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Short-term herbal supplementation on the physiological condition of Bali cattle under the oil palm integration system

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Abstract The effect of short-term herbal supplementation on the physiological condition of Bali cattle kept under the Oil Palm Integration system was investigated from April to July 2021. Twenty-eight mature 2 years old Bali cattle were studied with 7 cattle each with treatments of no herbs/control, *Andrographis paniculata* extract, *Melastoma malabathricum* extract, *Andrographis paniculata* extract and *Melastoma malabathricum* extract. All animals were fed *ad libitum* with a mix of 40% grass + 60% fermented palm oil sludge. Physiological parameters were recorded as respiration rate, pulse rate, skin temperature, and rectal temperature and conducted in the morning, noon, and afternoon. Temperature Humidity Index (THI) and Heat Tolerance Coefficient (HTC) were reported. Results showed that respiration rate and skin temperature measured in the morning gavea a similar effect for all treatments. However, when it was measured at noon and afternoon, the respiration rate of the T-0 value was significantly higher ($p<0.05$) than the T-1, T-2, and T-3. The pulse rate, skin temperature, and rectal temperature of the T-0 were significantly lower ($p<0.05$) than those of T-1, T-2, and T-3 respectively. There was no significant effect of all treatments for the THI and the HTC-Benezra values. However, the HTC-Rhoad of T-0 had significantly lower than that of the T-1, T-2, and T-3. All physiological values for all treatments were under the normal range for healthy cattle.

Keywords: Bali cattle, THI, Herbs, Supplementation

Introduction

Herbs have been introduced to feed supplementation on ruminant nutrition to stimulate the appetite, to manipulate the rumen ecology, to improve feed utilization, to decrease the adverse effects of environmental stress, and also to increase the average daily gain (Bhatt, 2015; Dwatmadji *et al.*, 2020; Wanapat, 2013; Wang and Wang, 2016). The manipulation of the rumen ecosystem is an important strategy for ensuring efficient feed utilization in ruminants (Adeyemi *et al.*, 2016; Wanapat *et al.*, 2008). The main goal of manipulating rumen fermentation is to increase the effectiveness of digestion and metabolism of nutrients, to increase the productivity of the animals, and to

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suppress the undesirable processes (Frankic *et al.,* 2009). Improved feed efficiency could help to achieve the desired production targets with a minimal negative impact on the environment (Frankic *et al*., 2009).

The beneficial effects of herbs could be due to the secondary plant metabolites found in a different part of a plant. *Andrographis paniculate* or the king of bitter can be used to manipulate rumen metabolism for improved nutrient digestibility in goats Yusuf *et al.* (2017). While Curcumin isolated from the *Curcuma longa*, C. *mangga,* and C. *aeruginosa,* has been used in traditional medicine as anti-bacterial, due to its antibacterial activity could interfere with the bacterial population in the rumen which then will affect digestibility (Kamazeri *et al.*, 2012; Vorlaphim *et al*., 2011). Our previous finding showed that the used polyherbal supplementation and *Melastoma* extract on goats could maintain the physiological responses in humid conditions (high THI) as indicated by the amount of Heat Tolerance Coefficient (HTC).

The experiment aimed to evaluate the use of herbs (*Andrographis paniculata* and *Melastoma malabathricum*) on the physiological responses, THI, and HTC of Bali cattle kept under an oil-palm-integration system.

Materials and methods

Animals

Twenty-eight (28) Bali cattle (male, BCS= 6; 2 years old, average live weight 221 ± 9.8 kg) were allocated for 4 treatments with 7 cattle each. All animals were kept in an animal house in the middle of an oil palm plantation (plant age 9 years). The 4 treatments were: T-0: no herbs/control; T1= *Andrographis paniculata* extract (200 mg/kg live weight), T-2= *Melastoma malabathricum* extract (200 mg/kg live weight), and T-3: *Andrographis paniculata* extract (100 mg/kg live weight) and *Melastoma malabathricum* extract (100 mg/kg live weight). All animals were fed *ad libitum* with a mixture of 40% grass + 60% fermented palm oil sludge. All animals were also given free access to clean drinking water.

Physiological and environment measurement

The respiration rate of goats was measured which based on the flank movement, rectal temperature (^oC) was measured using a rectal thermometer by inserting the thermometer about 1 inch into the rectum until stable, and pulse rate (x/minute) was obtained by placing the index and middle fingers on the femoral artery. Skin temperature was measured using an infrared thermometer. All physiological measurements were conducted in the morning (8 AM), noon

(12 AM), and afternoon (4 PM) for 10 days. All animals were experienced 7 days adaptation period before real measurement. While conducting physiological measurements, environment parameters (air temperature and humidity) were also measured.

THI (Thermal Humidity Index) and HTC (Heat Tolerance Coefficient)

The cattle thermal comfort zone, represented by Thermal Humidity Index/ THI were measured using equation THI= (1,8 x T + 32) – [(0.55-0.0055 x RH) x (1.8 x T - 26)] (NRC, 1971). While HTC (Heat Thermo Coefficient) was measured according to two methods, as follows:

1. HTC-Benezra = (RT/38,33) + (RR/22); where RT: Rectal Temperature (Benezra, 1954),
2. HTC-Rhoad= 100 -10(RT-38,33); where RT: Rectal Temperature (Rhoad, 1944)

Analysis of variance (ANOVA) was used to measure the effectiveness of treatments using SPSS Software version 24. When the means had significant differences in the level $p<0.05$, the data were further analyzed using DMRT (Duncan's Multiple Range Test).

Results

Temperature and humidity value

The temperature, humidity, and THI were slightly changed during the day (morning, noon, and afternoon) measured throughout the experiment period. Air temperature ranged from 24-26.71°C with humidity of 88.43-89.71%. The Thermal Humidity Index (THI) ranged from 74.19 to 78.82 (Table 1).

Table 1. Temperature (°C), humidity value (%), and Thermal Humidity Index (THI)

	Morning	**Noon**	**Afternoon**
Temperature (°C)	24.00	26.57	26.71
Humidity (%)	89.14	88.43	89.71
THI	74.19	78.46	78.82

THI: Thermal Humidity Index.

Physiological measurements

The respiration rate measured during morning time was not significant ($p>0.05$) among all 4 treatments, whereas T-0 was statistically higher ($p<0.05$) than those of T-1, T-2, and T-3 respectively. The pulse rate of T-0 both measured during morning and afternoon time was lower ($p<0.05$) than those of T-1, T-2, and T-3. The result indicated when the pulse rate was measured at noon, T-0 was higher ($p<0.05$) than their T-1 and T2 counterpart, but it was similar to T-3 (Table 2).

Table 2. Means ± std value of physiological measurement for all treatments

Parameters	Treatment	Morning	Noon	Afternoon
Respiration rate	T-0	22.6 ± 2.62	26.3 ± 3.06[a]	23.9 ± 3.60[a]
(x/minute)	T-1	22.6 ± 2.24	24.8 ± 2.51[b]	22.5 ± 2.99[b]
	T-2	22.7 ± 2.83	24.9 ± 4.16[b]	22.2 ± 2.60[b]
	T-3	22.5 ± 2.79	24.3 ± 3.27[b]	23.1 ± 3.15[b]
	p-value	ns	0.05	0.05
Pulse rate (x/minute)	T-0	56.9 ± 8.45[a]	66.6 ± 7.42[a]	63.7 ± 7.26[a]
	T-1	61.4 ± 7.04[b]	63.8 ± 5.65[b]	60.2 ± 5.04[b]
	T-2	60.2 ± 6.61[b]	63.8 ± 5.83[b]	60.0 ± 5.12[b]
	T-3	62.1 ± 5.77[b]	64.2 ± 4.99[ab]	62.7 ± 5.11[a]
	p-value	0.05	0.05	0.05
Skin temperature (^oC)	T-0	36.4 ± 0.20[a]	36.4 ± 0.48[a]	36.2 ± 0.44[a]
	T-1	36.4 ± 0.17[a]	36.6 ± 0.15[b]	36.6 ± 0.34[b]
	T-2	36.4 ± 0.19[a]	36.6 ± 0.26[b]	36.5 ± 0.31[b]
	T-3	36.4 ± 0.17[a]	36.6 ± 0.20[b]	36.5 ± 0.25[b]
	p-value	ns	0.05	0.05
Rectal temperature	T-0	37.0 ± 0.30[a]	37.8 ± 0.27[a]	37.1 ± 0.52[a]
(^oC)	T-1	37.5 ± 0.29[b]	38.0 ± 0.29[b]	37.8 ± 0.90[b]
	T-2	37.6 ± 0.29[b]	38.1 ± 0.18[c]	37.8 ± 0.91[b]
	T-3	37.6 ± 0.29[b]	38.1 ± 0.22[c]	38.0 ± 0.26[b]
	p-value	0.05	0.05	0.05

Different superscript letters in the same column and the same parameters indicated a difference statistically. T-0: no herbs/control; T-1= *Andrographis paniculata* extracts (200 mg/kg live weight), T-2= *Melastoma malabathricum* extracts (200 mg/kg live weight), and T-3: *Andrographis paniculata* extracts (100 mg/kg live weight) and *Melastoma malabathricum* extracts (100 mg/kg live weight).

Skin temperature trend was somewhat similar to respiration rate response for all treatments, in which all treatments were not different (p>0.05) when it measured in the morning, while T-0 had lower ST (p<0.05) compared to T-1, T-2, and T-3 values. All rectal temperatures of T-0 measured in the morning, noon, and afternoon were significantly lower than those of T-1, T-2, and T-3 (Table 3).

Table 3. Average and its STD of HTC-1 and HTC-Rhoad value among all treatments

Treatment	HTC-Benezra Mean ± STD	HTC-Rhoad Mean ± STD
T-0	1.998 ± 0.0884[a]	92.2 ± 2.72[a]
T-1	2.000 ± 0.0708[a]	95.4 ± 2.90[b]
T-2	2.002 ± 0.0862[a]	95.0 ± 3.07[b]
T-3	2.028 ± 0.0849[a]	94.7 ± 3.11[b]

Different superscript letters in the same column indicated a difference statistically. T-0: no herbs/control; T-1= *Andrographis paniculata* extracts (200 mg/kg live weight), T-2= *Melastoma malabathricum* extracts (200 mg/kg live weight), and T-3: *Andrographis paniculata* extracts (100 mg/kg live weight) and *Melastoma malabathricum* extracts (100 mg/kg live weight).

The ideal HTC value of 2 was closely by T-0 and T-3 measured in the afternoon is shown in Figure 1.

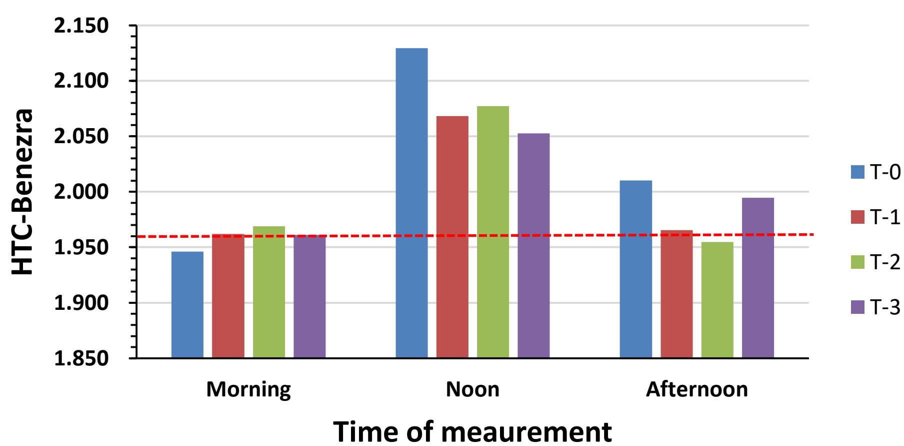

Figure 1. HTC score for all treatments measured during the morning, noon, and afternoon. T-0: no herbs/control; T-1= *Andrographis paniculata* extracts (200 mg/kg live weight), T-2= *Melastoma malabathricum* extracts (200 mg/kg

live weight), and T-3: *Andrographis paniculata* extracts (100 mg/kg live weight) and *Melastoma malabathricum* extracts (100 mg/kg live weight).

HTC measurements

HTC measurement of two methods showed different results, in which the HTC-Benezra value were all not different ($p>0.05$) among all treatments. Whereas the HTC-Rhoad value of T-0 was lower ($p<0.05$) than those of T-1, T-2, and T-3 respectively.

Discussion

The THI of this experiment ranging from 74.19 to 78.82 indicated that Bali cattle were either under normal to alert conditions (Hahn *et al*., 2009). Different authors provided the different THI threshold values at which heat stress begins, ranging from 68 to 74 units (Herbut *et al*., 2018) or 74 to 84 (Hahn *et al*., 2009). Hahn *et al*. (2009) classified levels of heat stress in the following THI ranges: < 74 as normal, 75 to 78 as alert, 79 to 83 as danger, and > 84 as an emergency. However, these two authors referred to high-yielding dairy and temperate cows, not for Bali cattle. However, although they were somewhat under heat stress, all physiological parameters were in the normal and healthy range. The normal range of physiological parameters were pulse rate: 40-70 (Kubkomawa *et al.*, 2015), respiration rate: 26 and 50 breaths per minute (Eley, 2021) skin temperature: 36.66-37,89 ℃ (Nuriyasa *et al*., 2015); and rectal temperature: 38.5 ℃ (Eley, 2021), 39,0 – 39,7^{o}C (Nuriyasa *et al*., 2015).

The HTC-Benezra value for all treatments, on average, indicated that all animals were under their comfort zone. However, when data were presented at a different time of measurement (morning, noon, and afternoon), it showed that most animals experienced heat stress, especially at noon (HTC>2). These conditions were similar for all treatments. The HTC-Benezra value had shown that all cattle under this experiment were all in normal condition. The HTC-Rhoad value, however, had shown a different result. The HTC-Rhoad of T-0 had significantly lower ($p<0.05$) than their counterparts treatments (T-1, T-2, and T-3), indicating that T-0 had significantly less adaptability in countering the humid environment compared with T-1, T-2, and T-3. It is clearly showed that the addition of herbs in T-1, T-2, and T3 could improve the heat and humidity tolerance for Bali cattle. The result was similar to the addition of feed supplementation (concentrate) on crossbred cattle in Indonesia (Nursita *et al.*, 2015), in which the HTC was optimized.

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