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Hematological Profile of Aceh Cattle

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Abstract | The study aimed to analyze the hematology profile, differential leukocytes, and the N/L ratio of Aceh cattle. The obtained result were compared to the data available for zebu (*Bos indicus*), Ongole grade (*Bos indicus*), and Bali cattles (*Bos javanicus*). The data would be important as a physiological reference of this cattle species. Blood samples were obtained from 17 adult male Aceh cattle which were slaughtered at slaughterhouses in Banda Aceh City and Aceh Besar District. The animals showed a healthy condition with an average body weight of 312.42 ± 66.91 kg. Blood was collected into the tube containing EDTA after the cattle were slaughtered. Blood analysis was done using hematology analyzer and staining the peripheral blood morphology. Data were expressed in the average and 95% confidence interval for further descriptive analysis. The average number of erythrocytes (x10^6 µl^{-1}) of Aceh cattle reached 8.34 (95% confidence interval (CI); 7.32-9.36). The average number of leukocytes (x10^3 µl^{-1}) 13.83 (95% CI; 10.26-17.40), hemoglobin (g dL^{-1}) 14.05 (95% CI; 11.85-16.25), hematocrit (%) 38.64 (95% CI; 29.90-47.38), MCV (fl) 46.16 (95% CI; 40.21-52.11), MCH (pg) 15.13 (95% CI; 13.65-16.61), MCHC (g dL^{-1}) 32.96 (95% CI; 31.65-34.27), and platelets (x 10^3 µl^{-1}) 226.20 (95% CI; 131.20-321.20). The average percentage (%) of lymphocytes, neutrophils, eosinophils, basophils, and monocytes were 61.69 (95% CI; 52.69-70.69), 30.59 (95%CI; 21.53-39.65), 6.31 (95% CI; 3.12-9.50), 0.51 (95% CI; 0.20-0.82), and 0.90 (95% CI; 0.43-1.37), respectively. The N/L ratio of Aceh cattle in the study was 0.66. The present study showed that profiles of hematology and differential leukocytes of Aceh cattle were generally similar to those of *Bos indicus* rather to those of *Bos javanicus*. Aceh cattle tend to be more adaptive to various exposure factors as indicated by the number of erythrocytes and a higher N/L ratio than other breeds.

Keywords | Aceh cattle, Differential leukocytes, Hematology, Livestock, Physiology

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INTRODUCTION

Aceh cattle is a local Indonesian beef cattle that are still kept hereditary by the people of Aceh (Abdullah, 2008). Aceh cattle is one of the local genetic resources of Indonesian livestock according to Minister of Agriculture Decree No 2907/Kpts/OT.140/6/2011 concerning Determination of Aceh Cattle Breed (MoA, 2011). These local beef cattle are traditionally raised and have low performance and productivity. Male Aceh cattle have a larger body size than the female and have a more aggressive nature (Abdullah, 2008). The total population of Aceh cattle in 2011 reached 435 146 (Statistic Indonesia, 2011). The number of Aceh cattle is expected to decrease, so various studies are needed to increase the population and productivity of this Indonesia local cattle breed. Studies conducted on Aceh cattle, including physiological baseline studies, are relatively fewer compared to other Indonesian local cattle breed. The knowledge of physiological status is essential as a reference for the implementation of various

maintenance systems in livestock.

The hematological profile is one of the physiological variables that can be used to determine health status, production, and animal welfare of livestock (Siswanto, 2011; Otter, 2013; Roland et al., 2014; Bezerra et al., 2017; Brunel et al., 2018). A proper blood profile can support the physiological processes of the livestock so they can provide optimal performance (Ali et al., 2013). Also, ideal physiological profiles can have an impact on increasing livestock production and productivity (Bezerra et al., 2017). The parameter of hematology profile of livestock that commonly examined are erythrocytes, leukocytes, hemoglobin, hematocrit, erythrocyte index, and platelets.

Previous studies have examined the hematological profile of several cattle breeds, including beef cattle and dairy cattle and its relation with age, sex, race, feed, infection, reproductive status, and environmental maintenance (Mohri et al., 2006; Rafia et al., 2012; Sripad et al., 2014; Kim et al., 2016; Syam et al., 2016; Lawrence et al., 2017; Moretti et al., 2017; Suprayogi et al., 2017). These studies are essential to understand the condition of livestock through the hematological profile. Currently, there are limited studies regarding hematology profile of Aceh cattle. Adam et al. (2015) have reported the number of erythrocytes and hematocrit values of Aceh cattle. However, other hematological profiles are not yet available. Therefore, this study aims to provide a complete profile of hematology in Aceh cattle. The results are expected to give a better understanding of Aceh cattle condition kept by the community.

MATERIALS AND METHODS

Ethical Approval

This study has received ethical approval from the IPB University Ethics Committee with approval number: 101-2018 IPB.

Study Sites and Subjects

This study was conducted in Banda Aceh and Aceh Besar District, Aceh Province, Indonesia. The study used blood samples from 17 adult male Aceh cattle that were slaughtered at the slaughterhouse of Keudah, Banda Aceh and Lambaro, Aceh Besar District, and abattoirs in Bayu Village and Lhong Cut Village, Banda Aceh City. The animals showed a healthy condition with an average body weight of 312.42 ± 66.91 kg.

Blood Sample Collection and Analysis

A mixture of arterial and venous blood samples was collected immediately after the cattle slaughtered. The blood samples were collected using a 5 ml syringe and were inserted into a tube containing ethylenediamine tetra-acetic acid (EDTA). Blood samples were immediately stored in a cool box with a temperature of around 4°C and transferred to the laboratory for further examination.

The examination of Aceh cattle hematology profile was carried out at the Clinical Laboratory of the Faculty of Veterinary Medicine of Syiah Kuala University, Indonesia using an automated hematology analyzer (Mindray BC-2800®). The variables examined were the number of erythrocytes, leukocytes, hemoglobin, hematocrit, and erythrocyte indexes (mean corpuscular volume or MCV, mean corpuscular hemoglobin or MCH, mean corpuscular volume concentration or MCHC), and platelets. Leukocytes differential counts are performed by observing the morphology of leukocytes in blood smear preparations. Leukocyte differential count observed including the total number of lymphocytes, neutrophils, eosinophils, monocytes, and basophils in 100 leukocyte cells. The ratio of neutrophils to lymphocytes (N/L) is calculated by comparing the number of neutrophils to the number of lymphocytes (Davis et al., 2008).

Statistical Analysis

The data obtained are expressed in the average and 95% confidence interval for further descriptive analysis and compared with secondary data from Bali, Zebu, and Ongole grade breeds.

RESULTS

Hematological profiles of Aceh cattle are presented in Table 1. The average total number of erythrocytes of Aceh cattle reached 8.34 x 10^6 μl^{-1} (95% confidence interval (CI); 7.32-9.36 x 10^6 μl^{-1}), average total number of leukocytes of 13.83 x10^3 μl^{-1} (95% CI; 10.26-17.40 x10^3 μl^{-1}), hemoglobin value 14.05 g dL^{-1} (95% CI; 11.85-16.25 g dL^{-1}), hematocrit value 38.64 % (95% CI; 29.90-47.38 %), MCV 46.16 fl (95% CI; 40.21-52.11 fl) , MCH 15.13 (95% CI; 13.65-16.61 pg), MCHC 32.96 g dL^{-1} (95% CI; 31.65-34.27 g dL^{-1}), and platelets 226.20 x 10^3 μl^{-1} (95% CI; 131.20 -321.20 x 10^3 μl^{-1}).

The results of differential leukocytes and ratio of neutrophils to lymphocytes (N/L) of Aceh cattle and the comparison with Ongole grade cattle, and reference are shown in Table 2. Aceh cattle have an average percentage of lymphocytes of 61.69% (95% CI; 52.69-70.69 %), neutrophils 30.59 % (95% CI; 21.53-39.65 %), eosinophils 6.31 % (95% CI; 3.12-9.50 %), basophils 0.51 % (95% CI; 0.20-0.82 %), and monocytes 0.90 % (95% CI; 0.43-1.37 %), and N/L ratio of 0.66.

Table 1: Hematology profile of Aceh cattle and comparison with Bali cattle, Zebu cattle, and the reference.

Variable	Aceh cattle (95% CI) (n)	Bali cattle (Siswanto, 2011) (95% CI)	Zebu cattle (Aggarwal et al., 2016) (95% CI)	Reference (Kessell, 2015)
Erythrocytes (x10^6 µl^{-1})	8.34 (7.32-9.36)a (n=7)	5.21 (5.14-5.28)b	7.94 (7.58-8.30)a	5-10
Leukocytes (x10^3 µl^{-1})	13.83 (10.26-17.40)a (n=10)	**	10.82 (9.48-12.16)a	4-12
Hemoglobin (g dL^{-1})	14.05 (11.85-16.25)a (n=10)	8.74 (8.61-8.87)b	12.22 (11.40-13.04)a	8-15
Hematocrit (%)	38.64 (29.90-47.38)a (n=7)	29.15 (29.02-29.28)b	35.54 (33.89-37.19)a	24-46
MCV (fl)	46.16 (40.21-52.11)a (n=7)	56.51 (56.47-56.55)b	45.48 (42.03-48.93)a	40-60
MCH (pg)	15.13 (13.65-16.61)a (n=7)	16.70 (16.68-16.72)b	15.65 (14.39-16.91)a	11-17
MCHC (g dL^{-1})	32.96 (31.65-34.27)a (n=7)	29.88 (29.86-29.90)b	34.43 (31.60-37.26)a	30-36
Platelets (x 10^3 µl^{-1})	226.20 (131.20-321.20) (n=5)	**	**	150-650

Note: * : Analyzed data **: No data available
Different letters on the same line show significant differences
95%CI: 95% confidence interval

Table 2: Differential leukocytes of Aceh cattle and comparison with Ongole grade cattle and the reference.

Variable	Aceh cattle (n=17) (95%CI)	Ongole grade cattle (Astuti et al., 2009)* (95%CI)	Reference (Kessell, 2015)
Lymphocytes (%)	61.69 (52.69-70.69)a	62.00 (58.16-65.84)a	62.50
Neutrophils (%)	30.59 (21.53-39.65)a	28.00 (23.05-32.95)a	15.00-33.33
Eosinophils (%)	6.31 (3.12-9.50)a	2.00 (1.10-2.90) b	< 6.00-20
Basophils (%)	0.51 (0.20-0.82)	**	*
Monocytes (%)	0.90 (0.43-1.37)a	8.00 (6.63-9.37) b	< 7.50-22.50
N/L ratio	0.66	0.45	0.24-0.53

Note: * : Analyzed data ** : No data available
Different letters on the same line show significant differences
95%CI: 95% confidence interval

DISCUSSION

Erythrocytes (red blood cells) are one of the cellular components of blood that bind to hemoglobin and function as oxygen carriers (Aspinall and Cappello, 2015). The number of erythrocytes in Aceh cattle was significantly higher than in Bali cattle reported by Siswanto (2011) but not significantly different from those in Zebu cattle reported by Aggarwal et al. (2016). The difference in the number of erythrocytes is thought to be due to cattle gender and breed. Research conducted by Roland et al. (2014) and Adam et al. (2015) shows that the sex of livestock influences the number of erythrocytes. The number of erythrocytes in male cattle is higher than in female cattle. The present study used male Aceh cattle, while other studies in the Bali cattle Siswanto (2011) did not distinguish between the sexes.

The number of erythrocytes in Aceh cattle was also higher than the results obtained by Adam et al. (2015) which is 7.75 x 10^6 µl^{-1}. This difference is thought to be influenced by the altitude of the cattle rearing location. The results of interviews with livestock owners, Aceh cattle used in this study were raised in lowland, while animals studied by Adam et al. (2015) maintained in the middle plateau. Murthy (2002) states that the higher an area above sea level, the lower the temperature in that region. High environmental temperatures can cause livestock vulnerable to heat stress so that more energy is needed to carry out the process of homeostasis Kim et al. (2016). According to Adam et al. (2015), the cattle breed also influences the number of erythrocytes. Based on the results of this study and a study conducted by Adam et al. (2015), Aceh cattle tend to have a higher number of erythrocytes compared to Bali cattle.

Leukocytes (white blood cells) are other cellular components of blood that play a role in the body defense system to against infection (Aspinall and Cappello, 2015). The number of leukocytes of Aceh cattle obtained in the study was not significantly different compared to the number of leukocytes of Zebu cattle studied by Aggarwal et al. (2016). However, the number of leukocytes is slightly higher than the reference value compiled by Kessell (2015). The number of leukocytes in the blood is very volatile (Roland et al., 2014). The amount and the proportion of leukocytes in the blood represent the condition of leukocytes distribution. It also describes the immune system in the body (Dhabhar et al., 2012). Hemoglobin is a red pigment, which is a complex protein containing iron that functions as a carrier of oxygen molecules (Aspinall and Cappello, 2015). The high value of hemoglobin is thought to be related to the high number of erythrocytes in Aceh cattle. Lawrence et al. (2017) and Sonjaya (2013) state that an increase in hemoglobin was correlated with an increase in the number of erythrocytes. Increased hemoglobin concentrations occur in response to the body's adaptation to high oxygen demand (Gravena et al., 2010). The Hemoglobin value of Aceh cattle is significantly different compared to the hemoglobin value of Bali cattle, but similar to those in Zebu cattle. However, the value is still in the reference range compiled by Kessell (2015).

Hematocrit (in percentage) is a comparison of the number of erythrocytes compared with the overall blood volume (Cunningham, 2002). Hematocrit value of Aceh cattle is similar to Zebu cattle, but significantly different compared to those in Bali cattle. The high number of erythrocytes is also the cause of the high hematocrit values in Aceh cattle compared to other breeds. Sonjaya (2013) states that the number of erythrocytes influences the hematocrit value. A study by Syam et al. (2016) in beef cattle shows that the type of feed can affect the hematocrit value. Cattle fed by forage and urea molasses block cause lower hematocrit values than those given supplemental concentrates. Based on interviews with farmers, we revealed that the Aceh cattle used in the study were fed only on grass without the addition of concentrate. Ariana et al. (2018) also state that nutritional factors can cause changes in the blood profiles. The erythrocyte index includes the mean corpuscular volume (MCV) that shows the average volume of one erythrocyte cell, the mean corpuscular hemoglobin (MCH) that describe the amount of hemoglobin contained in red blood cells, and the mean corpuscular hemoglobin content (MCHC) that represent the amount of hemoglobin concentration in the MCH red blood cells (Cunningham, 2002). Platelets (thrombocytes) are components of blood that play an essential role in the process of blood clotting (Aspinall and Cappello, 2015). MCV value of Aceh cattle is not different from Zebu cattle but different from Bali cattle. MCH and MCHC values of Aceh cattle similar with Zebu cattle, but differ from Bali cattle. The number of platelets between Aceh cattle was still in the reference range compiled by Kessell (2015). The difference in MCV, MCH, and MCHC values between Aceh cattle and other breeds (Bali breed) is closely related to the high number of erythrocytes found in Aceh cows. The high number of erythrocytes results in low MCV, MCH, and high MCHC values.

The results of Aceh cattle differential leukocytes showed that the variable number of leukocytes and neutrophils have the same value as Ongole grade cattle, while the other variables are different. The eosinophil value of Aceh cattle is higher than Ongole grade cattle is suspected to be due to worm infection, although in this study, it is not known for sure because there was no examination of cow feces. Huang and Appleton (2016) state that eosinophilia (increasing number of eosinophils) is the response of animal or livestock body to worm infection. The N/L ratio in Aceh cattle is higher than in Ongole grade cattle, which indicates that Aceh cattle tend to be stressed that caused by various exposure factors. However, in this study, it is not known with certainty the exposure factors that cause cows to experience severe anxiety. The ratio of N/L is one of the hematological indicators that can be used to determine the stress response in cattle (Davis et al., 2008). Differential leukocytes examination results showed the percentage of the number of lymphocytes, neutrophils, eosinophils, basophils, and monocytes of Aceh cattle still within the reference range compiled by Kessell (2015), except the N/L ratio.

Stress is an adaptive mechanism of living things, including cattle. Stress levels vary significantly between individuals and breeds of animals. Roland et al. (2014) state that stress is one of the causes of leukocytosis (high level of leukocytes). Dhabhar et al. (2012) state that stress can cause the mobilization of immune cells, especially leukocytes. Leukocytes mobilization cause changes in the dynamics of leukocyte counts. These changes affect the functioning of the immune system. The current study has proven high numbers of leukocytes followed a higher N/L ratio in Aceh cattle. Also, Aceh cattle tend to have more aggressive traits (Abdullah et al., 2007), and this is thought to be a factor causing these cows to be prone to stress. Ariana et al. (2008) state that stress factors can also cause changes in the blood picture. Handling of animals during maintenance, transport, and handling before slaughter can also show variations in the blood profile due to stress in cattle. The high ratio of neutrophils can demonstrate stress in cattle compared to lymphocytes (N/L), in addition to high levels of stress hormones in the blood (Gomes et al., 2011; Anton et al., 2016). Variations in the hematological profile can provide information related to oxygen transport, the sensitivity of cattle to stress, and is an indication of animal

tolerance to heat and environmental stress (Ariana et al., 2018; Gomes et al., 2011).

In general, the hematological profile of Aceh cattle is still within the reference range compiled by Kessell (2015). Variations in the hematological profile are often found, even in the same type of livestock. Hematological profiles can vary which are affected by feed, age, sex, breed, genetics, livestock health status, height of breeding site, season, environmental climate (temperature, humidity, and rainfall), physiological status of livestock, reproductive status, presence of infection, blood collection methods, and hematological profile measurement techniques used (Roland et al., 2014; Sonjaya, 2013; Yaqub et al., 2013; Ahmadi-Hamedani et al., 2014; Mazullo et al., 2014; Oramari et al., 2014; Kachhawa et al., 2016; Mariana et al., 2019). Beef cattle have a higher number of erythrocytes compared to dairy cows. The number of erythrocytes in male cattle is more elevated than female cattle. Young cows have higher erythrocyte counts, and MCH and MCHC values are lower than adult cattle, especially at the age of the first month (Roland et al., 2014).

Aceh cattle is the result of a cross between *Bos javanicus* (Bali cattle) and *Bos indicus* (Abdullah, 2008), therefore genetically, the physiology performance of Aceh cattle has similarities with its parents. The phylogenetic analysis of an individual with their parents is related to the percentage of similarities of genes between the two. The same genes can be found in both individuals, both parents, and offspring (Noor, 2010). These results in similarity to the phenotypic picture. Hematology profile of Aceh cattle in this study shows different values from Bali cattle even though Bali cattle are the parents of Aceh cattle. The hematological value of Aceh cattle is thought to be closer to those of *Bos indicus* cattle such as Zebu cattle. The percentage of lymphocytes and neutrophils of Aceh cattle have the same value as Ongole grade cattle, while the percentage of eosinophils and basophils differ between the two breeds. Abdullah (2008) have conducted microsatellite DNA analysis in Aceh cattle, Ongole grade cattle, Coastal cattle, and Bali cattle. Based on the study by Abdullah (2008), it is known that in the phylogeny tree, Aceh cattle are in one cluster with Ongole grade cattle and Coastal cattle, one group with Madura cattle, but different cluster and group with Bali cattle. It means that Aceh cattle have a higher resemblance to *Bos indicus* than *Bos javanicus*. Sutarno and Setyawan (2016) also grouped Aceh cattle into Zebu cattle (*Bos indicus*).

CONCLUSION

Profiles of hematology and leukocytes differential count of Aceh cattle are generally similar to Zebu cattle (*Bos indicus*). Aceh cattle were in a closer cluster with *Bos indicus*. Aceh cattle tend to have a more adaptive nature or responsive to various exposure factors as indicated by the number of erythrocytes and a higher N/L ratio than other breeds.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

AUTHORS CONTRIBUTION

HS conducted the study, data analysis and writing of manuscript, ES and CS involved in the data analysis and revision of manuscript, AS and SA designed and supervised the study.

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