Nutritive value and rumen fermentability characteristics of the diet were supplemented by dried carboxylate salts mixture (DCM)

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Abstract. The objective of this study is to determine the effect of supplementation of a mixture of dried carboxylic salt (DCM) protected by fatty acids in fermented feed on nutritional values and fermentation characteristics and ammonia concentration. Rumen liquid, sago waste, rice bran, fish waste, and sap liquid are used as material. The total ration mixture formulation is based on fermented feed and DCM supplements as follows: R0 (40% rice bran, 40% fermented sago waste, 20% commercial concentrate), R1 (40% fermented rice bran, 40% fermented sago waste, 20% commercial concentrate), R2 (R1 + 1.5% DCM) R3 (R1 + 3% DCM) and R4 (R1 + 4.5% DCM) The nutritional value of fermented feed obtained by DCM supplementation was significantly different between treatments, supplementation 1.5-4.5% DCM significantly increased dry matter, ash, and ether extract. DCM supplementation significantly reduced crude fibre and not in crude protein. The addition of DCM increases the dry matter, ash, and ether extract and decreases crude fibre and does not affect the crude protein. The addition of DCM in ration decreases rumen pH but increases total VFA and N-NH₃ ammonia concentration.

1. Introduction

Total mixed ration for ruminant can be formulated and compound of the by-product available locally, such as sagoo waste, rice bran, and tofu waste [1]. By product have a limiting of fermentability in the rumen, it becomes a limiting factor to the utilization of rations. Fermentation is the most method strategy that can be applied to improve fermentability via utility inoculants containing fibrous degrading microbes such as cattle rumen liquor from slaughterhouse waste. If this is successful, then it can be used to increase the growth of Bali cattle to obtain carcasses with maximum meat, minimal bone and optimal fat [2]abc.

Microbes from rumen liquor utilized some component of the total mixed ration for their growth and activities, therefore reducing the organic matters, crude protein, and crude fibre content of a feed. However, the addition of rumen liquor was able to hydrolyse the feed component. It improved the availability as well as the fermentability of the complete feed component [3] fermented product – feeds with cattle rumen liquor such as fermented rice bran (FRB) 45%-60%, sago waste (SW) 30%-

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45% and tofe waste (TW) in the ration could improve dry matter digestibility of ration on the goat [1] Fat or oil as energy source in the ruminant rations, but by using it will decreased fermentability and digestibility of the rumen. Therefore, oil as feed must be protected before offered to the ruminant. The protection of unsaturated fatty acid using microencapsulation and calcium soaps has reported increased rumen pH significantly compared to the control. Different sources of unsaturated fatty acid did not affect rumen PH. Protected vegetable oils reported has about 5% in the ration resulted in VFA production highest compared to the other treatments. The result of the experiment supplementing dry carboxylate salt mixed 1.5%-6% in the concentrate reported has increased VFA production in the cattle rumen liquor but decreased NH3 production. Supplementation of 15% protected PUFA in the cattle feed reported has different ammonia concentration significantly, VFA concentration highly significant while ruminal pH not significant. Supplementation of essential oil in alfalfa hay and corn silage reported increased ruminal PH and ammonia concentration.

The experimental was design to evaluate the effect of supplementation protected fatty acid in the ration based on fermented feeds on nutritive value and rumen fermentability characteristics.

2. Method

The experiment was conducted at the Laboratory of Nutrition and Feed Technology, Faculty of Animal Science Halu Oleo University Kendari South East Sulawesi. A completely randomized design was used to an in vitro incubation of ration based on fermented feeds with rumen liquor, which is supplementation protected fatty acid.

2.1 Preparation of fermented feed

Fermentation of rice bran and sago waste
Rice bran or sago waste (50:50) about 1 kg was mixed with 300 ml solution of rumen liquor and sugar solution (1:2). In the silo, fermentation was done anaerobically at room temperature for 21 days. After that, biomass was dried in the oven with a temperature 55˚C for 48 hours.

2.2 Protected fatty acid (PFA)

Fish waste processing consist of bone, head, and viscera was cooked at 60˚C for 30-60 minutes to produce fish oil. Fish oil was mixed with fermented Nira liquor, and Supernatant of Spondias Dulcis leaves Extract (3:1). This solution was added to fermented rice bran than it was mixed until homogenous, so the fermented fatty acid was dried in the oven 55˚C for 48 hours.

2.3 Ration diets experiment

Formulation of total mixen ration based on fermented feeds and supplementing protected fatty acid (PFA) as follow : RO (40% rice bran, 40% fermented sago waste, 20% commercial concentrate), R1 (40% fermented rice bran, 40% fermented sago waste, 20% commercial concentrate, R2 (R1+1.5% DMC), R3 (R1+3% DCM) and R4 (R1+4.5% DMC).

2.4 Data collection and analysis

Nutrient content of the total mixed, including dry matter (DM), ash, crude protein (CP), and crude fibre (CF), were determined using the procedure of proximate analysis. Nutrient content or chemical composition was analysed to evaluate ration nutritive value. The fermentation characteristic (ruminal pH, NH3-N, and volatile fatty acid/VFA concentration), the ruminal pH was measured using pH meter, ammonia-N concentration was analysed by Conway microdiffusion method. VFA concentration was analysed by the steam distillation method. Statistical analysis. The statistical analysis of the data was carried out according to one way ANOVA [8] significance was declared at P<0.05 if a significant F-test was detected, multiple comparisons using Duncan Multiple Range Test.
3. Results and discussion

3.1 Nutritive value of ration based

The overall results of the nutritive value of ration based on fermented feed with supplementing DCM as protected fatty acid were significantly different \( (p<0.05) \) among treatments. The supplementing 1.5%-4.5% protected fatty acid (PFA) increased \( (p<0.05) \) dry matter (DM), ash, and ether extract (EE) contents. Inversely, supplementing PFA decreased crude fibre content \( (p<0.05) \) and non-significantly difference \( (p>0.05) \) of crude protein (Table 1).

Table 1. Nutritive Value of Rations Based on Fermented Feed with Supplementing Dried Carboxylate Salt Mixture (DCM)

| Treatment | Nutritive Value |
|-----------|-----------------|
|           | % DM            |
| R0        | 92.42<sup>a</sup> |
| R1        | 91.52<sup>d</sup> |
| R2        | 91.51<sup>c</sup> |
| R3        | 91.52<sup>b</sup> |
| R4        | 91.57<sup>a</sup> |
| SEM       | 0.002, 0.009    |

The increasing dry matter content showed that supplementing of DCM could improve water content in the rations. Fermented feeds with rumen liquor could increase water content because of their abilities to degrading chemical components, especially cellulose, that could result in water. The increasing ash content showed that ration based on fermented feed and supplementing DCM decreased organic matter (DM) content, although those experimental rations did not affect crude protein ether extract content could increase in the rations. Supplementing protected fatty acid did not affect crude protein content based on fermented feed; it indicated that the impact of the utility of nutrients in the feed by rumen microbial (inoculants) did not significantly for microbial protein synthesis to growth and support its activities. Protected fatty acids have contributed to crude protein content in the rations.

The increasing ether extract content as along with increasing levels of DCM in the rations indicated that fatty acid from fish oil, including in the protected fatty acid. Therefore, fatty acid could be determined in the rations. [10] Reported that the values of ether extract were not affected by fermented feed, such as fermented coffee pulp. Reduction of crude fibre content in the complete feed was associated with the increase in microbial activities, especially cellulolytic microbes, have ability to the grading cellulose a primary component fibre. The experiment was supported by [10] that the effect of using calcium salt fatty acid (CSFA) as protected fatty acid increase nutritive value and dietary energy level. The same as [12] that chemical composition of the experimental diet containing either 5% soybean oil or 5% sunflower oil decreases the percentage of dry matter and ether extract.

3.2 Rumen fermentation characteristics of ration of fermented feeds with supplementing protected fatty acids

The overall result of rumen fermentation characteristic of ration rations based on fermented feeds with supplementing PFA was significantly different \( (p<0.05) \) among treatments. Supplementing 1.5%-4.5% PFA in the ration decreased rumen pH inversely this supplementation increased total VFA concentration and ammonia N-NH3 concentration (Table 2). Reduction of pH value might be due to (1) increased the lactic acid produced by lactic acid bacteria, (2) increased fatty acid from protected fatty acids Canarium sp level extract as fatty acids protection techniques partially, and (3) effect total VFA is increasing from fermented feeds in the rations. The homofermentative lactic acid bacteria metabolism, the majority of glucose present in the medium converted to pyruvate via glycolysis pathway, which is reduced to lactic acid. The acid was produced by another heterofermentative group
lactic acid bacteria from hexoses of pentoses via pentose phosphate pathway, along with volatile fatty acid, CO₂ and ethanol. The acid product will reduce the pH of the medium. This experiment was suggested by [9] that addition rumen cellulite microbes to feed that protection techniques using microencapsulation and calcium-soap significantly increased rumen pH, but a different source of unsaturated fatty acid did not significantly increase rumen pH.

Table 2. Fermentation characteristics

| Treatment | pH   | Total VFA | N-NH₃ |
|-----------|------|-----------|-------|
| R0        | 6.87d| 156.12c   | 7.84c |
| R1        | 6.81cd| 160.03bc  | 8.13d |
| R2        | 6.62cd| 167.08ab  | 8.53c |
| R3        | 6.47bc| 170.10a   | 9.11b |
| R4        | 6.37ab| 172.12a   | 10.76a|
| SEM       | 0.12 | 2.55      | 0.07  |

The difference of this experiment showed that protection techniques-extract Tannin of fatty acids in the fish oil could decrease pH rumen. Although the increasing level of supplementing VFA in the ration was followed by increasing total VFA concentration, supplementation 1.5-6% VFA could result in VFA concentration of protected PUFA in the cattle feed effect VFA level highly significant. These experiments indicated that supplementing PFA in the ration based on all of the kind feeds (pasture, fermented by-product). Supplementing 1.5%-4.5% PFA increase (p<0.05) N-NH₃ ammonia production in the cattle ruminal liquor. This indicated that ruminal microbes degrade the structural protein in the fermented feed, so it does not interfere with ruminal metabolism.

The increasing total VFA and N-NH₃ ammonia production indicated that supplementing VFA as a result of Canarium sp leaves extract protection of fish oil – fatty acids did not affect pressure activity of ruminal microbes inoculated into the fermented feed to hydrolysed and degraded the large molecules of nutrient such as carbohydrate, fat, and protein. This experiment was supported by [12] that fermented feed such as coffee husk fermented with Pleurotusostreatus as ruminant feed increased volatile fatty acid (VFA) production in vitro, and [13] that addition of 5% rumen cellulolytic microbes did not affect of the pH value. However, the addition of 10% rumen cellulolytic microbes decreased ruminal pH.

There was not an interaction between the protection techniques and sources of unsaturated fatty acid (USFA) using microencapsulation and calcium-soap on carboxylate salt significantly increased ruminal pH compared to control [4] essential oil supplementation in the diets containing three different forages increased N-NH3 ammonia concentration and VFA concentration [8]. The experiment was not supported by [14] that adding protected fatty acid (dry carboxylate salt mixed, DCM) did not affect ammonia N-NH₃ concentration. Inversely, it was supported by [14] that adding DCM significantly increased total VFA concentration and decreased ruminal. This experiment showed that PFA could be a source of energy for a ruminant. Without the negative effect of rumen fermentability characteristics.

4. Conclusion

Supplementing PFA a result of protecting fatty acid-fish oil with extracted Canarium sp leaves (PFAFORECL) in the ration based on fermented feed Increased dry matter, ash, and ether extract but decreased crude fibre and did not affect on crude protein. Supplementing PFA in the ruminal rations pH, but it increased total VFA and N-NH₃ ammonia concentrations.

Reference
[1] Tasse A M, D Ev vyernie Rahman 2014 Feed intake, daily gain and feed conversion of etawah crossbreed goat feed ration containing fermented rice bran Proceeding the 2nd Asian-Australian dairy goat conference April 25-27th IPB Bogor Indonesia
[2] Hafid H, Gurnadi RE, Priyanto R and Saeefuddin A Identifications of carcass characteristic for estimating the composition of beef carcass Journal of the Indonesian Tropical Animal Agriculture 35 (1) pp 22-6
[2] Hafid H, Nuraini, Inderawati and Kurniawan W 2018 Bali cattle characteristic of different butt shape IOP Conf Series: Earth and Environmental Science 119 pp 1–6
[2] Hafid H, Hasnudi, Bain A, Nasiu F, Inderawati, Patriani P and Ananda S H 2019 Effect of fasting time before slaughtering on body weight loss and carcass percentage of Bali cattle IOP Conf Series: Earth and Environmental Science 260 pp 1–7

[3] Mudita M, Wibawa A P, Wirawan I W, Sitti N W and Cakra I G I O 2011 Improving the nutritive value of total mixed ration base on by-products fermented by rumen liquor and enzyme Indon J Nutri and Feed Sci 2 (1) pp 20-5

[4] Suharti, Hidayah N and wiyawon K G 2014 Effect of protected unsaturated fatty acids addition on in vitro digestibility and rumen microbes Proceeding of the 16th AAAP animal science congress vol II Gadjah Mada University Yogjakarta, Indonesia

[5] Bain A, Astuti D A, Suharti S, Arman T and Wiryawan K G 2014 The effect of protected vegetable oils on in vitro fermentation characteristic and nutrient digestibility of Bali cattle rumen fluid Proceeding of the 16th animal science congress vol II Gadjah Mada University, Yogjakarta, Indonesia

[6] Riyanto, J, Baliary E, Hartatik T, Widayati D T and Yusiati L M 2014 Supplementation of protected PUFA in cattle feed based on rumen fermentation and nutrient digestibility products by in vitro Proceeding of the 16th AAAP animal science congress vol II Gadjah Mada University, Yogjakarta, Indonesia

[7] Lee H J , Kim D H, Amanullah S M, Jon Y H, Kim S C, Kim S B and Adesogan A T 2014 Effects of essential oil supplementation on in vitro digestibility and rumen fermentation characteristic of three different diets Proceeding of the 16th AAAP animal science congress vol II 10-14 November Gadjah Mada University, Yogjakarta, Indonesia pp 460

[8] Steel R and Torie J 1980 Principes and procedures of statistics (New York: MCGrawhill)

[9] Yusiati, Mira L and Bachrudin, Zaenal and Utomo, Ristianto and Harwanto, Harwanto 2014 The Effect of Cinnamon (Cinnamomum burmanni Ness ex BI) as Source of Cinnamaldehyde in the Sheep Diet on Nitrogen Balance and Rumen Microbial Protein Supply in the 16th AAAP Congress, Yogjakarta

[10] De souza R, Alcaide B Hygino C R, De Labio Molona G T Dos Santos B R and Gomes L C 2014 Effect of dietary energy level using calcium salts of fatty acids on the nutritive value of diets and milk quality in peripartum dairy goats Ciene Agrotec 38 (3)

[11] Titi H 2011 Effect of varying levels of protected fat on the performance of Shami goats during early and mid-lactation Turk J Vet Anim Sci 35 (1) pp 67-74

[12] Badarina I, Evyyernie D, Tohamat T, Herliyana E N and Darusman L K 2013 Nutritive value on coffee husk fermented with Pleurotus ostreatus as ruminant feed Media peternakan 36 (1) pp 58-63

[13] Yusiati L M, Hanim C and Az Zahra F 2011 The use of cellulolytic microbes from cattle rumen fluid to improves in vitro digestibility of fermented robusta pulp (coffee canephora sp) Indon J Nutr and feed Sci 2 (1) pp 15-8

[14] Yurleni, Priyanto R, Gurnadi E and wiyawon K G 2013 The effect of protected lemurs fish oil on rumen microbes and its fermentation in buffaloes and cattle J Vet 14 (3) pp 285-93