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Physiological Characteristics of Sumatera's Organic Chicken that was Raised in Cool and Hot Climate Regions

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ABSTRACT

This study was aimed to analyze the physiological characteristics including respiratory rate, rectal temperature, and heterophil-lymphocyte (H:L) ratio of Sumatera's organic chicken (SOC) that was raised in cool and hot climate regions. One-hundred-and-eighty-seven male and female SOC aged about 6 months were taken from cool and hot climate regions in Sumatera Island. Regions with cool climate were represented by highlands in West Sumatera including the subdistrict of Tilatang Kamang, Canduang, and East Padang Panjang. Regions with hot climate were represented by lowlands in Riau Province including the subdistrict of Bunga Raya, Lirik, and East Kampar. Samples of SOC were collected from farmers where the distance of sampling was about 500 m. Measurements were taken on respiratory rate, rectal temperature, and heterophil-lymphocyte ratio. Data was analyzed by t-test. The result showed that the respiratory rates of SOC in hot climate regions were higher than the ones in cool climate regions, the rectal temperatures of SOC in hot climate regions were lower than the ones in cool climate regions and there was no difference between the Heterophil:Lymphocyte ratio of SOC in hot climate and in cool climate regions.

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INTRODUCTION

Organic chicken (also known as *ayam kampung*) is the Indonesian native chicken. Sumatera's Organic Chicken (SOC) is the one that have been long lived and bred in Sumatera Island. The chicken is commonly raised in traditional management system by smallholder farmers. In Indonesia, the organic chicken found throughout the country, from the highlands with cool climate to the lowlands with hot climate. The chicken has a great potential to develop as they have enormous genotype and phenotype variations as reflected in their varied plumage

colour patterns which might be resulted from uncontrolled crossbreeding over generations. However, the attention to development of the organic chicken is still limited so that the genetic potential of the chicken is not yet optimally elaborated to produce superior Indonesian organic chicken strains.

Chickens can be optimally productive when they are raised within their optimum environment (thermoneutral zone). The thermoneutral zone of the chickens is 18-23.9°C (Czaririck and Fairchild, 2008), however, the

optimum environmental temperature for the native chickens in Indonesia is not well defined yet.

Meanwhile, the effects of climate change have been found throughout the world including in Indonesia. For the last 25 years, temperature increment was found to be increasing sharply by 0.18°C/decade (BMKG, 2012). In some regions of the country, especially in Riau Province, air temperature is quite high. Data of the Meteorological, Climatology, and Geophysical Agency, Meteorological Station of Japura Rengat of Riau Province showed that the maximum air temperature reached 36.4°C in July 2015. The temperature of earth surface and sea keeps increasing as the result of global warming (Lendrum and Woodruff, 2006).

The increasing in ambient temperature gives negative effects on chicken farming in the tropic. High ambient temperature in chicken farms leads to heat stress (Cooper & Washburn, 1998; Mujahid *et al.*, 2007) as almost their whole body is covered with feathers making them difficult to release their body heat to the environment (Lin *et al.*, 2005; Al-Fataftah & Abu-Dieyeh, 2007; Al-Ghamdi, 2008; Al-Aqil & Zulkifli, 2009; Zulkifli *et al.*, 2009; Ajakaiye *et al.*, 2010). Heat stress leads to decreased productivity, retarded growth, and economic loss as a result of increased mortality rate (St-Pierre *et al.*, 2003). Heat stress also affects chicken physiological properties including increases in rectal temperature (Gaviol *et al.*, 2008), respiratory rate (Etches *et al.*, 2008), and heterophil-lymphocyte (H:L) ratio (Aengwanich & Chinrasri, 2002).

This study was aimed to analyze the difference between the physiological characteristics including respiratory rate, rectal temperature, and heterophil-lymphocyte ratio of Sumatera Kampung chickens raised in cool and hot climate regions.

MATERIALS AND METHODS

Description of sampling area

The samples of chickens were taken from cool and hot climate regions in Sumatera Island. The regions with cool climate were represented by highlands in West Sumatera including Tilatang Kamang Subdistrict, Agam Regency (altitude 800-1,100 masl, air temperature 18-29°C), Canduang Subdistrict, Agam Regency (altitude 750-2,891 masl, air temperature 19-26°C), and East Padang Panjang Subdistrict, Padang Panjang City (altitude 650-

850 masl, air temperature 17.4-28.8°C). The regions with hot climate were represented by lowlands in Riau Province including Bunga Raya Subdistrict, Siak Regency (altitude 3-15 masl, air temperature 25-32°C), Lirik Subdistrict, Indragiri Hulu Regency (altitude 4-15 masl, air temperature 20.6-36.4°C), and East Kampar Subdistrict, Kampar Regency (altitude 38 masl, air temperature 20.6-36.4°C).

Bird collecting and rearing

One-hundred-and-eighty-seven male and female Sumatera Kampung chickens aged about 6 months were used as samples. The sample chickens were collected from farmers where the distance of sampling was about 500 m. Forty-eight sample chickens were taken from Tilatang Kamang Subdistrict, 17 chickens from Canduang Subdistrict, 37 chickens from East Padang Panjang Subdistrict, 32 chickens from Bunga Raya Subdistrict, 42 chickens from Lirik Subdistrict, and 11 chickens from East Kampar Subdistrict. The chicken samples that have been collected from the farmers in every subdistrict, were pooled and reared in a pen of a certain farmer in the same subdistrict for a month. This was aimed as providing a similar rearing management and comfortable condition for them to get rid the transportation stress the birds might suffer during sampling period. In addition, this was conducted to make data collecting and blood sampling easier to do.

In all sampling locations, chickens were reared in a semi-intensive management system by which chickens were released outdoor during the day and kept in the pens at night. The chickens were fed rice bran meal, corn, cassava, oil palm fruit, coconut pulp, and kitchen food waste. Pens were made of wood and placed in the yard.

In this study, no heat stress treatment was given yet to the birds. The birds were left to live in their habitat namely regions with cool and hot climate. This was done to assess natural physiological characteristics of chickens reared in regions with cool and hot climate.

Measurement and statistical analysis

The measurements were taken on respiratory rate, rectal temperature, and heterophil-lymphocyte ratio. Respiratory rate and rectal temperature were measured in the rearing place. Respiratory rate was measured by observing and counting the abdomen breathing movements per minute by using a stopwatch. Rectal

temperature was measured by inserting a digital thermometer into the cloaca. The amount of heterophil, lymphocyte, and the heterophil-lymphocyte ratio were determined by using method according to Kolmer *et al.* (1959.) Blood samples for heterophil-lymphocyte ratio analysis were taken from brachial veins by using 3 ml syringe with needles. A drop of blood was put onto an object glass for blood smear preparation. Blood was spreaded onto the object glass. The preparations were dried and fixated with methanol. Then, the ones were stained by dipping in eosin for 20-30 second. Next step, the glasses were rinsed by using running water and then dried. The difference of respiratory rate, rectal temperature, and heterophil-lymphocyte ratio between Sumatera Kampung chickens raised in cold and hot regions were analyzed by t-test.

RESULTS AND DISCUSSION

Respiratory rate

Respiratory rates of Sumatera Kampung chickens raised in regions with cool and hot climate are depicted in Figure 1.

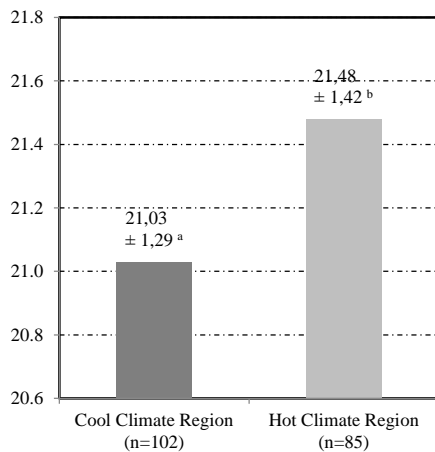


Figure 1. The respiratory rates of SOC raised in regions with cool and hot climate; means with different letters (a and b) are significantly different ($P < 0,05$)

It can be seen in Figure 1 that the respiratory rates of Sumatera Kampung chickens were 21.03 ± 1.29 times per minute in cool regions and 21.48 ± 1.42 times per minute in hot region which were significantly different ($P < 0.05$). The respiratory rates in this study were in the normal ranges of 18-23 times per minutes (Mushawwir, 2011).

The higher respiratory rate found in the chickens raised in hot climate region might be as an adaptation mechanism of the chickens toward high ambient temperature. High ambient temperature was found to affect chicken respiratory (Sohail *et al.*, 2010). In this kind of situation, in order to maintain the body temperature balance, chickens will increase heat loss through evaporation (evaporative heat loss, EHL) as sensible heat loss (sensible heat loss, SHL) through radiation, conduction, and convection, declines. Body heat loss through EHL occurs through skin and respiration by which 586 cal/g of water evaporates at 20°C (Hillman *et al.*, 1985). In birds, water evaporation through skin is limited as the limited number of sweat glands. Therefore, in hot climate region water evaporation through respiration increased.

Higher respiratory rate in the chickens raised in the region with hot climate was also suspected as an adaptation mechanism to a drought as a result of El Nino phenomenon occurring during this study was conducted. El Nino is an unusual warm ocean temperature in Nino region along the equatorial Pacific. El Nino which is an effect of global warming also affects global climate. In Riau Province, strong El Nino effect was found in 2015 when a long drought and forest fires occurred in areas covering about 220 thousand hectares. As a result, in September to November 2015, there was a smoke haze disaster which was declared as an air pollution disaster (Ardhitama *et al.*, 2015). In a normal situation, the amount of oxygen in air is about 20% (Mushawwir, 2011). Forest fire reduces the oxygen content in air. In condition of low oxygen content and high carbon dioxide level, the respiratory system will respond by increasing the respiratory rate.

Rectal Temperature

Rectal temperature of Sumatera Kampung chickens raised in regions with cool and hot climate is depicted in Figure 2.

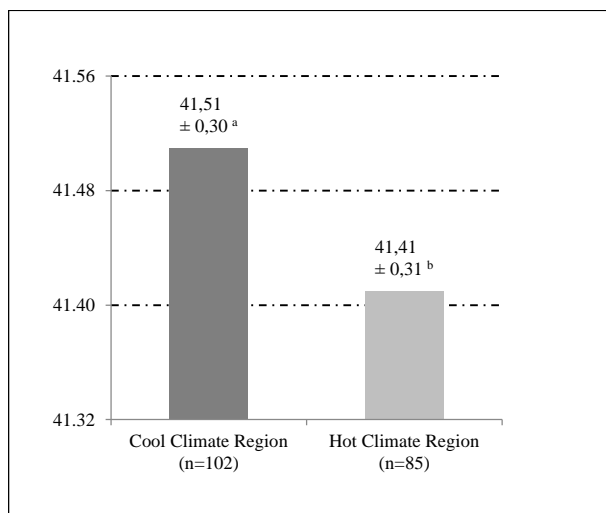


Figure 2 The rectal temperature of SOC raised in regions with cool and hot climate; means with different letters (a and b) are significantly different ($P < 0.05$)

It is shown in Figure 2 that rectal temperatures of Sumatera Kampung chickens were 41.51 ± 0.30 °C in cool regions and 41.41 ± 0.31 °C in hot regions which were significantly different ($P < 0.05$). Chickens' rectal temperatures found in this study were still within the normal ranges of chicken body temperature of 41-42°C with a variation of 1.5 °C (Aengwanich & Chinrasri, 2002) or 40.5-41.5°C (Etches *et al.*, 2008).

Rectal temperature of Sumatera Kampung chickens raised in the regions with cool climate was found to be higher than that of chickens raised in regions with hot climate. This was suspected to be the adaptation mechanism of Kampung chickens to maintain their body temperature in cool climate as they are endothermic/homeothermic animals whose body temperature is internally regulated. As homeothermic animals, in cool ambient temperature, chickens require more heat to maintain their body temperature constant (Abbas, 2009) and for this purpose they must recruit metabolic heat production (MHP) (Hillman *et al.*, 1985). This in line with Abbas (2009) that heat produced from metabolism and heat loss play a role as a regulator of body temperature in response to changes of ambient temperature.

Heterophil:Lymphocyte Ratio

Heterophil:lymphocyte (H:L) ratio of SOC raised in regions with cool and hot climate is depicted in Figure 3.

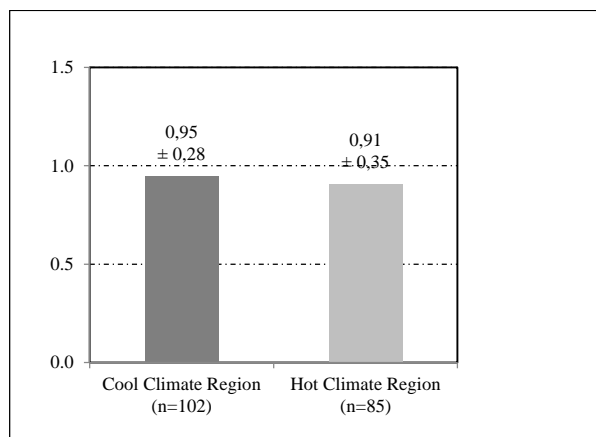


Figure 3. The H:L ratio of SOC raised in regions with cool and hot climate

H:L ratio of SOC were 0.95 ± 0.28 in cool regions and 0.91 ± 0.35 in hot region. The results showed that there was no significant difference ($P > 0.05$) in mean H:L ratio of SOC raised in regions with cool and hot climate. It indicated that the higher temperature of hot climate regions had not increased the H:L ratio of SOC yet. The chickens suffering from heat stress will have decreased amount of lymphocyte and increased amount of heterophil leading to increase of H:L ratio (Tamzil, *et al.*, 2014). The results of other studies showed that there were an increasing of H:L ratios from 0.36 ± 0.05 to 0.68 ± 0.04 (Sugito and Delima, 2009), from 0.358 to 0.581 (Mahmoud and Yaseen, 2005) in broiler chickens, from 0.10 ± 0.07 to 0.21 ± 0.06 in organic chickens and *arab* organic chickens (Tamzil *et al.*, 2014), and from 0.169 to 0.406 in layer chickens (Mahmoud and Yaseen, 2005).

The amount of heterophil and lymphocyte in blood varied widely among species (Soeharsono and Hernawan, 2011). In this study, the quantities of heterophil of SOC were 45.44 ± 6.84 (cool regions) and 43.57 ± 8.00 (hot regions) and those of lymphocyte were 49.79 ± 7.04 (cool regions) and 43.57 ± 8.00 (hot regions). The amount of heterophil and lymphocyte found in this study was in line with the results of work by Mitruka and Rawnsley (1981) who found that the amount of chickens heterophil was 15-45% and the amount of the chickens' lymphocyte was 40-80%. In this study, the amount of heterophil of SOC was closed to the highest proportion of it found by Mitruka and Rawnsley (1981). This might be caused by the fact that in this study, chickens were raised in semi intensively management. This way, chickens were left outside the pens during the day

allowing them to a bigger chance of getting bacterial infection. The main function of heterophil is to fight bacterial infection (Soeharsono & Hernawan, 2011).

CONCLUSION

The respiratory rates of SOC in hot climate regions were higher than the ones in cool climate regions. The rectal temperatures in hot climate regions were lower than the ones in cool climate regions and there was no difference between the H:L ratio in hot climate and in cool climate regions.

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