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Effect of Macronutrient Needs on Digestibility and Average Daily Gain of Sheep (*Ovisaries var. Padjadjaran*, Family Bovidae)

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***Abstract*—Feeding management is a very important factor that makes sure fulfil quality and quantity for livestock nutrient sufficiency that affects the success rate in livestock farming. The excellent macro nutrient needs determination is an absolute thing to achieve the optimal growth which represented by digestibility and average daily gain. Feed formulation that considering the material selection, availability, and the price of feed materials could gave sustainable livestock feed management. The study was carried out to evaluate the effect of macronutrients needs on digestibility and average daily gain of sheep. Twenty Padjadjaran sheep (*Ovisaries var. Padjadjaran*, Family Bovidae), which resulted from crossbreeding between South-African Capstaad, Merino, and local, were chosen as tested animals. These white sheep were placed separately in individual metabolism cages. All animals were 8-10 months of age and their body weights ranged between 15-33 kg. The animals were divided into 5 groups and each group was treated with different dietary feeds (4 times replication) that contained dry material, crude protein, crude fiber, crude fat, and nitrogen-free extract (NFE). The parameters measured were dry matter intake (DMI), dry matter digestibility (DMD), organic matter digestibility (OMD) and average daily gain (ADG). The treatments showed no significant effect on DMI, DMD, and OMD, whereas an increase of ADG (113.33 – 169.17 g/animal/day) was observed on all animals. One of R2-treated animal showed an increase of 276.67 g/day.**

***Keywords*— animal nutrition; animal feed; dry matter intake; dry matter digestibility; organic matter digestibility.**

I. INTRODUCTION

Sheep feeding needs a significant cost in all sheep-farms in Indonesia. Considering that in our tropical country, the climate differences between dry and rainy seasons are extremes, which affect the quantity and quality of the feed sources. The pastures are usually scarce during the dry season, therefore animal diets need to be formulated in such ways that support optimum production and minimize nutritionally related problems. Sheep need macronutrients to maintain their products quality. Macronutrients needed are energy, protein, minerals, and vitamins. The excellent feed can provide all of the nutrient needs in term of quality and quantity both for macronutrient and micronutrient. Besides that, the sheep should also easily accept this feed. Therefore, feed formulation should fulfil the rule of nutrient requirement for the sheep and the palatability. The quality feed is very necessary to generate the sheep body weight, which is expected. The expected body weight and average daily gain (ADG) from sheep fattening should be high [1]. However, the high body weight was not always generated a good quality of the carcass, because high fat carcass will cause loss to the producer [2].

Giving quality feed to the sheep can be done through supplementary feeding. Supplementary feeding is done to hand feed as little as possible to achieve the required sheep production. The indicator of the total energy contained in the feed is digestibility (Fig.1). A digestibility value of 75% in early October can drop to 55 % by early January. Below 55% of digestibility, sheep are unable to consume enough pasture to maintain their weight. It includes a lot of lactose, significantly modified nitrogen processing of the Lucerne hay in the rumen; supplementation permitted a more prominent take-up of ammonia for microbial synthesis [3]. Subsequently, rumen ammonia levels, blood urea, and urinary nitrogen excretion diminished enormously with lactose, from 20.5 mg/100 ml, 20.6 mg/100 ml and 6.96 g/day to 2.3 mg/100 ml, 8.7/100 ml and 2.5 g/day, respectively. The measure of nitrogen streaming into the duodenum expanded by 47%, and the measure of non-ammonia nitrogen clearly processed inside the small intestine by 83%. Nitrogen in feces expanded with lactose in view of expanded microbial nitrogen. Retained nitrogen

expanded just slightly (from 5.0 to 6.4 g/day) because of the low nitrogen needs of sheep [4].

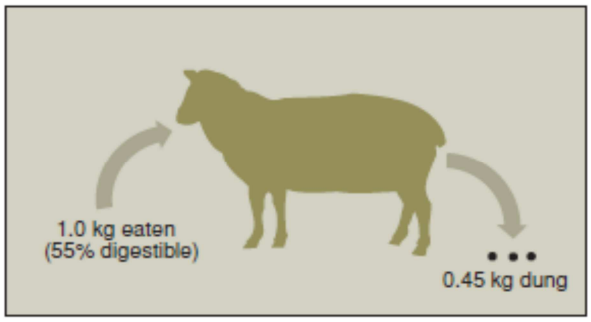

Fig.1 Digestibility of sheep as a measure of the amount of pasture consumed by sheep (copied from Feeding and Managing Sheep in Dry Times)

Probiotic supplementation is another solution for increasing feed efficiency. Probiotic in the livestock body can affect the digestibility, increase Average Daily Gain (ADG), and be able to decrease fat. Direct supplementation of probiotic in the feed could increase feed efficiency [36]. Probiotic used in feed supplementation usually consists of yeast, lactic acid bacteria, or the other microorganisms, which have a positive effect in digestion tract. One of the probiotics which are used in feed supplementation is *Saccharomyces cerevisiae* with the ability to increase ADG, feed conversion, and to produce volatile fatty acid (VFA) [5]–[8]. The other types of probiotics are *Lactobacillus acidophilus* and *Lactobacillus lactis* which are able to produce and utilize lactic acid which can increase ADG and feed efficiency [9] [10]. Besides that the type of *enterococci* as *Enterococcus faecium* can be used to decrease acidosis that happens in the rumen [11]. Previous studies showed that the average weight of local sheep at Northern area of West Java ranged between 12.5 to 32.5 kg [12] whilst at Southern area were 20 to 35 kg [13]. These data indicated that there is a significant decreasing of sheep performance compared to that in 1980-era that the weight of adult sheep in West Java were 60 to 80 kg (male) and 30 to 40 kg (female) [12].

Padjadjaran sheep (*Ovisaries var. Padjadjaran*, Family Bovidae), are white sheep resulted from cross-breeding between South-African Capstaad, Merino, and local sheep [14]. These sheep were bred by Bandiati by employing biotechnology reproduction (estrus synchronization) followed by artificial insemination [15]. They continued their project to standardize her product characters by applying the polymorph pituitary-specific transcription factor (PIT1) gene and biotechnology reproduction [14]. As newly breeds, the nutrient needs of these sheep have not been recognized yet. The sheep of Padjadjaran are cattle, which have been maintained with the main purpose to produce meat. The characteristic of Padjadjaran sheep has a huge body, rectangular or beams, maximum meat quality, fast reaching adult, a high feed efficiency, and easy to be marketed [16]. According to Kurnani [17] Padjadjaran sheep are the particular sheep which is maintained for fattening due to its characters like the high growth and the good-quality meat. These sheep commonly are used as calves, which are intensively maintained for several months, so that the ideal body weight gain is obtained to slaughter. This study aimed to evaluate the effect of macronutrients needs on digestibility value measured as dry matter intake, dry matter digestibility, organic matter digestibility, and average daily gain of sheep.

II. Material and Method

A. Animal preparation

Twenty healthy Padjadjaran sheep (*Ovisaries var. Padjadjaran*, Family Bovidae), 8 to 10 months of age, 15 to 33 kg of body weight, were obtained from Faculty of Animal Husbandry, University Padjadjaran, Jatinangor, Sumedang, West Java Indonesia. The animals were treated with anthelmintic, washed, and put in separate metabolism cages.

TABLE I
MIXED-DIETARY FEED INGREDIENTS

No	Feed (%)	R0	R1	R2	R3	R4
1	Pasture grass	40.0	40.0	35.0	30.0	25.00
2	Palm kernel	0.0	0.0	0.0	0.0	0.00
3	Beancurd	0.0	0.0	0.0	0.0	0.00
4	Soy kernel	16.0	17.5	18.0	20.0	25.00
5	Tapioca fiber	6.0	10.0	13.0	27.0	38.00
6	Pollard	3.0	5.0	10.0	10.0	0.00
7	Rice bran	4.0	3.0	4.0	0.0	0.00
8	Molases	3.0	3.0	3.0	5.0	7.00
9	Urea	0.0	0.0	0.0	0.5	0.75
10	Calcium	1.0	1.0	1.0	1.0	1.00
11	Corn	11.0	11.0	12.0	4.5	2.25
12	Coconut kernel	16.0	9.5	4.0	2.0	1.00
	Total (%)	100.0	100.0	100.0	100.0	100.00

TABLE II
NUTRIENTS CONTENT

Formula	Nutrient content (%)								
	Dry material	Crude protein	Crude fiber	Crude fat	Nitrogen-free extract (NFE)	Total digestible nutrient	Ca	P	Ash
R0	52.00	13.18	15.03	2.83	45.05	53.93	0.63	0.31	9.47
R1	43.62	14.16	15.17	3.21	50.04	59.01	0.65	0.34	9.63
R2	44.80	15.14	14.26	3.85	55.12	64.15	0.66	0.42	9.40
R3	41.60	16.07	12.00	4.19	60.01	67.06	0.67	0.41	8.66
R4	48.13	16.99	9.80	4.70	63.12	70.01	0.68	0.36	8.32

B. Experiments

The sheep were divided into 5 groups according to their weights. Each group consisted of 4 animals and fed with different dietary feeds in the form of powder according to Kearl [18] (Table 1). The nutrients contained in each mixture were provided in Table 2.

C. Measurements

The parameters measured were dry matter intake (DMI), dry matter digestibility (DMD), organic matter digestibility (OMD) and average daily gain (ADG).

III. Results and Discussion

A. The Determination of Feed Intake Calculated as DMI

Consumption dry matter is a very important benchmark in determining palatability level of feed and nutrient for livestock. The main advantage nutrient for livestock's body is to maintenance, production, and reproduction. A number of nutrients consumed livestock affected by external and internal factors. The external factor consists of age, sex, and livestock physiology status. An amount of consumption and nutrient content highly effect on livestock productivity. The average of daily consumption of dry material (DM) showed at Table 3.

TABLE III
Feed Intake or Dry Matter Intake

	Feed intake (DMI) in g/animal/day				
Iteration	**R0**	**R1**	**R2**	**R3**	**R4**
1	769.63	649.66	665.35	617.09	716.53
2	773.21	645.79	667.30	612.19	716.75
3	558.41	479.33	490.92	461.95	521.05
4	571.75	473.00	483.46	456.26	526.09
Total	**2673.00**	**2247.77**	**2307.04**	**2147.49**	**2480.42**
Average	**668.25**	**561.94**	**576.76**	**536.87**	**620.10**

Group of sheep, which consumed R3 feed (contained dry material 41.60%, crude protein 16.07%, crude fiber 12.00%, crude fat 4.19%, and NFE 60.01%), showed the lowest intake (average 536.87 g/animal/day as showed in Table 3), probably due to its low dry material content. On the contrary, feeding R0 (contained dry material 52.00%, crude protein 13.18%, crude fiber 15.03%, crude fat 2.83% and NFE 45.05%) showed the highest intake (average 668.25 g/animal/day), which was caused by its highest dry material content. Apparently, the flavor of dry material increased the ruminant's consumption level [19].

The Flavor factor of feed determines consumption level [20]. The supplementation of probiotic can give a fragrant flavor on feed until more preferable by livestock. The supplementation probiotic in feed lead rumen condition become more anaerobic because of there an activity of yeast degradation which utilizes oxygen in the rumen [21]. The anaerobic condition makes rumen bacteria work more active so that a digestive process becomes faster [22]. This condition makes rumen become faster to empty so that livestock become faster to hungry. The feed which easier to digest will increase food rate so that occur stomach empty which leads livestock easier to hungry. The increasing of digestive also will be accompanied with the increase of consumption [23].

B. The determination of dry matter digestibility (DMD)

Digestibility of sheep is defined as a measure of the amount of pasture consumed by sheep (Fig.1) and calculated by DMD. This parameter indicates the quality of feed that could be digested by rumen microbes and/or digestion enzymes. Table 4 shows DMD of all dietary feed formulas.

TABLE IV
Dry Matter Digestibility (DMD)

	Dry matter digestibility (DMD) in %				
Iteration	**R0**	**R1**	**R2**	**R3**	**R4**
1	73.65	59.25	59.19	62.98	62.55
2	68.26	61.37	65.08	60.18	64.66
3	60.77	53.96	64.14	49.79	61.65
4	66.46	51.15	52.68	56.32	50.90
Total	**269.14**	**225.72**	**241.10**	**229.27**	**239.76**
Average	**67.29**	**56.43**	**60.27**	**57.32**	**59.94**

The calculations of digestibility from marker concentrations were carried out using the equation of Schneider and Flat. Table 4 showed that the intervals of DMD are 56.43 to 67.29%, especially for R0, R2, and R4 which exceed Schneider and Flat's criteria for normal digestibility (50.7 – 59.7%) [24] [25]. The results indicated that there is a positive correlation between feed intake (higher value for R0, R2, and R4) with DMD, furthermore, it was compared to the work of Cruz, et al. who concluded that diet digestibility was affected by the type of feed used as energy and protein sources. In general, the high digestibility values indicate that broilers are able to efficiently digest and absorb the supplied feed [26].

Analysis of variance was performed to study the effect of treatment to DMD, and the results showed that the variation of feed given to the sheep did not give significant effect to DMD. This fact proved that all types of feed could provide sufficient nutrients needed by rumen microorganisms. The previous study of, who treated rice straw with ammonia, showed that there was an increase of ruminal cellulolytic bacteria in ruminants [27]. Moreover, our result was compared to the work of Broudiscou et al. [28] who studied the effects of alfalfa extract supply on rice straw degradation, fermentation, and biomass synthesis by rumen microorganism. They confirmed the hypothesis of that higher N retention and nutrient utilization with protein-supplemented feed to better conversion of rumen ammonia into microbial protein [29]. The correlation between plant extract supplementation and microbial activity legitimized the addition of fresh materials to the diet [30]. According to their ability to digest dry matter feed, Padjadjaran sheep (*Ovisaries var. Padjadjaran*, Family Bovidae) was categorized as good digestive ruminants.

C. The determination of organic matter digestibility (OMD)

The cell contains carbohydrates, organic acids, lipids, proteins, nitrogenous substances and a large portion of the inorganic constituents. The organic matters digestibility

incorporates absorbable cell substance and edible cell wall substance. While cell substance is absorbable from practically 100%, the degree of cell wall degradation is unique. Organic matter digestibility has a negative connection with NDF, ADF, and hemicelluloses. A huge negative connection was found between absorbable organic matter and NDF (%) in organic matter [31].

TABLE V
ORGANIC MATTER DIGESTIBILITY (OMD)

	Organic matter digestibility (OMD) in %				
Iteration	**R0**	**R1**	**R2**	**R3**	**R4**
1	72.64	62.05	61.60	66.40	66.84
2	67.07	64.24	67.09	63.75	68.21
3	59.39	56.47	66.18	54.65	65.96
4	65.36	54.13	56.08	61.46	56.85
Total	**264.46**	**236.88**	**250.96**	**246.26**	**257.86**
Average	**66.11**	**59.22**	**62.74**	**61.56**	**64.46**

Organic matter digestibility (OMD), as provided in Table 5, ranged between 59.22 – 66.11%. The lowest OMD was given by R1 (59.22%), while the highest was R0 (66.11%). This data showed that there is a positive correlation between DMD and OMD. R0, which contained the highest dry material (52.00%), showed the highest intake (average 668.25 g/animal/day) and consequently affected its DMD and OMD.

Analysis of variance was performed to study the effect of treatment to OMD, and the results showed that the variation of crude protein and NFE gave to the sheep did not give significant effect to OMD. Ruminant's consumption level was affected by the flavor of dry material contained in the feed [32], therefore higher dry material content could increase OMD.

D. The determination of average daily gain (ADG)

Table 6 shows that the ADG ranges between 113.33 to 169.17/g/sheep/day, moreover the highest ADG was observed on sheep that were treated with R2 (contained dry material 44.80%, crude protein 15.14%, crude fiber 14.26%, crude fat 3.85%, NFE 55.12%, and total digestible nutrient 64.15%) (See Table 2) and contained the highest corn concentration (Table 1).

The growth can be identified as weight gain and other tissue. The growth rate for every kind of animal will difference. Some factor and environment affect growth and development. A growth pattern, which is systematic, also looks in the growth of each tissue. The body parts of adult animal there a relation with a sequence where those parts reach the maximum growth.

TABLE VI
AVERAGE DAILY GAIN (ADG)

Iteration	**Average daily gain (ADG)**				
	R0	**R1**	**R2**	**R3**	**R4**
1	170.00	226.67	213.33	93.33	150.00
2	253.33	123.33	276.67	193.33	203.33
3	86.67	93.33	60.00	66.67	50.00
4	123.33	103.33	126.67	100.00	100.00
Total	**633.33**	**546.67**	**676.67**	**453.33**	**503.33**
Average	**158.33**	**136.67**	**169.17**	**113.33**	**125.83**

The growth level of livestock is very dependent on some of the nutrients which consumed and used by livestock [29]. Table 6 showed an average of livestock's weight during research from every treatment.

Analysis of variance was performed to study the effect of treatment to ADG, and the results showed that variation of crude protein and NFE gave to the sheep did not give significant effect to ADG of Padjadjaran sheep. A group of garut tup, which gives a treatment feed UDP, premix, and probiotic has the highest ADG value. This matter shows if utilize UDP in feed can increase Garut tup's ADG. Protein feed which protected can more benefit from host livestock because can be used directly as a source of protein for livestock. Tanin condensed will be more used in feed because of its effect of antinutrient and its potential in increasing protein supply. Potential from tannin condensed in increasing protein digestive at rumen caused by its ability in binding protein at neutral condition that is at pH 4-7. However, in conditions of pH below four or acid, such as in the abomasum the protein will be released so that it can be digested in the abomasum and also in the small intestine [33].

Utilization of tannins by extracting tea pulp with a concentration of 0.25% gives the best influence on the protection of coconut cake protein. The indicator of success is seen in the decrease in ammonia concentration and increase in Undegraded Dietary Protein (UDP) compared to without the use of tannin extract [34]. In addition, the protein protection of castor seed meal with tea pulp tannin extract of 0.25% reduce ammonia concentration and increase the percentage of Undegraded Dietary Protein (UDP) compared to without the use of extracts [35]. Based on [36] protein protection by various sources of tannin, the origin of guava leaves provides the strongest protection among other tannin sources. According to Jenny, et al. [37] the use of tannin concentrations of 0.75% gave the best effect on protein protection for kapok seed meal.

Protection of soybean meal proteins in similar studies from the two studies above has not been widely reported. Soybean meal has a higher protein value than coconut cake and castor oil cake so that the tannin content needed to protect soybean meal protein must be higher so that all soybean meal proteins can be protected and utilized by the landlady. The level of use of tannin extract for the protection of castor oil cake and coconut cake is 0.25%, and then the level of use of tannin extract in soybean meal must be higher, which is 0.8%.

This result was compared to the work of [38] who treated the sheep with tannin-protected soy kernel feed. They concluded that the ADG was 42.70 – 55.70 g/sheep/day [10]. Other work of showed a lower ADG 92.5 g/sheep/day whilst [15] reported that there was an increase of ADG on SPTD Trijaya 96.64 g/day for male ruminants and 89.33 g/day for the female.

IV. CONCLUSIONS

No effect on DMI, DMD, and OMD was observed of Padjadjaran sheep (*Ovisaries var. Padjadjaran*, Family Bovidae) which were treated with various feed, whereas an increase of ADG (113.33 – 169.17 g/animal/day) was observed on all animals. One of R2-treated animal showed an increase of 276.67 g/day.

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