



Assessing Heat Tolerance in Pote Goats: A Case Study from Madura Island

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Abstract. Temperature and humidity significantly influence productivity and animal welfare. Goat rearing, despite their generally heat-resistant nature, can be challenged by heat stress. The Benezera Coefficient of Adaptation (BCA) is a tool used to assess livestock's adaptive capabilities. This study evaluated the adaptive ability of Pote goats raised on smallholder farms in Bangkalan, Madura Island. Two hundred Pote goats of various ages were observed under a grazing management system. Environmental temperature and humidity were recorded twice daily (07:00 and 15:00 local time), along with rectal temperature and respiration rate. Results indicated temperatures in Bangkalan ranged from 25-33°C with humidity levels between 50-70%. Goats under 1 year old exhibited an average rectal temperature of $39.04 \pm 0.58^\circ\text{C}$ and a respiration rate of 26.704 ± 5.66 breaths/minutes. For goats over 1 year old, these values were $38.81 \pm 0.60^\circ\text{C}$ and 28.10 ± 5.36 breaths/minutes, respectively. The BCA values for goats under 1 year old were 2.00, and for those over 1 year old, they were 2.15. These results suggest that Pote goats in Bangkalan, regardless of age, demonstrate strong adaptive abilities (BCA values close to 2).

Keywords: Pote goat, rectal temperature, respiration rate, adaptability

1 Introduction

Small ruminants (sheep and goats) are an important source of livelihood for rural communities. In their development, they are a sustainable and environmentally friendly production system, especially in environments experiencing extreme heat. Heat stress is one of several factors that are difficult to overcome due to global warming and affects the production and reproduction of livestock worldwide. This results in disturbances in production, reproduction, growth, rumen physiology, quantity, and quality of milk, as well as natural immunity and makes livestock more susceptible to various diseases [1].

Heat stress affects ruminant livestock through a combination of environmental factors such as high ambient temperature, relative humidity, high solar radiation, low wind speed, and rainfall. Air temperature and relative humidity are factors that directly affect the production potential of ruminants. However, in extreme environmental conditions, goats have better adaptability to heat stress compared to other ruminants [2]. They are the most adaptable and widely distributed livestock species geograph-

ically, ranging from high mountains to extreme lowlands with thermally stressed environments [3]. Waheb & Khalil [4] argued that different types of livestock have differences in their sensitivity to temperature and environmental humidity, where heat stress tolerance is much higher in local breed than in crossbred. Local breed can dissipate heat more effectively by sweating, while crossbred have a lower ability to sweat.

For this reason, this study aims to examine the adaptive ability of Pote goats raised on smallholder farms in the lowlands of Bangkalan Regency, Madura Island, which is the genetic plasma of Madura Island. The ability of animals to adapt to their environment can be assessed by knowing the thermal resistance coefficient. Das et al. [1] defined the thermal resistance coefficient as the ability of an animal to withstand heat, which has a significant impact on productivity, namely they could maintain the natural body temperature of animals in the face of high temperatures in the environment where these animals live. The thermal resistance coefficient is known as one of the oldest indicators for evaluating heat stress in animals and this is done using rectal temperature and respiratory rate [4]. Goats are considered one of the species that is best able to adapt to heat stress conditions through production and reproduction, as well as resistance to disease [1], and the ability of goats to adapt to heat stress is due to their morphological, anatomical, and physiological characteristics. Morphological mechanisms in goats in the face of heat stress consist of body shape and size, light fur color, light pigmented skin, and less subcutaneous fat, and their physiological way is an increase in respiratory rate (RR), an increase in sweating rate (SW), a decrease in metabolic rate, and changes in endocrine function [5]. In addition, goats can minimize the adverse effects of high heat stress by eliciting behavioral responses such as eating, drinking, seeking shade, and increasing drinking frequency.

2 Materials and Methods

This study was conducted for two months on a smallholder farm in Bangkalan Regency, Madura Island, where goats were raised through grazing. A survey was conducted with male and female goats of various ages on 200 Pote goats of various ages by observing the dental structure. The feed given was the available forage in the pasture, which consisted of dry leaves, bamboo leaves, and dry grasses without concentrate. Ambient temperature and relative humidity were continuously observed twice a day at 7:00 AM and 3:00 PM throughout data logger (OneMed Thermometer Digital Hygrometer HTC1). Physiological responses, namely rectal temperature (RT), and respiratory rate (RR), were recorded in all goats studied, twice a day before and after grazing at 7:00 AM and 3:00 PM, then those data calculated to get an averaged for that day. The animals' left flank motions were directly observed for one minute (breaths/min) in order to determine RR. A veterinary clinical thermometer was inserted straight into the animal's rectum for two minutes in order to measure its RT (°C). The adaptability was calculated based on the Benezera formula modified for goats by putting the values of normal rectal temperature and pulse rate of Indian goats under the most favorable conditions, as 39.44 °C (103.0 °F) and 24 breaths/minutes [6].

$$\text{Benezera Coefficient of Adaptability (BCA)} = RT/39.44 + RR/24 \quad (1)$$

The data was presented as means, maximum, minimum, standard deviation and coefficient of variance.

3 Results and Discussion

The research was conducted in Bangkalan Regency, Madura, a lowland area 35 meters above sea level. The ambient temperature in the morning was $24.95 \pm 1.320\text{C}$ and the relative humidity was $50.25 \pm 1.49\%$, while in the afternoon it was $33.39 \pm 1.310\text{C}$ and $70.38 \pm 1.92\%$, respectively. The majority of the local people raises Pote goats. According to Rohman et al. [7], Pote goats are a small-sized goat breed among local goats in Indonesia, with an adult body weight of 27-35 kg. The study was conducted on 200 dam of different ages (1–3 years) by Susilorini et al. [8] found that Pote goats morphometric characteristics, included, chest girth, body length, wither height, tail length, and ear length was 59.94 ± 11.02 cm, 51.29 ± 8.64 cm, 59.09 ± 9.10 cm, 15.82 ± 3.25 cm, and 19.35 ± 2.40 cm, respectively. Body size and shape are the most dominant morphological characteristics influencing thermoregulation mechanisms in livestock in extremely hot environments [5]. Naturally, animals are characterized by large, small, or dwarfed bodies, which help them adapt to extremely hot environmental conditions. Imaniah et al. [9] revealed that the dominant phenotypic characteristics of Pote goats include a pitcher-shaped udder, long drooping ears, flat horns, rectangular pupils, convex facial profiles, the presence of reвос hair in both males and females, and the absence of a beard. Notably, phenotypic characteristics did not differ significantly among Pote goats of different ages.

Heat stress is defined as the subjective discomfort and physiological strain experienced when an individual is exposed to an extremely hot environment. The effects of heat stress can be categorized into nine parameters related to animal productivity and reproductive welfare: behavioral response, growth and development, reproductive performance, physiological response, health and immunity, milk quality and quantity, cashmere production, meat quality and carcass characteristics, and genetic adaptation [10]. The average rectal temperature and respiration rate of Pote goats under 1 year and over 1 year of age are presented in Table 1.

Table 1. Rectal temperature, Respiration rate and BCA value of Pote goats

Variables	Age <1 year (n : 110)			Age >1 year (n : 90)		
	Rectal Temperature (°C)	Respiration Rate (breaths/minutes)	BCA	Rectal Temperature (°C)	Respiration Rate (breaths/minutes)	BCA
Min.	37.60	15.00	1.62	37.70	18.00	1.72
Max.	40.50	38.00	2.58	40.30	39.00	2.59
Avg	39.04	26.70	2.00	38.81	28.10	2.15
SD	0.58	5.66	0.24	0.60	5.36	0.22
CV	1.48	21.20	11.21	1.53	19.06	10.22

Note: min: minimum; max: maximum; avg: average; SD: standard deviation; CV: coefficient of variance

Rectal temperature is a good indicator of a livestock animal's internal body temperature, and it can also serve as a parameter to show the effects of heat stress. In this study, the rectal temperature of Pote goats was still within the normal range. This was true for both goats under one year and those over one year of age, and the same applied to their respiration rate. When analyzing the adaptive capacity of Pote goats on Madura Island, it was found that all age groups had adapted well to environmental temperature of Madura Island. This was indicated by an average BCA of 2.00-2.15 [6]. When the adaptation value (BCA) is at a minimum or equal to 2, it indicates that the livestock has adapted well to the environment. If the BCA value increases above 2, it can be identified that the animal has low heat tolerance.

4 Conclusion

In conclusion, the adaptation mechanism of Pote goats in Bangkalan Regency, Madura, is considered good, as evidenced by the average adaptation value of 2.0-2.15 across all age groups of livestock could underline the main result and significance of study.

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