

Heat tolerance of several beef cattle breeds in Astomulyo Village, Lampung Tengah District

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ABSTRACT: Animals' productivity and health status in tropical regions are significantly influenced by their ability to adapt to hot and humid tropical environments. This study aimed to compare the heat tolerance of the Ongole-cross (OC), Simmental-cross (SC), and Limousin-cross (LC) breeds raised in Astomulyo Village, Lampung Tengah District. This location had a high environmental stress index in the afternoon and moderate environmental stress in the morning and evening. Most cattle have a Heat Tolerance Coefficient (HTC) above 100, and there are no significant differences in HTC values among cattle breeds. The OC, SC, and LC cattle breeds exhibit good heat tolerance and can adapt to hot and humid environments in Lampung Tengah District.

Keywords:

cattle, environmental stress, heat tolerance

■ INTRODUCTION

The cattle population in Lampung Province, which has the largest cattle population in Sumatera Island, is supported mainly by Lampung Tengah District, as nearly half of the cattle population in Lampung Province is located there (Badan Pusat Statistik Provinsi Lampung 2023). The average temperature in Lampung Tengah District is 31.7 °C, which is not ideal for raising beef cattle because it is outside the thermoneutral zone for cattle, which is 10–26 °C (Belhadj Slimen *et al.* 2016; Badan Pusat Statistik Lampung Tengah 2023). Local farmers commonly raise *Bos indicus* cattle breeds, such as Ongole-cross, and *Bos taurus*, such as Ongole-cross and Simmental-cross (Suretno *et al.* 2017). *Bos taurus* has faster growth, earlier puberty, and a higher carcass percentage than *Bos indicus*. However, *Bos indicus* is more resistant to hot temperature and disease than *Bos taurus* (Kasarapu *et al.* 2017).

The expression of genes in animals can be altered by internal and external environment. Crossbreeding in beef cattle has been carried out in Indonesia to combine superior genetic traits of *Bos taurus* at a high production rate with *Bos indicus*, which has already adapted to the hot and humid tropical environment (Widyas *et al.* 2022). This study aimed to compare the heat tolerance of Ongole-cross, Limousin-cross, and Simmental-cross cattle breeds in the hot and humid farming environment in Lampung Tengah District.

■ MATERIAL AND METHODS

This study involved each of six heads of Ongole-cross, Simmental-cross, and Limousin-cross cattle breeds. The animals were randomly selected based on specific criteria: (1) male, (2) aged at least 2 years, (3) having a minimum Body Condition Score (BCS) of 3.5, being physically healthy, and (4) having no history of Foot and Mouth Disease (FMD) or Lumpy Skin Disease (LSD). This study was conducted in Limousin farmers group, Astomulyo Village, Punggur Sub-district, Lampung Tengah District, Lampung Province. The cattle pen was located 40 m above sea level, with an average daily temperature 29.15±2.33°C, an average relative humidity 86.15±13.31%, and an average temperature humidity index (THI) 82.17±2.36, indicating a moderate level of environmental stress. Heat Tolerance Coefficient (HTC) is calculated using the Rhoad coefficient formula Nawaan 2006): $DTP = 100 - 18 (\text{Body temperature} - 38.3^\circ\text{C})$, where body temperature = $(0.65 \times \text{rectal temperature}) + (0.35 \times a)$; 100 is the value of total efficiency at normal body temperature; and 38.3°C is the equivalence factor of 100°F. Rectal and skin temperature were measured in the morning (06:00 AM), afternoon (12:00 AM), and evening (06:00 PM) using a digital thermometer inserted into the rectum. Skin temperature were

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measured using a thermal gun on the forehead, ribs, flank, rump, legs, cheeks, neck, and ears.

■ RESULTS AND DISCUSSION

Animal welfare in tropical regions is significantly influenced by environmental conditions such as temperature, humidity, wind speed, and sunlight (Mader et al. 2006). Temperature humidity index (THI) is an indicator of environmental stress, calculated using the formula: $THI = (1.8 \times Tab) + Rh$ ($Tab - 14.4$) + 46.4, where Tab represents the average ambient temperature, and Rh is the relative humidity. A comfortable environment has a $THI \leq 74$ and a THI between 75–78, 79–83, and ≥ 84 , indicating mild, intermediate, and severe environmental stress, respectively (Bulitta et al. 2015). All cows were exposed to severe environmental stress in the afternoon but experienced moderate environmental stress in the morning and evening (Figure 1).

Despite the significant dynamics of ambient temperature, there were no significant changes in rectal temperature (Figure 1a), surface temperature (Figure 1b), or body temperature (Figure 1c) between morning, afternoon, and evening. This result suggests that cattle are homeothermic animals that can maintain their body temperature despite changes in the ambient temperature.

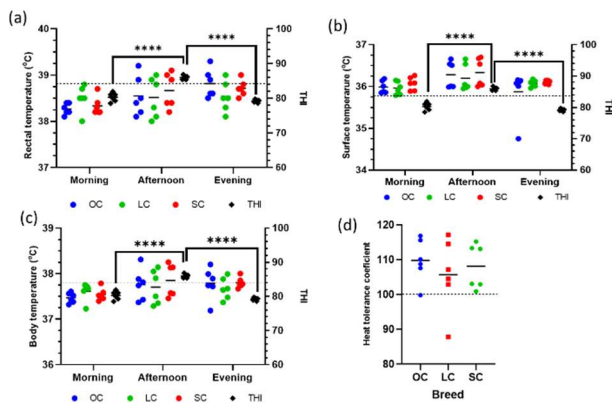


Figure 1. (a) Rectal temperature, (b) surface temperature, (c) body temperature in Ongole-cross (OC), Limousin-cross (LC), and Simmental-cross (SC) in the morning, afternoon, and evening. -----: threshold for severe environmental stress, ****: $p < 0.0001$, (d) Heat tolerance coefficient (HTC) of OC, LC, and SC cattle breeds. -----: threshold for ideal HTC value (100).

The heat tolerance coefficient (HTC) reflects the ability of animals to adapt to hot and unfavorable environments. A higher HTC value indicates greater adaptability of animals to hot environmental conditions, and heat tolerance is ideal when the HTC value approaches 100 (Putra 2016). Most Ongole-cross, Limousin-cross, and Simmental-cross cows raised in Astomulyo Village had good heat tolerance because their HTC values were above 100. Body temperature should be maintained, as an increase in rectal temperature of 1°C is

sufficient to suppress animal productivity. Body temperature is regulated by the balance between heat production and loss. In a hot environment, the body compensates by increasing heat loss or suppressing heat production. If the body is unable to dissipate heat, it enters a heat stress phase (Belhadj Slimen et al. 2016).

■ CONCLUSION

The majority of Ongole-cross, Limousin-cross, and Simmental-cross cattle raised in Astomulyo Village, Lampung Tengah District, have heat tolerance coefficient (HTC) above 100 (PO), indicating their ability to adapt to hot and humid environments.

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■ REFERENCES

- Badan Pusat Statistik Lampung Tengah. 2023. Rata-Rata Suhu Udara dan Kelembaban Relatif Setiap Bulan di Lampung Tengah.
- Badan Pusat Statistik Provinsi Lampung. 2023. Populasi Ternak Sapi di Provinsi Lampung Tahun 2019-2021.
- Belhadj Slimen I, Najar T, Ghram A, Abdrrabba MJOAP. 2016. Heat stress effects on livestock: molecular, cellular and metabolic aspects, a review. *Journal of Animal Physiology and Animal Nutrition*. 100(3):401–412.
- Bulitta FS, Aradom S, Gebresenbet G. 2015. Effect of transport time of up to 12 hours on welfare of cows and bulls. *Journal of Service Science and Management*. 8(02):161–182.
- Kasarapu P, Porto-Neto LR, Fortes MRS, Lehnert SA, Mudadu MA, Coutinho L, Regitano L, George A, Reverter A. 2017. The *Bos taurus*–*Bos indicus* balance in fertility and milk related genes. *PLoS One*. 12(8):e0181930.
- Mader TL, Davis MS, Brown-Brandl T. 2006. Environmental factors influencing heat stress in feedlot cattle. *Journal of Animal Science*. 84(3):712–719.
- Nawaan S. 2006. Daya Tahan Panas Pada Sapi Peranakan Simmental, Peranakan Ongole Dan Sapi Pesisir. *Jurnal Peternakan Indonesia (Indonesian Journal of Animal Science)*. 11(2):158–166.
- Putra RR. 2016. Identifikasi daya tahan panas sapi Pasundan di BPPT Cibeunjing Kecamatan Cibeunjing Kabupaten Ciamis. *Students e-Journal*. 5(4).
- Suretno ND, Purwanto BP, Priyanto R, Supriyatna I. 2017. Evaluasi kesesuaian lingkungan berdasarkan penampilan produksi empat bangsa sapi pada ketinggian berbeda di Provinsi Lampung. *Jurnal Veteriner*. 18(3):478–486.
- Widyas N, Widi TSM, Prastowo S, Sumantri I, Hayes BJ, Burrow HM. 2022. Promoting sustainable utilization and genetic improvement of Indonesian local beef cattle breeds: A review. *Agriculture*. 12(10):1566.