

## THE EFFECTS OF EXERCISE MODELS ON HEMATOLOGICAL PROFILE AND MEAT PHYSICAL QUALITY IN GARUT SHEEP

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### ABSTRACT

The objective of this study was to evaluate the effect of exercise levels on the hematological and metabolic status, and carcass quality of Garut sheep. In total 24 of Garut sheep used in this study. The levels of exercise contain three treatments namely non exercise, semi-exercise and exercise. Blood collection through the jugular vein of sheep samples was carried out at the end of the study, using a 5 mL EDTA tube to measure the haematological condition of the animal sample. Likewise, collecting muscle samples to determine the physical quality of meat. The data was analyzed by analysis of variance and continued by Duncan test. The results showed that the models of exercise were not significantly ( $P>0.05$ ) affected to hematological level and also carcass quality including juiciness, tenderness, drip loss and water holding capacity. Organoleptic sensory using semi-exercise was more favourable meat compare to exercise and non exercise. While for the colour of meat, non exercise treatment was significantly ( $P<0.05$ ) affected to the colour of meat compare to exercise and semi-exercise. Furthermore the semi-exercise was the best treatment to produce fresh taste meat with good sensory characteristic.

Key words: exercise models, hematologic, meat quality, sheep

### ABSTRAK

Penelitian ini bertujuan mengevaluasi pengaruh tingkat exercise terhadap status hematologi dan metabolisme dan kualitas karkas domba. Tingkat exercise (non-exercise, semi-exercise, dan exercise) telah dikaji dan diamati dalam penelitian ini. Pengambilan sampel darah dan otot, masing-masing dilakukan pada akhir penelitian untuk mengetahui kondisi hematologik dan kualitas fisik daging. Data dianalisis dengan analisis varian, dan dilanjutkan dengan uji Duncan. Hasil penelitian menunjukkan bahwa model latihan/exercise tidak signifikan ( $P>0,05$ ) memengaruhi tingkat hematologi dan juga kualitas karkas termasuk juiciness, kelembutan (tenderness), kehilangan air dan kapasitas menahan air. Sensor organoleptik menggunakan semi-exercise adalah daging yang lebih disukai dibandingkan dengan exercise dan non-exercise, sedangkan untuk warna daging, perlakuan non-exercise secara signifikan ( $P<0,05$ ) memengaruhi warna daging dibandingkan dengan exercise dan semi-exercise. Oleh karena itu, setengah latihan/exercise merupakan teknik terbaik untuk menghasilkan daging rasa segar dengan karakteristik sensorik yang baik.

Kata kunci: latihan, hematologik, kualitas daging, domba

### INTRODUCTION

Sheep is one of the most popular livestock in Indonesia. For one thing, because sheep have rapid growth. Therefore it is able to be a livestock that contributes to the adequacy of national meat. Procedures for food production today, prioritizing healthy and natural production systems. Conventional food products tend to only prioritize product quantity as the main indicator, whereas natural products prioritize natural production systems as a guarantee of the quality of products produced. People are more familiar with organic products (Pangestu *et al.*, 2003; Tanuwiria *et al.*, 2011).

According to SNI 01-6729 of 2010 concerning organic food systems, the general principle used in organic livestock products is that management must be based on the principle of animal welfare. The principles of animal welfare are closely related to the physiological functions of livestock. Animal welfare is regulated in SNI 01679 of 2010 in Appendix 1 regarding the principles of organic food production in letter B item 3 which reads: "Herbivores must have access to pasture while other animals must have access to open fields". The opportunity to access open space regularly and in sufficient time will give livestock enough time to exercise, and is a means of playing and communicating to young animals. The animal exercise

can build muscle and skeletal well in young cattle as long as it is not excessive, can also maintain and enhance physical strength, improve body balance, prevent disease, and can reduce stress, improve welfare and comfort of life. Exercise has also been shown to improve cardiovascular abilities and hematologic status (Fahey *et al.*, 2007).

The skeletal muscle is believed to have a rapid adaptability to "exercise". Trained muscles have more capillaries, and mitochondria, higher carbohydrate storage capacity and more oxidized fat. The most important finding is that exercise can increase the number and size of mitochondria (Holloszy, 1967; Mushawwir *et al.*, 2011; Mushawwir *et al.*, 2017; Mushawwir *et al.*, 2018). The number of mitochondria in untrained individuals can increase to 50% after exercise within 6-8 weeks of training (Henriksson and Reitman 1977; Tonkonogi *et al.*, 2000; Aliverti *et al.*, 2005; Benson *et al.*, 2013). The increased number of mitochondria causes energy production to increase and is stored in the form of glycogen (Fahey *et al.* 2007). Information on how the optimal pattern of exercise is still lacking, and debate is still ongoing, which one is better, low intensity exercise/long duration or high intensity exercise/short duration (Behnke *et al.*, 2001; Allen *et al.*, 2008; Bishop *et al.*, 2014; Suwarno and Mushawwir, 2019).

Mitochondria are very important because they produce energy for cells. Mitochondria convert

carbohydrates, fats, and proteins into adenosine triphosphate (ATP). Mitochondria produce ATP through oxidative phosphorylation, which requires oxygen. Energy is released when ATP is converted into adenosine diphosphate (ADP) and adenosine monophosphate (AMP), and this energy can be used for various cellular processes such as muscle contraction (Bangsbo *et al.*, 2002; Mushawwir *et al.*, 2020). Adenosine triphosphate is known to play an important role in the formation of the taste of meat. Adenosine triphosphate also produces Inosin Monophosphate (IMP) which gives a good /tasty taste, besides producing energy (Mushawwir *et al.*, 2011). The combination of IMP and glycogen in the muscles is thought to affect the unique taste of meat. Exercise is believed to provide a positive response to animal welfare and be able to improve the quality of the products, if supported by adequate nutrition (Mushawwir *et al.*, 2019a).

The purpose of this study was to evaluate the effect of providing different exercise loads on hematologic and physical quality of Garut sheep meat. The results of this study can be applied to the development of small ruminants, especially in the Sheep and Goat Breeding Development Center (BPPTDK), Margawati, Garut.

## MATERIALS AND METHODS

### Animal Samples and Treatments

Twenty four of Garut sheeps, 7 months-age were used in this experiment. The animal samples were divided into three experimental groups, each group consisted of eight sheep. The treatment conditions were described following: Treatment group III (P3) without exercise, sheep in cages without access to grazing land; Group II (P2) semi-exercise, sheeps were grazing for 6 hours from 9 am to 3 pm, and group I (P1) full exercise, grazing for 6 hours + run 3 km everyday + swim for 10 minutes every week.

### Sampling Procedure

This experiment consisted of two stages; the first stage was carried out for 9 months. At the end of the first stage, the blood sample was collected, followed by the second stage, an analysis of the physical quality of the meat. Blood samples were collected from the jugular vein, using EDTA tubes and a 5 mL syringe. The samples were analyzed using a hematology analyzer to determine the levels of erythrocytes, hematocrit and leukocytes. The suction needle taken 100 µL of fresh blood from the EDTA tube, 30 seconds later the results of the analysis were displayed on the LCD screen.

Measurement of meat quality performed on loin and extremitas posterior muscles included meat pH, cooking loss, water holding capacity, total water content, tenderness, fat and meat color, and organoleptic test. The meat pH measured using a pH meter, immediately after the animal samples were slaughtered. The cooking loss was measured to determine changes in meat weight after cooking, while water resistance was measured to determine the ability of the tissue to store water.

### Data Analysis

A completely randomized design was used in this study, with three treatments and eight replications. The experiment data collected were analyzed using one-way ANOVA analysis. The treatment significant difference ( $P < 0.05$ ), was determined followed by Duncan's multiple area test for a post hoc test.

## RESULTS AND DISCUSSION

### Hematologic

The results of this study showed that sheep with non- exercise, semi-exercise and exercise treatments was not significantly influenced on the hematologic status. This indicates that exercise treatments on sheep are not feared to damage energy in animal. Hematology in highly individual animals has no effect on groups. Hemoglobin levels, among others, are influenced by the adequacy of feed, especially protein in the ration and digestibility (Schalm *et al.*, 1986).

In a previous study in animal reported that the different immunophysiological responses in explain the differences in the anatomical properties cow and physiological of the two breeds horses (Khummuang *et al.*, 2020; Tanuwiria *et al.*, 2020). In this study also showed animal samples were less sensitive to exercise-induced stress.

The hematology levels based on the results in this study show different results from the previous studies. Walsh *et al.* (2011) reported that physical exercise and its correlated stresses trigger the mobilization and activation of erythrocytes, leukocytes, platelets, and fibrinolytic pathways. A study Breitbach *et al.* (2012) using cell free DNA (cfDNA) to observe the effect exercise on blood profile reported that there is no changes in cfDNA levels, despite the induction of neutrophil extracellular (NETosis), hemoglobin and red blood cells. The result of other study showed that continuous exercise can be improved cfDNA levels in the blood (Velders *et al.*, 2014), also hematologic level (Beiter *et al.*, 2014; Mushawwir *et al.*, 2019b; Tanuwiria and Mushawwir, 2020). In horse, the different physiological status was a consequence of by exercise models can be raised the amount of cfDNA in the plasma (Mushawwir *et al.*, 2018; Lee *et al.*, 2019), although this condition depend upon the type, intensity and duration of the exercise, the associated metabolic stress (Burton *et al.*, 2004), and the inflammatory response of leukocytes an also blood profile (Heinicke *et al.*, 2001; Mushawwir *et al.*, 2010; Hernawan *et al.*, 2017; Mushawwir *et al.*, 2018; Suwarno and Mushawwir, 2019). In this study showed that blood parameter levels were not significantly different ( $P > 0.05$ ) between treatments. This result showed that the formation of blood cells is not only affected by exercise but also some factors effecting in this blood synthesis. Previously study, showed a low correlation between physical work on sheep aged  $>1$  year and erythropoiesis (Adriani and Mushawwir, 2020). Investigation in some animal by Mushawwir *et al.* (2019a), Mushawwir *et al.* (2019), and Mushawwir *et al.* (2020) reported that animal tend to maintain

erythrocyte and Hb levels under physical stress as evidence of the homeostasis mechanism.

### Meat pH

The effect of exercise on the meat pH in sheep showed in Table 2. The measurement of meat p was carried out to the ultimate pH during 48 hours. This is different from the common treatments which only takes 24 hours. The overall pH value of meat has decreased, in all three treatments. Previously study by Aberle *et al.* (2001) and Tanuwiria *et al.* (2007), showed that the meat pH can decrease rapidly to 5.4-5.5 for several hours after cutting. The pH standard for healthy, sufficiently rested animal meat is 7-7.2 and will continue to decline for 24 hours. The pH value will be lower in animals that experience stress before cutting and will produce pale, soft and runny meat (exudative = PSE). Purnomo (1985) also explained that the formation of lactic acid causes a decrease in the pH of meat and causes damage to muscle protein structure and that the damage depends on temperature and low pH.

The results of this investigation in Table 2 showed a decrease in pH with increasing exercise duration. The results of this study showed the same results as the results of previous studies. Kamil *et al.* (2020) showed an increase in an aerobic glycolic rate with increasing physical activity and stress of livestock. Another study by Adriani *et al.* (2014) and Jiwandini *et al.* (2020) showed that an increase in an aerobic glycolic cause an increase in lactate so that blood and muscle pH decreases.

### Meet Physical Quality

The effect of exercise on the meat physical quality in sheep, showed in Table 3. The results showed that tenderness, cooking losses and water holding capacity did not show significant results in all three treatments. Lamb meat treated with exercise, semi-exercise and non-exercise can be said to have the same level of tenderness, because what affects the level of meat tenderness is the physiological age of the livestock itself. The fat color of all treatments received a value of

**Table 1.** Hematologic level in sheep with different exercise treatment

Parameters	Treatments			P-Value	Referens
	1	2	3		
RBC ( $10^6/\text{mm}^3$ )	3.9±0.05a	3.7±0.01a	3.8±0.09a	0.92	9.0-15.0
Hb (g%)	8.6±1.13a	9.4±2.29a	8.9±2.09a	0.73	9.0-15.0
WBC ( $10^3/\text{mm}^3$ )	19.68±5.29a	23.19±13.56a	20.91±9.02a	0.79	4.0-12.0

<sup>a,a</sup>Means in each row with same superscripts are no significantly different ( $P>0.05$ ); 1= Exercise; 2= Semi-exercise; 3= Non-exercise; RBC= Red Blood Cell, Hb= Hemoglobin, WBC= White blood cell. Referens: Smith and Mangkoewidjojo (1988)

**Table 2.** pH of sheep meat with different exercise

Treatments	0 hour	1 hour	2 hours	3 hours	6 hours	8 hours	10 hours	12 hours	15 hours	24 hours	48 hours
1	7.34	6.97	6.49	6.23	6.28	6.21	6.14	6.17	5.99	5.94	5.74
2	7.26	6.99	6.62	6.35	6.24	6.19	6.1	6.09	5.99	5.92	5.73
3	7.3	6.93	6.51	6.29	6.24	6.09	6.1	6.03	5.94	6.02	5.86

1= Exercise; 2= Semi-exercise; 3= Non-exercise

**Table 3.** The effect of exercise on the meat physical quality in sheep

Physical quality	Treatment			P-Value
	1	2	3	
Tenderness	2.87±0.65 <sup>a</sup>	3.08±0.66 <sup>a</sup>	2.63±0.75 <sup>a</sup>	0.54
Cooking loss	51.43±3.55 <sup>a</sup>	48.20±7.26 <sup>a</sup>	51.61±2.51 <sup>a</sup>	0.38
Water holding capacity	27.86±1.19 <sup>a</sup>	28.71±1.629 <sup>a</sup>	27.65±1.58 <sup>a</sup>	0.42
Meat color	2.00±0.00	2.00±0.00	2.00±0.00	-
Fat color	3.00±0.00	3.00±0.00	3.00±0.00	-

<sup>a,a</sup>Means in each row with same superscripts are no significantly different ( $P>0.05$ ); 1= Exercise; 2= Semi-exercise; 3= Non-exercise

**Table 4.** The effect of exercise on acceptability of meat in sheep

No	Acceptability test	Treatments		
		1	2	3
<b>Hedonic test</b>				
1	Color	3	3	3
2	Taste	3	3	3
3	Texture	3	3	3
4	Aroma	3	3	3
<b>Hedonic quality</b>				
1	Color	3 <sup>a</sup>	3 <sup>a</sup>	4 <sup>b</sup>
2	Taste	2 <sup>a</sup>	3 <sup>b</sup>	2 <sup>a</sup>
3	Texture	2	2	2
4	Aroma	3	3	3

<sup>a,b</sup>Means in each row with different superscripts are significantly different ( $P>0.05$ ); Color: 4= Gray, 3= Brownish gray, 2= Brown, 1= Reddish brown; Taste: 4= Very sweet, 3= Sweet, 2= Rather sweet, 1= Tasteless; Texture: 4= Very tough, = Tough, 2= Soft, 1= Very soft; Aroma: 4= Very meaty aroma, 3= Aroma of meat, 2= Aroma of blood, 1= Very aroma of blood; Treatments: 1= Exercise; 2= Semi-exercise; 3= Non-exercise

3, while the value of the fat color of all treatments received a value of 2. Marbling has not formed in all treatments. Tenderness is one of the main indicators and factors of consideration for consumers in choosing good quality meat (Bredahl and Poulsen, 2002).

Cooking loss is a parameter of the nutritional value of meat that is associated with the water content of meat, namely the amount of water that is bound in and between muscles. The amount of cooking loss is influenced by the amount of cellular membrane damage, the amount of water that comes out of meat, protein degradation and the ability of meat to bind water (Shanks *et al.*, 2002; Siregar *et al.*, 2020). Meat with low cooked loss has a relatively better quality than meat with a high percentage of cooking loss, because the loss of nutrients during the cooking process will be less. Cooking loss of meat is also closely related to the ability to bind meat water, the lower the binding power of meat water, the cooking losses will be even greater, and also enzyme (Dinana *et al.*, 2019).

### Organoleptic

Data of organoleptic test were provided from 37 panelists on a hedonic test and a hedonic quality test with indicators of color, aroma, taste and texture of lamb meat treated with exercise, semi-exercise and non-exercise. The results of data analysis can be seen in Table 4. Table 4 showed that the results of hedonic test of sheep meat color did not differ for all treatments. Color changes from before and after cooking in exercise and semi-exercise are relatively more stable compared to non-exercise.

The results in Table 4 showed that the hedonic quality test of the color of sheep meat treated the non-exercise treatment was significantly different ( $P < 0.05$ ), and for the taste of meat was also significantly different ( $P < 0.05$ ). The difference in aroma, taste and color indicates that the difference in exercise will be able to improve the color and taste of lamb meat. This was in accordance with Soeparno (1992) and Nurazizah *et al.* (2020) who explained that the taste and aroma of cooked meat is greatly influenced by the length of time of storage and storage conditions, withering after being cut. Intramuscular fat factor (marbling) also plays an important role in the impression of juice and taste as a stimulus for salivation.

### CONCLUSION

Based on the results from this study exercise and without exercise treatments in sheep are not showed a significant effect on hematological and meat quality. However, semi-exercise can improve the taste of the meat sweeter.

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