

Stamina Prediction of Cows and Goats to Exercise Changes by Measuring Body Temperature, Heart Rate, and Respiratory Rate

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Abstract

Environmental factors play an important role in livestock life. An unsuitable environment can cause disturbances to the growth of animal and cannot produce properly. The purpose of this study was to determine changes in respiratory frequency, heart rate and body temperature of cows and goats at rest, when given running training, and when a rest one hour after being rushed, to find out the stamina of the animals. The results showed that exercise treatment had a very significant effect on respiratory rate, body temperature, and heart rate. The respiratory rate after exercise was significantly different from the respiratory frequency before exercise and after resting for one hour, but quickly returned to normal after one hour rest which indicates that the stamina of these two animals is very good.

Keywords : Livestock, environmental factor, exercise, body temperature, heart rate

INTRODUCTION

Environmental changes can affect directly or indirectly the lives of livestock (Rojas-Downing *et. al.*, 2017; Lacetera, 2019). Environmental factors such as temperature, humidity, radiation, exercise, feed can affect livestock life. Cows and goats can be directly affected by their environment by responding to these effects by carrying out a homeostatic process (Indrissou *et. al.*, 2020; Bova *et. al.*, 2014). The response of each animal will be different, some are able to adapt and others are less able to adapt. Only well-adapted animals will thrive.

The heart is an involuntary blood pumping organ that stimulates the heart to perform systole and diastole. The heart beats automatically because the network of muscle weave was able to generate an action potential spontaneously (Monfredi *et. al.*, 2013). Goats have a higher heart rate than cows or other large animals. This is due to the high metabolic activity of small animals (Miwa *et. al.*, 2015). When the ambient temperature increases or due to exercise, the heart rate of the animals will also increase (Lopedote *et. al.*, 2020; Seijin *et. al.*, 2018). When the ambient temperature increases, the animal's heart rate will also increase. An increase in animal body temperature can also occur due to exercise. The size of the animal is also related to the function of the heart in pumping blood throughout the body, as well as the need for body heat

dissipation and removal and the exchange of gases (oxygen and carbon dioxide) in respiration. Increased body temperature can improve blood circulation to tissues and help the process of heat dissipation on to the body surface by conduction, convection and evaporation. An increase in ambient temperature or exercise causes an increase of heart contractions followed by a heart rate (Fletcher *et. al.*, 2001).

Breathing is a metabolic exchange process, from oxygenic acid gas taken from the air by the lungs that have undergone biochemical process in the body, released back as carbon dioxide gas (Hsia *et. al.*, 2013). Regulating the respiratory frequency is one way to maintain a stable body temperature, especially in high temperature environment (McKindley *et. al.*, 2017). Another way to dissipate heat loads; in both animals (cows and goats) the main route is via sweat glands and evaporation from the skin.

Related to the effect of exercise on animals, this study examines and compares the stamina of cattle and goats by measuring body temperature, respiratory frequency, and heart rate.

MATERIALS AND METHODS

Experimental Conditions

This research was conducted in a tropical environment, temperatures between 28-31°C, with sunny weather conditions, in an open pasture area. Cows and goats were given training to run by the animal handlers at a running speed for cows in general about 7.5 km/h, walking speed 4.5 km/h; and goats with walking speed 4.6 km/h and running speed at 9.5 km/h during 30 min and rest 60 min.

Experimental Animals

This study used 6 Bali Cattle and 10 Indonesian local goats. The cows used in this study were a mixture of males and females, aged between 3-5 years. The sheep used are also a mixture of males and females aged between 1-2 years. Both types of cows and female goats are not in a state of pregnancy with healthy physical and physiological conditions.

Each animal was measured for body temperature, respiratory rate and heart rate. The body animal's body temperature can be determined by using a rectal temperature using a thermometer. Heart rate was checked using a stethoscope placed on the chest (Grais, 2013).

Respiratory rate was calculated by calculating the frequency of breaths per minute using a stop-watch (Takayama *et. al.*, 2019; Adedeji, 2012).

Research Design

This study used a completely randomized design (Tavares *et. al.*, 2016) with the following factors:

A = before exercise

B = after exercise

C = after resting for 1 hour

Data analyzed using analysis of variance, followed by the least significant difference test (Bewick *et. al.*, 2004).

RESULTS AND DISCUSSION

Respiratory Frequency

Table 1 shows that the respiratory frequency of cows and goats varies in each treatment. After being exercised, the cows respiratory frequency was higher than before and after resting for one hour.

Table 1. The respiratory frequency, heart rate and body temperature of cattle

Treatments	Respiratory frequency (breath/minute)	Heart rate (beat/minute)	Body temperature (°C)
Before exercise	21±1 ^a	70±5 ^a	37.66±0.4 ^a
After exercise	26±2 ^b	96.66±6 ^a	39.66±0.5 ^b
After resting for 1 h	21.33±0.67 ^a	68.66±5.14 ^a	39.00±0.5 ^c

Note: Data in the same column with different signs indicate significant differences between treatments

The analysis of variance showed that the treatment had a significant effect ($P < 0.05$) on the respiratory frequency cattle. The result indicated that in cows that were given a fairly strenuous job, the respiratory rate increased drastically, then return to normal after being rested for 1 hour. Animals try to adapt to their environment through gas exchange in their metabolic processes (Maina, 2002). The smallest significant difference test showed a significant difference between animals at rest and after exercised. In addition, there was no significant difference between the respiratory frequency of cattle before exercise and after resting for one hour.

The increase in the respiratory rate after exercise was caused by physiological response of the heart to pump blood rapidly throughout the body (Burton *et. al.* 2004). The condition is a result of the metabolism of ATP release due to exercise, and the response to release the heat from the body through the exchange of oxygen and carbon dioxide through the respiratory mechanism (Cummins *et. al.*, 2020). The process of respiration is a very important mechanism for the release of body heat (Robertshaw, 2006). Different environmental conditions and animal species can cause difference in respiratory rate.

Respiration is a metabolic exchange process, from oxygenic acid gas taken from the air by the lungs, undergone a biochemical process in the body, and then released again in the form of carbon dioxide (Hsia *et. al.*, 2013). The exchange of gases, oxygen and CO₂, in the air with those in the blood capillaries is called external respiration and the exchange in the tissues is called tissue respiration (internal respiration). The transfer of O₂ and CO₂ from the air contained in the alveoli of the lungs into the blood, and between the blood capillaries and the cells of the lung tissue takes place by diffusion. Respiratory frequency is one way to maintain body temperature stability (Kolettas *et. al.*, 2014). Normal goat resting respiration rate is between 12-20 breath per minute (Texas A & M Agrilife Extension, 2009), 16-34 breath per minute (McGee Equine Veterinary Clinic, 2021) and in cows 30 breath per minute (Texas A & M Agrilife Extension, 2009), 26-50 breath per minute (McGee Equine Veterinary Clinic, 2021).

Related to body heat production, ventilation of the lung is also important in regulating body temperature. At a critical temperature, the animal will start to sweat; the respiration rate increases rapidly with increasing ambient temperature or body temperature, the breathing will be

shallower to maintain high ventilation (Tsuji *et. al.*, 2016). During calm and normal breathing, only 2-3 total energy is expended by the body to activate the ventilation process of the lungs. During vigorous exercise such as running, the absolute amount of energy required to ventilate the lungs can be increased by up to twentyfold. This is caused by chemical changes in body fluids during exercise, which include an increase in oxidant carbon and hydrogen ions and a decrease in oxygen. Another thing is that during exercise, there are impulses to the cerebral cortex of the contracting muscles, which send collateral impulses to stimulate the respiratory center.

Heart Rate

Table 1 showed an increase in the heart rates in cattle after exercise, although statistically there was no significant effect after being given treatment. This can happen because Bali cattle have been able to adapt to their environment both to temperature, humidity and handling of these cows.

Table 2. The respiratory frequency, heart rate and body temperature of goat

Treatments	Respiratory rate (breath/minute)	Heart rate (beat/minute)	Body temperature (°C)
Before exercise	37±3.0 ^a	83.67±3.5 ^a	40.53±3.1 ^a
After exercise	46.33±0.5 ^b	155.33±6.1 ^b	42.4±3.5 ^a
After resting for 1 h	36.67±0.7 ^a	85.67±3.2 ^a	41.56±2.5 ^a

Note: Data in the same column with different signs indicate significant differences between treatments

Analysis of variance showed that the treatment had a significant effect ($P < 0.05$) on the goat's heart rate. Increase in ambient temperature will cause the heart to contract, so that the heart rate also increases. The least significant difference test showed that the heart rate increased sharply after the flight but immediately returned to normal after resting for one hour. This is in line with the respiratory rate. The increase in heart rate occurs due to body activity that causes metabolism so that the heart needs to pump blood faster. Even so, cows and goats quickly adjust back to normal after resting for 1 hour.

Goats have a higher heart rate than cattle or other large animals because the metabolic activity of smaller animals is greater than that of large animals. The size of the animal also related to the function of the heart in pumping blood throughout the body. Body temperature is closely related to heart rate. An increased in body temperature can increase blood circulation tissues and help the process of heat dissipation the body surface either by conduction, convection and evaporation.

From various studies, it turns out that the pulse frequency of goats ranges from 70-80 times/minute; 70-140 times/minute. In young goat, the highest heart rate is 95 beats/minute. While, the cow's heart rate is 40-58 beats/minute. Myocardial systole and diastole occur due to contraction and relaxation of the myocardium and the opening and closing of its valves in order to allow flow from the left atrium to the right ventricle and from the ventricle to the artery. This is called the heart rate when a stethoscope is used.

Body Temperature

Table 1 showed that treatment had a very significant effect ($P < 0.05$) on the temperature of the cows, while Table 2 shows that treatments A, B, and C have no significant effect on body temperature of goats. The increase in body temperature is caused by the body's metabolic activity which causes the burning of energy in the body, which causes blood to be pumped by the heart throughout the body. In goats, there is no difference in temperature between the 3 treatments, because goats were able to regulate their body temperature by regulating the balance between their body heat and the heat of their environment (Maia *et. al*, 2016). Normal body temperature of cattle is between 38.1-39.1°C (Wenz *et. al.*, 2011).

Cows and goat are homoioterm animals that can restore their body temperature to a stable temperature in the concept of homeostatic. Homeostatic is a physiological mechanism by which the animal maintains its body temperature. Cattle have a body temperature between 38-39°C (average 38.6°C), and goats have a body temperature of 38.5-40°C (average 39.4°C). In exercise conditions, there is an increase in muscle work, thereby increasing heat production, as a result there will be an increase in body temperature, but will soon return to normal by increasing blood flow to the body surface and increasing evaporation water from the body surface. As a result, the loss of body heat in small animal is greater than that of large animal.

In a healthy state, the temperature of the goat will have a relatively constant temperature even though it is exercising, the changes only shift in a narrow variation. Oral temperature measurements are generally 1°C higher than rectal temperature, so rectal temperature measurements are considered more precise.

CONCLUSION

Giving activity to animals increases the respiratory frequency, heart rate and body temperature of the cows and goats, but returns to normal after resting. In cattle, heart rate was not significantly different after being given exercises, while in goat body temperature was not significantly different after being given exercises. The exercise treatment had a very significant effect on respiratory rate, body temperature, and heart rate. The respiratory rate after exercise was significantly different from the respiratory frequency before exercise and after resting for one hour, but quickly returned to normal after one hour rest which indicates that the stamina of these two animals is very good.

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