



Physiological Status of Four Breed Cattles on Some Different Altitudes in Lampung Province

Nandari Dyah Suretno^{a*}, Bagus Purwanto^b, Rudy Priyanto^c, Iman Supriyatna^d

^a*Balai Pengkajian Teknologi Pertanian (BPTP) Lampung*

^{b,c,d}*Lecturer in Bogor Agricultural University*

^a*Email: nandari.dyah@yahoo.co.id*

^b*Email: bpp030560@yahoo.com*

Abstract

Fulfilling the needs of today's society meat comes from local cattle (Bali and PO cattle) plus import cattle and beef. Among the import cattle are Limousin and Simental cattle which are from temperate climates. Based on these conditions, the purpose of this study was to determine the physiological response on import cattle and local cattle during rainy and dry season at various altitudes in Lampung province. The material used were adult cattle: 99 Bali cattles, 155 PO cattles, 66 Limousin cattles and 39 Simental cattles. Collected data were simultaneous weather conditions with the measurement of physiological responses. Data were analyzed using a completely randomized design. The results showed, based on their physiological responses, Bali cattle is the best local cattle and for import cattle with good adaptability is Limousin cattle. Overall the best physiological response in minimizing the environmental effects are Limousin cattle.

Keywords: altitude; beef cattle; physiological responses ;season.

*Corresponding author.

1. Introduction

A decline in population and rising meat consumption of Indonesian society forced the government to make livestock development policy. Started in early 1980s.

Meat fulfillment was shifted of previously primary source are from farmers local cattle into a small plus import cattle and beef. Import cattle that include Limousin and Simental are from temperate climates. Limousin had been crossed with various other cattle such as Ongole, Brahman and Hereford. Simental developed in Indonesia since 1985 through frozen semen mated to PO (Ongole Crossbred) and Holstein Friesian.

Lampung as one of the centers of the beef cattle development in Indonesia has various types of beef cattle. Data Collection of Beef Cattle, Dairy Cattle and Buffalo 2011 [1] showed that the number of cattle population in Lampung province as much as 742,776 heads which is the first ranks on Sumatera Island. According to the data in [1] the breed cattle most commonly found in Lampung Province are Ongole crossbred (*Bos indicus*), Bali cattle (*Bos javanicus*), hybrid Limousin and Simental crossbred (*Bos taurus*) with a population of consecutive 408,954, 186,712, and 42,883 or consecutive 55.06%; 25.14% and 5.77%, respectively. The cattles are scattered throughout the region in Lampung which varied topography due to altitude above sea level in Lampung ranging from 1 meter above sea level (asl) up to 512 meters above sea level [2].

A side from differences in topography, Lampung province also have a clear distinction between dry and rainy seasons. July to August the wind blowing from East and Southeast (dry season) and blowing from west and northwest (rainy season) from November to March. The highest rainfall reached 459.8 mm in January and lowest in August of 22.3 mm. Those differences, mainly in rainfall will affect food availability that will ultimately affect the physiological response.

The existence of Limousin and Simental, which are originated from temperate climates, is likely to be problematic in thermoregulation in Lampung province. Based on that, it is need to be studied on physiological responses of importcattle and local cattle during rainy season and dry season in various altitudes. From the results of this study are expected to be known adaptability of import cattle compared to local cattle.

2. Materials and Methods

2.1. Research material

The experiment was conducted twice, in December 2013 - February 2014 represents rainy season and in July - September 2014 represents dry season. The research location was traditional cattle farm in three regencies in Lampung province. There were Central Lampung, Pesawaran and the West Lampung. Cattle used were adult cattles: 99 Bali cattles, 155 Ongole crossbred (PO), 66 Limousins and 39 Simentals. Age of cattles were two to three years, in way of stabled maintenance(intensive maintenance).

2. 2. Research methods

Physiological response data of Bali cattle, PO, Limousin crossbred and Simental crossbred was measured in rainy and dry season. Data collected at the variable weather conditions such as temperature, humidity, wind speed, Temperatur humidity index (THI) and solar radiation obtained by measuring and calculating the weather elements simultaneously with the measurement of physiological responses. Temperature and humidity are measured using a hygrometer. The wind speed was measured with a digital anemometer. Solar radiation obtained by recording the numbers showed on the lux meter. THI was calculated using the formula [3]:

$$\text{THI} = (0.8 \times T_{\text{db}}) + [(RH/100) \times (T_{\text{db}} - 14.4)]$$

Description: T_{db} = dry bulb temperature ($^{\circ}\text{C}$)

RH = Relative Humadity (%)

Measurement of physiological responses such as heart rate, respiratory frequency and rectal temperature of cattle were conducted three times during the study in morning (6:00 to 7:00 pm), afternoon (12:00 to 13:00) and afternoon (16:00 to 17:00). Heart rate measurement using a stethoscope performed by measuring the number of beats in the chest, near the left axilla bone (near the armpit). The frequency of respiration was measured by calculating how much movement on the section between the last rib and flank in a minute. Rectal temperature data obtained by inserting a digital rectal thermometer into the rectum as deep as ± 8 cm.

2. 3. Data analysis

Weather elements data which included temperature, humidity, wind speed and solar radiation calculated by mean and standard deviation. Physiological responses of four breed cattles were maintained at three different altitude and analyzed by completely randomized design.

3. Results and discussion

3.1. The Weather Circumstances on Research Locations

Changes in weather elements that occur in Lampung province in this study lasted very varied. Rainfall on dry season (July, August, September) respectively 48.5 mm; 109.2 mm and 0 mm lower when compared with rainy season (in December, January, February) respectively 426.3 mm; 162.9 mm and 220 mm [2].

Temperatures in this study, especially in rainy season was decreasing with higher altitude. The average reduction in air temperature in Indonesia around $0.5\text{-}0.6^{\circ}\text{C}$ each increment of 100 meters [4]. Decrease in surface temperature with increasing altitude also affected by many factors, such as the density of vegetation, receipt of solar radiation, cloud cover and land use.

Humidity measurement results showed that the relative humidity in rainy season was higher than dry season. This difference was influenced by different rainfall in both season. The author in [3] noted that high humidity

can increase heat stress in cattle because the humidity increases the vapor pressure and inhibit evaporation of skin in the process of body heat release through perspiration. Another author also [5] said at a temperature of 28°C with ambient humidity of 40-80%, body temperature and respiratory rate of dairy cows was still normal, but more than that will affect feed intake, milk production, milk composition, production and release of body heat.

Table 1: Average elements data of weather in the research environment

Weather elements environment	Dry Season			Rainy Season		
	Central Lampung Reg.	Pesawaran Reg.	West Lampung Reg.	Central Lampung Reg.	Pesawaran Reg.	West Lampung Reg.
T(°C)	29,30±1,74	30,12±1,10	24,54±1,74	29,45±0,86	27,27±0,72	23,18±0,39
RH(%)	66,45±13,38	63,77±8,81	68,50±7,33	78,60±6,10	81,43±3,66	81,18±4,15
Va(m/s)	0,48±0,60	0,23±0,26	1,00±1,44	0,75±0,34	0,82±0,42	1,22±0,50
Im(lux)	2,71±2,57	3,93±6,99	2,41±1,49	1,98±1,30	2,55±1,26	3,14±1,29
THI	79,07±1,58	79,87±1,23	72,53±2,03	80,82±2,82	78,60±1,19	71,94±0,55
Altitude (m asl)	35-50	120-136	494-500	35-50	120-136	494-500

Description : T (°C) = the ambient temperature in degrees Celsius; RH(%) = relative humidity in percentage; Va(m/s) = wind speed in meters per second; Im (lux) = Intensity of solar radiation in lux; THI = Temperature Humidity Index

The average of wind speed in this study during dry season was lower than rainy season. The average of wind speed was highest in West Lampung was 1.00 ± 1.44 m/sec (dry season) and 1.22 ± 0.50 m/sec (rainy season). The average of wind speeds was higher during low air temperatures and high humidity.

Solar radiation in dry season was higher than in rainy season. Heat stress conditions due to solar radiation on the cattle affected the color of skin. Cattle with light color of skin like PO was more resistant to dry season, because according to [6] cattle with white skin can absorb 20% sunlight radiation and black skin can absorb up to 98%.

The results of THI calculation in rainy season showed that the location with highest THI was Central Lampung regency, while in dry season was Pesawaran regency. Based on these calculations obtained, the convenient location for beef cattle is West Lampung regency both on rainy and dry seasons. Cattle need a comfortable environment with THI values ≤ 74 [7].

3.2. Physiological responses of Respiratory Frequency

Altitude affected physiological response of respiratory frequency in Bali cattle. Respiratory frequency of Bali cattles in Central Lampung regency showed significant differences ($P < 0.05$) with those in West Lampung

regency, while in Pesawaran regency the respiratory frequency equal to the lowlands in dry season and to the highlands during rainy season. The average respiratory rate showed in Table 2.

Shown in Table 2, respiratory frequency of Bali cattle in lowland both in dry season and rainy season was higher than in highlands. The author in [8] stated that lowlands with high ambient temperatures make the animals had a faster metabolism compared to animals whose cells are inactive. In addition to the environmental temperature exposure, increased frequency of respiration also occurs when there is an increase in oxygen demand, ie after the exercise, high relative humidity and obesity [9].

Respiratory frequency of Bali cattle in lowland in this study was higher than the results of [7] that 20.12 ± 7.27 (rainy season) and 18.97 ± 4.01 (dry season). This difference may be caused by differences in body size, which was chest girth, in this study 147.31 ± 15.30 cm (rainy season) and 153.89 ± 12.00 cm (dry season). That was higher than the result of [7], 137,04 cm (rainy season) and 137,5 cm (dry season). Respiratory frequency is influenced by body size, age, physical activity, anxiety, ambient temperature, pregnancy, disorders of the gastrointestinal tract, health condition of the animal, and position of the animal [9].

Table 2: Responses of physiological respiratory frequency (per minute) on four breeds of cattles n dry season and rainy season

Paramater	Dry Season			Rainy Season		
	Central	Pesawaran	West Lampung	Central	Pesawaran	West Lampung
	Lampung Reg.	Reg.	Reg.	Lampung Reg.	Reg.	Reg.
Sapi Bali	21,33±3,14 ^{a1}	19,56±4,05 ^{a1}	16,33±2,16 ^{b2}	21,92±7,38 ^{a1}	18,57±4,30 ^{b1}	17,52±4,46 ^{b12}
Sapi PO	19,82±3,58 ^{a2}	19,53±5,19 ^{a1}	18,14±3,36 ^{b12}	19,74±6,79 ^{a1}	19,08±5,10 ^{a1}	16,44±3,76 ^{b2}
Sapi Limousin	18,67±2,95 ^{a2}	19,92±6,10 ^{a1}	18,88±3,80 ^{a12}	20,97±3,78 ^{a1}	17,56±3,55 ^{b1}	19,14±4,42 ^{ab1}
Sapi Simental	18,83±3,02 ^{b2}	21,72±4,13 ^{a1}	19,76±5,58 ^{ab1}	20,88±6,11 ^{a1}	19,94±2,47 ^{a1}	17,36±3,18 ^{a12}

Description:

Different superscript letters in same row indicate significant differences (P<0.05).

Different superscript numbers in the same column indicate significant differences (P<0.05)

Altitude in dry and rainy season effected PO respiratory frequency. Respiratory frequency of PO in Central Lampung and Pesawaran regency were significantly (P<0.05) higher than in West Lampung regency. This difference was PO's response to the air temperature and the higher value of THI. Panting is one manifestation of the body's heat loss of livestock due to the high temperatures indicated by the high frequency of breathing. While the value of THI >78 cause the animal is unable to maintain its thermoregulation mechanism[10].

The cattles from temperate climates such as Limousin and Simental given a different response. Respiratory frequency of Limousin cattle in dry season at three different altitude was the same, while the highest of frequency respiratory of Simental was in Pesawaran regency. Different responses in both breed cattles showed that Limousins are more resistant to high ambient temperatures. This results was in accordance with the result reporting [11] that Limousin crossbred more suitable to be developed in lowlands compared with Simental crossbred. Simental is the type of dairy and beef cattle, Limousin is currently pure beef-type cattle, so the result of Limousin crossbreeding has the genetic potential for better growth and resistance to hot temperatures higher than Simental crossbreeding.

The breed cattles did not affect ($P > 0.05$) against the respiratory frequency in Pesawaran regency in both dry and rainy season, as well as in Central Lampung regency during rainy season. That mean four breed cattles can adapt well in all three of these conditions.

While in Central Lampung in dry season, the highest respiration frequency ($P < 0.05$) was Bali cattle. High value of frequency respiratory of Bali cattle was caused its smaller size. The smaller the size of the cattle body the higher heat additions to the cattle. PO in this study has the adaptability better than Bali cattle, because the author [12.1] has reported that PO remove the heat load of the body through the sweat glands better than Bali cattle.

The highest respiratory frequency in West Lampung regency is Simental (dry season) and Limousin (rainy season) which both is *Bos Taurus* breeds. This results were in accordance with research of [13] that the response of *Bos taurus* against air temperature earlier than *Bos indicus*, but at the end of the heat exposure indicates that the two breed have similarly high rates of respiration.

3.3. Physiological responses of heart rate

Altitude influenced ($P < 0.05$) on heart rate Bali cattle both in dry season and rainy season. The physiological responses of heart rate (per minute) on four breed cattles in dry season and rainy season showed in Table 3. Heart rate of Bali cattle in Central Lampung and Pesawaran was higher than Pesawaran. High heart rate in dry season in line with the high respiration due to increased muscle activity in the respiratory organs that require oxygen supply more and should be met through increased blood flow which is increased heart rate.

PO in dry season and rainy season in West Lampung regency has a heart rate significantly ($P < 0.05$) higher. The author in [14] defined increased heart rate is a response from the animal's body to spread the heat received into the cooler organs. In rainy season, cattle's heart rate in Central Lampung regency ($P < 0.05$) was higher than Pesawaran regency. High heart rate in Central Lampung regency in line with high-frequency of respiration as well.

Limousine has the same heart rate ($P > 0.05$) in rainy season, but in dry season has higher heart rate in Central Lampung and Pesawaran regency. Increased heart rate is a response from the animal's body to spread the heat received from the ambient temperature to the cooler organs. Increase in heart rate occurs due to the disposal or replacement of heat to the surrounding air through the respiratory fail to reduce the extra heat from outside the

body of livestock [14].

Table 3: Physiological of heart beats responses (per minute) on four breed cattles in dry season and rainy season

Paramater	Dry Season			Rainy Season		
	Central	Pesawaran	West Lampung	Central	Pesawaran	West Lampung
	Lampung Reg.	Reg.	Reg.	Lampung Reg.	Reg.	Reg.
Sapi Bali	71,44±8,90 ^{a23}	70,45±7,76 ^{a2}	64,00±7,13 ^{b2}	61,60±15,76 ^{a2}	56,67±14,71 ^{a1}	46,69±5,83 ^{b3}
Sapi PO	68,79±7,33 ^{b3}	69,53±7,71 ^{b2}	74,60±10,51 ^{a1}	68,63±17,77 ^{a12}	57,89±12,66 ^{b1}	69,21±17,87 ^{a12}
Sapi Limousin	73,40±7,10 ^{a12}	74,63±10,29 ^{a1}	66,31±7,47 ^{b2}	65,38±20,48 ^{a12}	58,53±15,11 ^{a1}	66,68±22,68 ^{a2}
Sapi Simental	75,50±8,33 ^{a1}	74,67±7,47 ^{a1}	65,67±6,37 ^{b2}	72,43±23,04 ^{ab1}	62,17±16,36 ^{b1}	79,61±14,72 ^{a1}

Description: Different superscript latters in same row indicate significant differences (P<0.05). Different superscript numbers in the same column indicate significant differences (P<0.05)

Simental heart rate during dry season in Central Lampung and Pesawaran reGENCY greater than in West Lampung reGENCY. Increased heart rate as a result of high ambient temperatures can be resolved by environmental management control, such as engineering modifications to control the heat temperature to provide a comfort level for livestock, so livestock can produce the optimal production [15]. Hot temperatures can be reduced by lowering the cattle body temperature by spraying cold water on the whole surface of the body [16]. Another author [17] also reported that Simental crossbred treated by water spraying twice for 2 hours at 10:30 to 11:30 pm and 1:00 pm to 14:00 pm make his heart rate dropped from 81.05±1.48 times/minute to 78, 35±1.71 times/minute.

During dry season in areas with higher air temperatures (Central Lampung and Pesawaran reGENCY), the smallest heart rate is PO due to the white-skin color. Type of covering layer of skin correlate with body temperature and livestock productivity in tropics. The author in [18] explained that a white coat, short and shiny will reflect 30 to 50% of radiant energy. If the coat is fluffy and black may only reflect 10% of incoming energy.

Heart rate in rainy season more varied, cattle breed give no effect (P> 0.05) to heart rate response in Pesawaran reGENCY. It mean that the four breeds can live well in Pesawaran reGENCY in rainy season. While the highest heart rate in Central Lampung and West Lampung reGENCY was Simental, but it was still in normal condition because according to the author in [19] the normal range of cattle heart rate is 60-80 beats per minute.

3.4. Physiological responses of Rectal Temperature

Rectal temperature of Bali cattle during rainy season is not affected (P> 0.05) by altitude, whereas rectal temperature in dry season in West Lampung is reGENCY lower. When rainy season, the body heat dissipation into

environment can still through respiration, whereas Bali cattle in the dry season in Central Lampung and Pesawaran regency had been not able to increase body heat dissipation into the environment so that the body temperature rises. Successive responses of livestock to high temperatures are enlarged blood flow, sweating, increase in frequency of respiration, increase heart rate, rectal temperature, and increase in body temperature.

Rectal temperature of PO that live in West Lampung regency was lower than other two regencies both in rainy and dry season. This happened because the wind speed in West Lampung regency higher than two other areas. According to the author in [20] the wind can be used to reduce heat stress on cattle.

In fact, Limousin in this study can be adapted to several altitude and both season, as shown by the response of rectal temperatures were similar ($P > 0.05$). The author in [21] stated that cattle included in group of homoeothermic because their body temperature is relatively constant at ambient temperature variations. Cattle body temperature under normal conditions can vary due to differences in age, gender, climate, day length, ambient temperature, activity, feed, digestive activity, and the amount of water intake.

Response to heat stress in Limousin better than Simental. Body heat dissipation in Limousin was enough through increased respiratory frequency and heart rate while heat dissipation for Simental into environment was not yet enough so that there is still an increase in body temperature. The highest of body temperature as the response to heat stress from Simental is in Central Lampung regency during dry season and in Pesawaran regency during rainy season. Both these areas have high temperatures and high humidity as well. Those cause the body heat expenditure of Simental inhibited.

Description: Different superscript letters in same row indicate significant differences ($P < 0.05$). Different superscript numbers in the same column indicate significant differences ($P < 0.05$)

In rainy season, four breeds had same rectal temperature in Pesawaran and West Lampung regency, while Simental in Central Lampung regency have higher rectal temperatures. This condition was likely due to the ability of Simental's heat dissipate the environment was less. Genetically, crossbred cattle are more sensitive to an increase in air temperature environments because they have less number of sweat glands per skin area [22], so the ability to dissipate heat from the body to the environment is becoming more limited [23.1].

Rectal temperature during dry season is more varied. The highest rectal temperature in Central Lampung regency was Simental. This was because the fur is longer and dense as well as body color is darker, so the body's ability to dissipate heat from the environment to be more limited [23.2].

The lowest of rectal temperature in West Lampung regency in dry season is Bali cattle, the condition is the possibility that the Bali cattle respond to lower body temperature than other cattles. The author in [21] reported that there are two ways in which cattles can anticipat the effects of cold stress, which are reducing the temperature of the body where adaptation is often the case when the availability of food energy is not enough to guarantee thermogenesis and increasing the temperature of the environment, for example looking for a hotter ambient temperature.

Table 4: Rectal temperature (°C) responses on four breed cattles during dry and rainy season

Paramater	Dry Season			Rainy Season		
	Central	Pesawaran	West Lampung	Central	Pesawaran	West Lampung
	Lampung Reg.	Reg.	Reg.	Lampung Reg.	Reg.	Reg.
Sapi Bali	38,16±0,49 ^{a12}	38,18±0,50 ^{a1}	37,10±1,47 ^{b2}	38,26±0,42 ^{a2}	38,35±0,52 ^{a1}	38,07±0,30 ^{a1}
Sapi PO	38,06±0,62 ^{a2}	38,02±0,58 ^{a12}	37,69±0,81 ^{b1}	38,35±0,40 ^{a12}	38,19±0,48 ^{b1}	38,01±0,47 ^{c1}
Sapi Limousin	38,05±0,56 ^{a2}	37,87±0,57 ^{a2}	37,97±0,83 ^{a1}	38,25±0,27 ^{a2}	38,15±0,97 ^{a1}	38,05±0,58 ^{a1}
Sapi Simental	38,36±0,50 ^{a1}	38,20±0,65 ^{ab1}	37,91±0,48 ^{b1}	38,47±0,49 ^{ab1}	38,51±0,56 ^{a1}	38,07±0,65 ^{b1}

4. Conclusion

Adaptability shown by the physiological response of local and import cattles in three different altitudes varies greatly. local cattles like PO and Bali cattle have different adaptability, Bali cattle can adapt to the three altitudes during rainy season, while during dry season in Central Lampung and Pesawaran regency need to get additional treatment to overcome the stress due to environmental conditions. Adaptability of PO cattle less than Bali cattle, during rainy season PO cattle adapt well in Pesawaran and West Lampung regency, while during dry season only in West Lampung regency.

The import cattles like Simental which is maintained in Central Lampung regency during dry season and in Pesawaran regency during rainy season should get the attention because of their physiological response is not good. Unlike Simental cattle, Limousin cattle apparently has the most excellent adaptability. Heat dissipation of this cattle is only increasing the frequency of breathing and heart rate while the body temperature is the same for three different places and in both seasons.

Based on the physiological response, Bali cattle is the best local cattle and Limousin is the import cattle with good adaptability. Overall, the best physiological response in minimizing the environmental effects are Limousin cattle.

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