Mapping efforts of the advantages of local beef thermodtolerance: comparison of sweating rate of Peranakan Ongole cattle and it’s cross with Bos taurus

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Abstract: Bos indicus was known for its superiority in thermotolerance compared to Bos taurus. The purpose of the study was to know the sweating rate of local cattle Peranakan Ongole (PO) and compare it with those of it’s cross with Bos taurus (Limousine or Simmental). The result showed that PO has higher sweating rate (p<0.05) than it’s cross with Bos taurus (Limpo or Simpo). There was no different (p>0.05) between Limpo and Simpo. The mean sweating value of PO was 86.7±5.05 and of Limpo/Simpo was between 78.2±2,95 and 79.0±4.58 ml/s.

Keywords: local cattle, thermodtolerance

1. Introduction
As a tropical country, Indonesia has a rich wealth of adaptive local beef cattle with high ambient temperatures, including Ongole Peranakan (Bos indicus) cattle. This white skin animal are now in continues decreasing population, especially in East Java Province. There is a fact that the small farmers prefer larger cows for some reasons so uncontrolled crosses occur of local beef cattle with Bos taurus (Limousin and Simmental). Loose germplasm control contributes to a decrease in the local beef cattle population. In recent years in the contest of Peranakan Ongole cattle in East Java has no participants at all. This is an illustration of the increasing scarcity of the local cattle population of Peranakan Ongole breeds in Indonesia, considering the province of East Java is a warehouse for beef cattle. The rescue of the wealth of adaptive local beef cattle germplasm seems to be a priority.

Several studies on the advantages of Peranakan Ongole cattle adaptation compared to crossbreeding have been widely carried out. However, based on a search of existing literature, research on sweating rates and sweat gland density in local beef cattle, especially Peranakan Ongole and it’s crossbreeding with Bos taurus has never been done before. The results of the research on the superiority of thermodtolerance of local beef cattle and their crossing with Bos taurus are expected to be a scientific basis for strengthening the policy program for increasing the population of beef cattle based on adaptive local beef cattle and the rescue of germplasm. The purpose of the study was the availability of scientific data comparing the sweating rate of local beef cattle and their crosses with Bos taurus.

2. Material and Methods
This study used Peranakan Ongole (PO), the crossing between PO and Limousin (Limpo) and between PO and Simmental (Simpo) bulls, each of 5 animals of 2-3.5 years of age. The data were taken from the
animals kept in the barn of registered slaughter house in Malang city, East Java Province, 2-5 days before slaughtering.

The tools used in the study include:

- Stopwatch: To measure the time the paper changes from blue to pink.
- Preparation of Cobalt Chloride Disc (CCD) 2%: To reduce the rate of drying by knowing the duration of the change from blue to pink. Object glass: For placing CCD (Cobalt Chloride Disc) before being affixed to animals.
- Perforator: To make a round shape on Whatman paper.
- Oven: to heat CCD before data collection.
- Razor blade (skin hair shaver): To shave the hair on the part of the skin that the CCD will place.
- Whatman paper: CCD maker material.
- Clear tape: To attach CCD to cow skin.
- Plastic aluminum foil: To wrap CCD during oven.

2.1. Cobalt Chloride Disc (CCD) preparation
Whatman No.1 filter paper was immersed in 2% Cobalt Chloride solution for one minute and dried at room temperature over a glass sheet for two hours. After that, the filter paper is dried again into the oven at 80°C for two hours. Next, the paper is made with a perforator spherical and placed on the object glass as much as three dots closed with tape with a distance of 5 mm per disc.

This study uses an experimental method. The method used to find out the sweating rate is as follows. Sweating rate observations are carried out at the time when the ambient temperature is the highest (12.00-13.00). Animals hair is shaved on the thighs of 5x3 cm. Then the Cobalt Chloride Disc (CCD) is applied to the skin that has been shaved and record the length of time the Cobalt Chloride Disc (CCD) changes color (seconds) by using a stopwatch. The color changes that will occur are blue to pink. The recorded time, then calculated using the formula:

\[
\frac{(4 \times 3600)}{(2.06 \times t)} = \frac{6990}{t}
\]

\[t = \text{the time needed to change the color of the disc from blue to pink}\]

3. Results and Discussion
PO cattle are the result of crossing Ongole cattle, with white or gray skin, but the body size and hump are smaller than those of Ongole’s. The screw also looks smaller or very little. If maintained in good condition, PO cattle have an average body weight of around 200 - 350 kg / head with daily gain of 0.6 - 0.8 kg / day. PO are beef and working cattle. This cow is relatively heat resistant and resistant to endoparasites and ectoparasites.

In cattle crossing PO and Limousin (Limpo), the color variations of their body skin are only dark brown and white brown. The dominant color of body hair in Limpo cattle from birth to yearling is dark brown. White brown colors that often appear at birth, appear more often when cows reach yearling age. In small quantities, there are Limpo cattle which at birth have white body skin (such as PO), but all of them will turn into white chocolate after the animal reaches yearling age.

Heat stress can be defined as a physiological condition when the core body temperature of a particular species exceeds a certain range for normal activity, which results in total heat load (internal and environmental production) exceeding heat dissipation capacity and this encourages physiological responses and behavior to reduce the burden. Armstrong (1994)[2] states that heat stress occurs when a combination of environmental conditions causes the effective temperature of the environment to be higher than in the animal's comfort zone. Four environmental factors that affect effective temperatures: 1) air temperature, 2) relative humidity, 3) air movement and 4) solar radiation (Buffington et al., 1981)[3].

Cattle respond to heat stress in several ways: 1) reduction in feed consumption, 2) increase water consumption, 3) change metabolic speed and basic life needs, 4) increase evaporative heat release, 5)
increase respiration rate, 6) change blood hormone concentration and 7) increase body temperature (Armstrong, 1994)[2].

Collier et al. (2006)[4] stated that the mammalian strategy in maintaining central body temperature (core body temperature) higher than ambient temperature (environment) is by flowing heat out of the center (body) through 4 basic routes of heat exchange (conduction, convection, radiation and evaporation). Three of these routes (conduction, convection and radiation) are expressed as sensible heat release routes and require thermal gradients to operate. The fourth route (evaporation) works on a vapor / pressure gradient and is defined as the release of incentive heat. Furthermore, it is said that if the ambient temperature conditions approach body temperature, the heat release route that can run is evaporation; if the ambient temperature exceeds body temperature then the heat flow will reverse and the animal will get worse due to heat.

Temperature-sensitive nerve cells are located throughout the animal’s body and send information to the hypothalamus, which will cause a number of physiological, anatomical or behavioral changes in an effort to maintain heat balance (Curtis, 1983)[5]. The skin plays an important role in maintaining homeotherm. The skin does not only contain thermal sensors with high density, but the temperature of the skin and therefore the speed of heat flow from the body is regulated by peripheral vasomotor mechanisms (Bligh, 1973[6]; Jansky et al., 1986[7]). Peripheral vascular vasodilation increases skin temperature and increases heat release on the skin surface (by conduction). This action is under the influence of autonomic nervous system control.

Control of body temperature is a consequence of the thermoregulatory mechanism and resistance for energy exchange between livestock and their environment. To show the effects of thermoregulation and resistance on body temperature in beef cattle, several studies were conducted relevant to Bos indicus genotypes and Bos taurus have been reviewed by Finch (1986) [8]. From the study it was found that, tissue resistance to transfer metabolic heat to the skin was lower in Bos indicus compared to Bos taurus, resistance of the mantle to solar radiation, was greater for cattle with mantle types similar to Bos indicus, there were interactions of color and type coat in resisting the transfer of environmental heat to the skin. It was concluded that there are several differences between Bos taurus and Bos indicus in the ability to increase and maintain evaporative heat release from the skin.

Heat tolerance is the resistance of livestock to surrounding heat. Montsma (1984)[9] states that livestock gripped by heat, among others, will be reflected in the response of body temperature and respiratory frequency. Livestock can be said to have a good level of heat resistance if the value of HTC = 2 and the higher the value of HTC means the lower the level of resistance (Montsma, 1984)[9]. Heat is produced by the body's biochemical reactions (especially in the liver) and by muscle contractions. Most of the heat lost from the body occurs through the skin.

Indonesia is located in tropical climates so it is not much affected by extreme climate differences. The difference that occurs on a daily basis is the temperature difference between day and night. At night, the ambient temperature tends to be lower than the ideal temperature so the cow needs to expend energy.
Panjono et al. (2009)[10] conducted a study that aimed to determine the effect of sun drying on the comfort and performance of cow production. Eight male Ongole breeds, white and 1.5–2 years old, were divided randomly into two groups. The first group was dried every morning at 7:00 to 11:00 WIB and the second group (control) was continuously kept in the cage without drying. The frequency of cow pulsus that is continuously stretched is higher (P < 0.01) than that in the sun. There were no differences in rectal temperature and respiration frequency between the two groups. There was no difference in behavior between the two groups except the duration of rumination. Rumination of cows that are dried in the sun is longer (P < 0.01) than those that are continuously in the cage. There was no difference in consumption and feed digestibility, daily gain, and feed conversion between the two groups. It was concluded that drying provides a comfortable environment for cattle but has not been able to give a significant influence on its production performance.

Jian et al. (2014) [11] conducted a study that aimed to compare the skin morphology between B. indicus, B. taurus and its crosses. Sahiwal skin samples (B. indicus) (n = 10, reddish brown skin) and Holstein (FH) Friesian (B. taurus) (n = 10, black and white skin) and FH crossing 75% (n = 10, blacks and white) and FH 87.5% (n = 10, black and white skin) biopsied for histological studies, followed by measurement of skin components. The results show that breeds significantly affect the morphology of sweat glands. The shape of the sweat glands, as indicated by the ratio of length / diameter, in Sahiwal is shaped baggier compared to FH (5.99 and 9.52) while the value for crossing is intermediate (7.82, 8.45). The density and volume of sweat glands in Sahiwal (1,058 glands / cm2; 1.60 μ3 x 10^-6) are higher than FH (920 glands / cm2; 0.51 μ3 x 10^-6) and their crossings, both FH 75 % (709 glands / cm2; 0.68 μ3 x 10^-6) and FH 87.5% (691 glands / cm2; 0.61 μ3 x 10^-6). However, the capillary surface area was greater for FH (2.07 cm2) than Sahiwal (1.79 cm2). Therefore, the lower genetic fraction of FH in cross cattle showed lower capillary surface area (1.83 and 1.9 cm2 for HF75% and HF87.5%) (P < 0.01). Nerve density was not significantly different between Sahiwal and FH but was higher in cross-bred animals (P < 0.01). In addition, the effects of skin color (black and white) were also evaluated and an interaction (P < 0.01) was found between skin type and skin color on the skin components. This study shows that there are differences in the morphology of the skin between B. indicus, B. taurus and its crossing, the difference is more or less related to the genetic fraction of FH. This may imply that the ability to release cutaneous evaporative heat and tolerance to heat in cross cattle can be associated with skin morphology.

Based on the results of statistical analysis it was found that there were significant differences (P > 0.05) sweating rate between cattle PO and cross linkage with Bos taurus, as listed in Table 1 below.

Tabel 1. Time for CCD color changes (seconds) and sweating rate (ml / second) Peranakan Ongole (Bos indicus) cattle and their crossing with Bos taurus.

| Breed     | Front leg | Hind leg | Time (s) | Sweating rate (mL/s) |
|-----------|-----------|----------|----------|---------------------|
|           | Right (s) | Left (s) | Right (s) | Left (s)            |                    |
| PO (n:10) | 81±5.1    | 80±6.7   | 81±6.3   | 80±4.8             | 81±4.7             | 87±5.1^a          |
| Limpo (n:10) | 89±7.6    | 89±5.6   | 89±5.4   | 92±5.1             | 89±3.4             | 78±2.9^b          |
| Simpo (n:10) | 88±5.4    | 89±6.8   | 90±6.1   | 88±5.4             | 89±5.4             | 79±4.6^b          |

Notes: Different superscript in different column is significantly different (P<0.05)

These result were in accordance with Jian et al [11] stated there is a better ability to release cutaneous evaporative heat and tolerance to heat in cross cattle. These differences can be associated with skin morphology. So it is suggested to follow this study with another skin morphology included sweat gland density and morphology.
4. Conclusion
It was concluded that local PO cattle has higher sweating rate than the crossing with Bos taurus. It is suggested to follow the study with anatomical observation about the density and form or size of sweat gland between the breeds for deeper explanation about the result.

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