Research Article

Effect of Altitudes on Blood Profiles of the Broilers

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Abstract | Broiler chicken has high productivity but the productivity is still not optimal. This study aims to determine effect of farm altitudes toward blood profiles of broilers. The method used in this study was Split Plot Design with completely randomized design (CRD). Blood profiles were measured and data were analysed statistically and followed by Least Significant Difference Test to see significant differences between treatments. The result showed that altitude has no significant effect on erythrocytes, hemoglobin, hematocrits, leukocytes, lymphocytes and monocytes. Although there was no significant difference, blood profile of broilers could be improved by the land altitude and total population of broilers, as well as the interaction between the altitudes. Blood profiles of broilers that raised in three altitudes are still within the normal range.

Keywords | Altitude, Blood profile, Broiler

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INTRODUCTION

Broiler is the crossbreeding chicken that have high productivity. This chicken can grow quickly and produces meat in a short time, between (5-6 weeks). Currently, broiler breeding is still limited by some factors, such as environmental and management factors. Therefore, the productivity of broilers is still not optimal.

In Indonesia, there are many broiler farms, and one of them is located in East Java Province. Data from Directorate General of Livestock Service and Animal Health (2013) stated that the population of broilers in East Java is around 12% of the total broiler population in Indonesia. Broiler farms in East Java have spread throughout the region, ranging from the highland, medium land, and lowland. Each of the areas has different characteristics. Highland temperature is ranging between 20.7-24.3°C and has 66-87% of humidity level, the medium land temperature is ranging between 24.6-26,8^{0}C and has 73-88% of humidity level, while the lowland temperature is about 28.0-31,9^{0}C and has 66-82% of humidity level (Indonesian Agency for Meteorological, Climatological and Geophysics, 2015). The ambient temperature in lowland areas is generally high, which can affect the livestock physiology, especially on lowland broilers.

The high temperature in a farm environment can lead to heat stress (Austic, 2000). When broilers suffer heat stress, physiological and metabolism changes will occur. The effort to accelerate the heat dissipation is done with changes in behaviour and body metabolism (Aengwanich and Simaraks, 2004). Those changes are a form of self-defense of homeostatic systems, so the body temperature can stay within the normal range. According to Charles (2002), a comfortable temperature for broiler growth ranges between 20-24°C.

High environmental temperature can influence the chicken physiology, for example on the hormone activities. Previous studies explained that heat stress could affect the blood profile. This statement is in accordance with Sugito (2009), which stated that the temperature increase inside the farming area could greatly impact the hematological profile of broilers.

Based on the description above, it is necessary to do further studies to locate the suitable breeding farm for broilers and to assess effect of farm altitude on the blood profile of broilers.

MATERIALS AND METHODS

The material used in this study was broiler farms from a company partnership, with 27 breeders. The criteria used were broilers, with population range from 3.000-10.000 broilers on each farm, and the cage is an open house type. This study used field trial with Split Plot Design in a completely randomized design (CRD) with 3 replications. The main plot (P) is the broiler farming location that consists of 3 treatments, as follows: P1: Broiler farm on low altitude (<400 meters above sea level); P2: Broiler farm on middle altitude (400-700 meters above sea level); P3: Broiler farm on high altitude (> 700 meters above sea level) (Ariffin, 2001). The division of the business scale were made based on the largest ownership minus the smallest ownership, then divided by the length of the class.

Interval = Range/Class Range
Interval = (10000-3000)/3
Interval = 2333

From the calculation above, the divisions of the business scale are Scale I = 3000 + 2333 = 5333, the number of livestock = 3000-5333 broilers; Scale II = 5333 + 2333 = 7666, the number of livestock = 5334-7666 broilers; Scale III= 7666 + 2333 = 10000, the number of livestock = 7667-10000 broilers. Subplot (Q) is the broiler population in a farm that consists of three treatments, as follow: Q1: Population of 3000-5333 broilers/farm; Q2: Population of 5334-7666 broilers/farm; Q3: Population of 7667-10000 broilers/farm. Based on the division above, there are 9 treatment combinations and each treatment was repeated for 3 times, so the total experimental unit was 27 units.

Data analysis were conducted using the formula of Split Plot Design in completely randomized design (CRD). If there is a difference between the effects of treatment, it will be continued with the Least Significant Difference (LSD) Test (Dallal, 2015).

RESULTS AND DISCUSSION

Table 1 shows not much difference in the average amount of erythrocytes from the three altitudes, but it is higher in the highland than the others. This may be due to the lower temperature in highlands. Sulistyoningsih (2004), stated that cold weather can increase oxygen demand. Cold weather can increase metabolism rate, thus increases the need for oxygen which bounded by erythrocytes. Soeharsono et al. (2010) stated that animals that live in highland areas generally have more erythrocytes, which were done as an attempt to overcome the lack of oxygen. Analysis of variance showed that the different altitudes were not give any significant effect to the number of erythrocytes (P>0.05). The average amount of chicken erythrocytes in three altitudes ranges between 2.21-2.25 x 10^6/mm^3. Mangkoewidjojo and Smith (1988), stated that the normal range chicken erythrocyte is 2.0-3.2 x 10^6/mm^3. The normal amount of erythrocytes indicates that the chickens are physiologically healthy.

Table 1: The average value of erythrocytes from broilers that were reared in different altitudes

Altitudes	Population	Erythrocytes (10^6/mm^2)	Total Mean
Highland	Q1	2.24±0.18	
	Q2	2.25±0.17	2.25±0.14
	Q3	2.25±0.12	
Medium Land	Q1	2.24±0.11	
	Q2	2.23±0.19	2.23±0.14
	Q3	2.22±0.17	
Lowland	Q1	2.21±0.01	
	Q2	2.24±0.11	2.21±0.09
	Q3	2.17±0.12	

The lowland broilers have lower average erythrocytes when compared to the other lands. According to Zhang et al. (2007), red blood cells (erythrocytes), hematocrit, and hemoglobin of broilers that live in the lowland (alt. 100 m) is tend to be lower than the highland. The high temperature on the farming area can cause a heat stress in broilers (Austic, 2000). Heat stress can lead to disruption of the erythrocytes formation (Mashaly et al., 2004). According to Aengwanich and Chinrasri (2003), heat stress in broilers may cause a decrease in the number erythrocytes.

Table 2: The average value of hemoglobin from broilers that were reared in different altitudes

Altitudes	Population	Hemoglobin (g%)	Total Mean
Highland	Q1	9.77±1.67	
	Q2	9.40±1.73	9.50±1.32
	Q3	9.33±0.99	
Medium Land	Q1	9.57±0.86	
	Q2	9.27±1.88	9.36±1.44
	Q3	9.23±1.99	
Lowland	Q1	9.60±0.53	
	Q2	9.13±0.76	9.29±1.10
	Q3	9.13±1.93	

Table 2 shows not much difference in hemoglobin average amount of the three altitudes, but the lowland tends to be lower than the others because of higher temperature in the lowlands and cause heat stress in broilers. According to Aengwanich and Chinrasri (2003), heat stress can decrease the amount of hemoglobin and the lowland broilers have lower amount of hemoglobin than those in the highland (Zhang et al., 2007). Low amount of hemoglobin is also caused by the close relation between the hemoglobin and erythrocytes. Coles (1982) stated that the decrease in hemoglobin amount positively correlated with the number of erythrocytes. Sturkie and Griminger (1976), in addition, also stated that high level of erythrocytes will be followed by high level of hemoglobin, and vice versa. Analysis of variance also showed no significant effect of different altitudes toward number of hemoglobin (P> 0.05). The average amount of hemoglobin in three altitudes chickens ranges between 9.29-9.50 g%. Swenson (1984) stated that the normal range of broiler hemoglobin is between 6.5-9.0 g%, while according to Mangkoewidjojo and Smith (1988), it is between 7.3-10.9 g%. Normal amount of hemoglobin indicates that the chickens are healthy.

The amount of hemoglobin in the highlands tends to be higher compared with the other two altitudes. It is believed to be related with the higher needs of oxygen in the highland, rather than other altitudes. Guyton and Hall (2010) stated that hemoglobin shows demand for oxygen and it serves as oxygen transporters from the lungs into the bloodstream, transport it to the tissues, and then carries the carbon dioxide from the tissues to the lungs.

Table 3: The average value of hematocrit levels from broilers that were reared in different altitudes

Altitudes	Population	Hematocrit (%)	Total Mean
Highland	Q1	26.10±5.14	
	Q2	25.37±5.35	25.83±4.26
	Q3	26.03±4.13	
Medium Land	Q1	25.50±1.80	
	Q2	25.47±5.70	25.34±4.48
	Q3	25.07±6.66	
Lowland	Q1	25.03±0.61	
	Q2	25.97±2.96	25.00±2.51
	Q3	24.00±3.63	

Table 3 shows not much difference in hematocrit values at the three different altitudes. The hematocrit value in lowland tends to be lower, while the highest hematocrit value founded in the highlands. Results from this calculation indicate that erythrocytes, hemoglobin and hematocrit value are positively correlated. Meyer and Harvey (2004) also stated that erythrocytes, hematocrit and hemoglobin are parallel to each other, even if there is a change. Hematocrit levels can be influenced by the number and the size of red blood cells (Sturkie and Griminger, 1976). Analysis of variance also showed that the effect of different altitudes was not significant to the hematocrit level (P> 0.05). The average number of hematocrit from chickens that were raised in three different altitudes ranges between 25.00-25.83%. Mangkoewidjojo and Smith (1988), reported that the normal hematocrit value ranges between 24.0-43.0%. Swenson (1984) added that the normal hematocrit values ranges between 30.0-33.0%, while Jain (1993) stated that the normal hematocrit value of chicken ranges between 22.0-35.0%. The entire hematocrit values, number of erythrocytes and hemoglobin in this study were within the normal range, showed that the chickens are healthy.

Table 4: The average value of leukocytes from broilers that were reared in different altitudes

Altitudes	Population	Leukocytes ($10^3/mm^2$)	Total Mean
Highland	Q1	12.12±0.34	
	Q2	13.92±1.97	12.68±1.39
	Q3	12.01±0.59	
Medium Land	Q1	13.93±0.42	
	Q2	12.96±0.78	12.98±0.99
	Q3	12.05±0.68	
Lowland	Q1	13.75±1.90	
	Q2	13.98±1.46	13.86±1.38
	Q3	13.84±1.38	

Table 4 shows that there is not much difference in the number of leukocytes in broilers which raised in three different altitudes, but the lowland have higher number of leukocytes when compared to the other two altitudes. This might be caused by the higher temperature on the lowland. The high temperature is alleged to trigger the heat stress on animals. According to Sugito (2009), the impact of heat stress can be seen from the increased number of leukocytes. Analysis of variance showed that the effect of different altitudes was not significant to the number of leukocytes (P>0.05). The average number of leukocytes from broilers that were raised in the three altitudes ranges between 12.68-13.86 x $10^3/mm^3$. Swenson (1984), who reported that normal amount of leukocytes ranges between of 20.0-30.0 $10^3/mm^3$, while Mangkoewidjojo and Smith (1988) founded that normal leukocyte in chickens ranges between 16.0-40.0 $10^3/mm^3$, and according to Jain (1993), normal leukocyte in chickens was between 12-30 x $10^3/mm^3$. The amount of leukocyte in all chickens in this study was still within the normal range, which indicates that the chickens are physiologically healthy.

Table 5 shows not much difference in the average value of lymphocytes in the three altitudes, the highland has the highest lymphocytes number and the lowland has lower number of lymphocytes. This is due to the higher temperatures in the lowland. High temperature can trigger the heat stress on animals. In contrary, Zurriyati and Dahono (2013), stated that broiler farming on low temperature area only has a little effect on their physiology. However, the lymphocyte is different with the leukocyte, when the heat stress occurs, the number of leukocyte increases, while lymphocyte decreases. Kusnadi (2009) reported that a stressed condition will decrease the number of lymphocytes. Factors that can be affected by the low temperature are heterophile-lymphocyte ratio (H/L), which indicates the occurrence of heat stress in broilers. This research only studied the number of lymphocytes, without studying the number of heterophile, so the exact ratio of H/L is unknown. Analysis of variance showed that the effect of different altitudes was not significant to the lymphocytes value (P> 0.05). The average number of lymphocytes from chickens in the three altitudes ranges between 50.86-51.93%. Swenson (1984), stated that the normal number of lymphocytes ranges between 55-60.0%. According to Mangkoewidjojo and Smith (1988), the value of normal lymphocytes in chicken ranges between 24.0-84.0%, while Jain (1993), stated that normal number of lymphocytes in chickens is between 45.0-70.0%. Lymphocytes value in this study is still within the normal range, which indicates that the chickens are healthy.

Table 5: The average value of lymphocytes from broilers that were reared in different altitudes

Altitudes	Population	Lymphocytes (%)	Total Mean
Highland	Q1	52.20±1.14	
	Q2	51.30±2.65	51.93±1.55
	Q3	52.30±0.60	
Medium Land	Q1	50.87±0.83	
	Q2	51.90±0.70	50.99±1.02
	Q3	50.20±0.89	
Lowland	Q1	50.33±0.91	
	Q2	50.50±0.79	50.86±0.92
	Q3	51.73±0.38	

Table 6: The average value of monocytes from broilers that were reared in different altitudes

Altitudes	Population	Monocytes (%)	Total Mean
Highland	Q1	8.13±0.47	
	Q2	8.23±0.40	8.39±0.46
	Q3	8.80±0.26	
Medium Land	Q1	8.37±0.38	
	Q2	9.00±0.36	8.50±0.51
	Q3	8.13±0.40	
Lowland	Q1	9.07±0.59	
	Q2	8.63±1.22	8.93±0.74
	Q3	9.10±0.36	

Table 6 shows no significant difference on the average value of monocytes from the three altitudes. The temperature difference did not affect the value of monocytes. Frandson (1992), stated that the monocytes will only start to change when infection occurs. Analysis of variance showed that the effect of different altitudes was not significant against monocytes value (P> 0.05). The average value of monocytes from broilers that were raised in the three altitudes ranges between 8.39-8.93%. Mangkoewidjojo and Smith (1988), stated that the normal value of monocytes ranges between 0-30%, while according to Dellman and Brown (1976), the normal range of monocytes is between 3-9%. Swenson (1984) stated that the normal number of monocytes in chickens is 10%. While Jain (1993) argued that the normal number of monocytes in chickens is between 5-10.0%. The amount of monocytes in this study, is still

Table 7: The average value of erythrocytes, hemoglobin, hematocrit, leukocytes, lymphocytes and monocytes based on broiler population in this research

Location	Broiler Population		
	Erythrocytes (10^6/mm^2)		
	Q1	Q2	Q3
P1	2.24±0.18	2.25±0.17	2.25±0.12
P2	2.24±0.11	2.23±0.19	2.22±0.17
P3	2.21±0.01	2.24±0.11	2.17±0.12
Mean	2.23±0.02	2.24±0.01	2.21±0.04
	Hemoglobin (g%)		
P1	9.77±1.67	9.40±1.73	9.33±0.99
P2	9.57±0.86	9.27±1.88	9.23±1.99
P3	9.60±0.53	9.13±0.76	9.13±1.93
Mean	9.65±0.11	9.27±0.14	9.23±0.10
	Hematocrit (%)		
P1	26.10±5.14	25.37±5.35	26.03±4.13
P2	25.50±1.80	25.47±5.70	25.07±6.66
P3	25.03±0.61	25.97±2.96	24.00±3.63
Mean	25.54±0.54	25.60±0.32	25.03±1.02
	Leukocytes (10^3/mm^2)		
P1	12.12±0.34	13.92±1.97	12.01±0.59
P2	13.75±1.90	13.98±1.46	13.84±1.38
P3	13.93±0.42	12.96±0.78	12.05±0.68
Mean	13.27±1.00	13.62±0.57	12.63±1.05
	Lymphocytes (%)		
P1	49.67±2.06	50.50±0.79	51.73±0.38
P2	52.20±1.14	51.30±2.65	52.30±0.60
P3	50.87±0.83	51.90±0.70	50.07±0.98
Mean	50.91±1.27	51.23±0.70	51.37±1.16
	Monocytes (%)		
P1	9.37±0.40	9.77±0.31	9.13±0.72
P2	10.50±0.53	10.30±0.53	10.47±0.32
P3	9.20±0.95	9.70±0.10	9.40±0.17
Mean	9.69±0.71	9.92±0.33	9.67±0.71

P1 = High altitudes; **P2** = Middle altitudes; **P3** = Low altitudes; **Q1** = Population 3000 – 5333 broilers; **Q2** = Population 5334 – 7666 broilers; **Q3** = Population 7667 – 10000 broilers within the normal range, which indicates that the chickens are healthy.

Broiler population in this study was divided into three scales, the first scales 3000-5333 broilers/farm, the second scales 5334-7667 broilers/farm and the third scales 7668-10000 broilers/farm. The blood profiles observed were erythrocytes, hemoglobin, hematocrit, leukocytes, lymphocytes and monocytes. Results of statistical analysis are consisted of the effect of farm altitudes in the raising process and in the broiler population, as well as its interaction with the broilers blood profile, which include erythrocytes, hemoglobin, hematocrit, leukocytes, lymphocytes and monocytes. Statistical analysis showed that the broiler population in the farm and its interaction are not significant (P> 0.05) to the values of erythrocytes, hemoglobin, hematocrit, leukocytes, lymphocytes and monocytes. The average values are presented in Table 7.

The results showed that the population of broiler chickens and its interactions does not affect the blood profile of broilers. This is due to the difference in broiler population that was used in this study, and also due to the size difference of the cages. If the high population of broiler chickens in a farm followed by a large enough cages, the population will have no effect on the blood profile of the chickens that are raised in that cage.

CONCLUSIONS

From this study, we can conclude that the farm altitudes and the total population of broilers as well as the interaction between the farm altitudes can improve blood profile in broilers. Blood profiles from broilers that were raised in three different altitudes are still within the normal range.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

AUTHOR'S CONTRIBUTION

All the authors contributed equally.

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