. https://doi.org/10.25077/jpi.20.2.116-123.2018
24. Preston, T. R., & Leng, R. A. (1987). *Matching ruminant production systems with available resources in the tropics and sub-tropics*. Penambul Books.
25. Rahayu, R I., Subrata, A. & Achmadi. J. (2018). In vitro ruminal fermentation on amoniated rice straw based feed with supplementation of banana flour and molasses. *J. Indonesian Animal Husbandry. 20* (3): 166 – 174. https://doi.org/10.25077/jpi.20.3.166-174.2018.
26. Rosa, R.A., M. A. Malik, I. G. Prakoso, R. W. Djati, & Purnamawati. Y. (2013). *Feed Supplements Based on Dragon Fruit Peel Waste (Hylocereus undatus) to Produce Quail Eggs Rich in Vitamin A and Low in Cholesterol*. Bogor: Bogor Agricultural Institute

27. Satria & Marhayani. (2020). Effectiveness of Dragon Fruit Peel Powder on Local Goat Body Weight Gain. *Indonesian Animal Husbandry Science Journal. 15*(4): 441- 447.
28. Suharti, S., Aliyah, D. N. & Suryahadi. (2018). Characteristics of in vitro rumen fermentation with the addition of vegetable oil calcium soap in different buffers. Journal of Nutrition Science and Feed Technology. 16(3):56–64. https://doi.org/10.29244/jintp.16.3.56-64
29. Sukria, H. A. & Krisnan. R. (2009). *Sources and Availability of Feed Raw Materials in Indonesia*. Bogor: IPB Press
30. Susilo, E., Nuswantara, L. K. & Pangestu. E. (2019). Evaluation of feed ingredients by-products of the agricultural industry based on ruminal fermentability parameters in vitro. *Indonesian Journal of Animal Science 14*(2):128-136. https://doi.org/10.31186/jspi.id.14.2.128-136
31. Tian, X., Xin, H., Paengkoum, P., Paengkoum, S., Ban, C., & Sorasak, T. (2019). Effects of anthocyanin-rich purple corn (Zea mays L.) stover silage on nutrient utilization, rumen fermentation, plasma antioxidant capacity, and mammary gland gene expression in dairy goats. *Journal of animal science*, *97*(3), 1384-1397. https://doi.org/10.1093/jas/sky477
32. Usman. Y. (2013(. Feeding Agricultural Plant Leftover Fiber (Peanut Straw, Corn Straw, Sugarcane Shoots) Against the Evolution of pH, $N\text{-}NH_3$ and VFA in the Rumen of Cattle. *Journal of Agripet. 13*(2). Syiah Kuala University. Banda Aceh.
33. Wahyono, D. E., & Hardianto, R. U. L. Y. (2004). *Pemanfaatan sumberdaya pakan lokal untuk pengembangan usaha sapi potong*. Jakarta: Lokakarya Nasional
34. Wahyuni, R. (2011). Use Super Red Dragon Fruit Skin (Hylocereus costaricensis) As a Source Of Antioxidants In Natural Dyes and Jelly Making.(Pemanfaatan Kulit Buah Naga Super merah (Hylicereus costaricensis) sebagai Sumber Antioksidan dan Pewarna Alami pada Pembuatan Jelly). *Food Technology Journal*, *2*(1), 68-83.
35. Waldron, M. R., Schrick, F. N., Quigley, J. D., Klotz, J. L., Saxton, A. M., & Heitmann, R. N. (2002). Volatile fatty acid metabolism by epithelial cells isolated from different areas of the ewe rumen. *Journal of animal science*, *80*(1), 270-278. https://doi.org/10.2527/2002.801270x
36. Widiyanti, A. R., Cardi, E. U., Tanuwiria, H., Tarmidi, A. R., & Hernaman. I. (2020). The effect of various levels of using ganyong dregs (*Canna edulis kerr*) in rations on fermentability and digestibility (*in vitro*). *Journal of Animal Husbandry.17*(2):90-95. http://dx.doi.org/10.24014/jupet.v17i2:9465