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Correlation of infrared tympanic and rectal body temperatures in lactating Bulgarian Murrah buffaloes in the Philippines

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Abstract

Determining body temperatures in a convenient, fast and less stressful method, like the infrared thermometry, is advantageous in the animal health industry. In this study, infrared thermometry and traditional methods (using mercury-in-glass and digital thermometers) in assessing tympanic and rectal (core body) temperatures in lactating Bulgarian Murrah were evaluated, respectively. A total of 9 animals in the Philippine Carabao Center at the Visayas State University, Baybay City, Leyte, Philippines were monitored twice daily (morning and afternoon) for 14 consecutive days within the warm season (May 2014). The procedure was repeated during the cool season (November 2014). Mean body temperatures were found higher in the warm season, and during afternoons. Ambient temperature readings using beechwood and infrared thermometers revealed no significant difference, and were found not strongly correlated with body temperature measures. Although infrared tympanic temperatures (ITT) were found significantly higher than rectal temperatures, the temperature readings were found moderately correlated. This indicates the reliability of the ITT as an alternative in assessing body temperatures. However, the study proposes that ITT and rectal temperature should not be interpreted as the same, and that normal range for ITT under different field conditions should be established. While infrared thermometry has been explored in several other livestock animals, this study is the first report in Bulgarian Murrah buffaloes in the Philippines.

Keywords: infrared thermometry; tympanic temperature; body temperature; Bulgarian Murrah; Philippines

Introduction: Routine animal health assessment includes measuring the body temperature, which has long been considered as among the vital signs that is checked to evaluate physical condition and status. Body temperatures below or above the normal range may connote an abnormal health condition that can impact animal productivity. Obtaining the body temperature measure in a convenient and less stressful method is therefore important. Infrared thermometry, among the current technologies, has afforded fast and convenient techniques in obtaining body temperatures. This technology has been shown to be reliable in other species (Goodwin 1998, Boere et al, 2003, Yanmaz et al., 2015) and in children (Abdulkadir and Johnson, 2013), but reports in dairy buffalo, which is considered as the world's 2nd most important milk animal in South Asia (Javaid et al., 2009), have been limited. In this study, the application of infrared thermometry in assessing body temperature of lactating water buffaloes (by comparing tympanic and rectal thermometer readings) is explored.

Methodology:

Animals: A total of 9 healthy lactating Bulgarian Murrah buffaloes aged 3-12 years old in the Philippine Carabao Center at the Visayas State University, Baybay City, Leyte, Philippines were used. The animals were handled in accordance with the Animal Welfare Act of the Philippines and the existing animal care and use guidelines of the Philippine Animal Laboratory Association.

Temperature Measurements: Temperature measurements (ambient, tympanic and rectal) were obtained 2x a day (between 4:00-6:00 AM and 2:00-4:00 PM) using beechwood, infrared (IR) (ThermoPet^{TM}, Sanomedics), digital (DT) and mercury-in-glass (MT) thermometers for 14 consecutive days within the warm (May 2014) and cool (November 2014) seasons in the Philippines. Infrared tympanic temperature (ITT) was measured 3x in one ear (either right or left) using manufacturer's recommendation, and averaged to obtain a mean ITT reading. For the rectal temperatures, readings were obtained only once in each session using mercury-in-glass thermometer (with 5-10 minutes contact) and digital thermometer (according to manufacturer's instructions). Animals were restrained to limit movements during temperature measurements. Before each rectal insertion, thermometers were reset and disinfected.

Data Encoding and Statistical Analyses: Data was written in a tally sheet, and subsequently encoded to a Microsoft Excel Office program (Microsoft Corporation, Redmond, USA), in which all statistical treatments were also performed. Descriptive statistics was used. Ambient temperature measurements were compared using F test (for variance determination) and t test. Correlation between temperature readings was performed using Pearson R and simple linear regression. Significant difference between body temperature measures was evaluated using F test and t test ($P < 0.05$).

Results and Discussion: The ambient temperature ranged from 22.0-38°C (22.0-30.0°C in the morning and 27.5-38.0°C in the afternoon) and 24.0-35.2°C (24.0-29.9°C in the morning and 23.5-35.2°C in the afternoon) during the warm and cool seasons, respectively. Statistical analyses revealed that the measurements using the 2 different devices (beechwood and infrared thermometers) did not vary significantly (P value > 0.05), suggesting that the infrared thermometer is a reliable instrument in measuring ambient temperatures. Infrared thermometry has been used to measure environmental temperatures with an average error of 0.1 to 0.3 °C (Fuchs and Tanner, 1966).

Ambient temperatures, regardless of the methods used, were found to be not significantly correlated with body temperature readings during warm season. However, weak to moderate correlations were found during cool season when morning and afternoon readings were analyzed all together (Table 1). These results did not corroborate with the findings in a human study where tympanic membrane temperature significantly changed during warm, but not to cool exposure (Zehner and Terndrup, 1991). However, it is also possible that the animals were already well adapted to the weather, or that the ambient temperature variations between seasons in the area were not high enough to cause a significant physiological response.

Mean body temperatures during warm seasons were 37.4 °C using MT, 37.7 °C using DT and 39.9 °C using IRT in the morning, and 37.6 °C using MT, 37.9 °C using DT and 40.0 °C using IRT in the afternoon. On the other hand, mean body temperatures during cool seasons were 37.3 °C using MT, 37.0 °C using DT and 39.0 °C using IRT in the morning, and 37.9 °C using MT, 37.6 °C using DT and 40.0 °C using IRT in the afternoon. Although only weak to moderate correlation between ambient temperature and body temperature readings was found, results of mean body temperatures appeared to be elevated when the ambient temperature is higher (Fig. 1). Physiologically, animals may have higher body temperatures in warmer environments. Elevated body temperatures in production animals have been shown to affect productivity (Finch, 1986; Igono et al., 1992; West, 2003). It is therefore ideal that healthy lactating animals have lower body temperatures by providing cooler holding areas or shades, which may improve reproduction and lactation (Roman-Ponce et al., 1977; Blackshaw et al., 1994). On the other hand, ITT results also revealed higher temperature readings, which is somehow different from usual ITT observations in other animals wherein values are usually lower than the rectal readings (Goodwin 1998, Boere et al, 2003). As buffaloes are animals that are capable of homeostasis, body temperatures can be well regulated by its system despite varying ambient temperatures. All the observed animals were apparently healthy during each assessment, and hence, may indicate that the higher values of the tympanic than the rectal temperature may be normal in lactating buffaloes.

Despite higher ITT values, the readings were still found correlated with the obtained rectal temperatures during warm (RT using MT vs ITT: pearson R=0.61, linear regression P value <0.05, R square 0.38; RT using DT vs ITT: pearson R 0.67, linear regression P value <0.05, R square 0.45) and cool (RT using MT vs ITT: pearson R=0.70, linear regression P value <0.05, R square 0.49; RT using DT vs ITT: pearson R 0.73, linear regression P value <0.05, R square 0.54) seasons. This is similar to the results of Yaron et al. (1995) where correlation between the temperature readings from the rectal thermometer and infrared tympanic thermometer was excellent, but significant differences were also found in the temperature readings.

The disagreement in the results does not indicate unreliability, but rather presented new findings that infrared tympanic temperature readings in lactating water buffaloes may be normally higher than the rectal temperature. Therefore, apparently elevated tympanic temperature readings compared to the rectal temperature must not be construed as fever. The average differences between mean temperature readings of infrared tympanic temperature and rectal temperature ranged from 1.84 to 2.56 °C. This difference is slightly higher than the findings of Yaron et al. (1995) where the average difference was found to be 0.1 +/- 0.7 °C, although > 1°C difference was also reported in some of the patients (Yaron et al., 1995). Sund-Levander et al. (2002) also showed relatively higher baseline tympanic readings than rectal readings in adult humans. However, further studies are needed to investigate the elevated ITT values in healthy lactating Bulgarian Murrah buffaloes.

Since the rectal method may present limitations on its accuracy due to variation on the portion of the rectum measured, variations of local blood flow and the presence of feces (Robinson et al., 1998), infrared thermometry appears to be a very good alternative of obtaining valid temperature measures (Buono et al., 2007). Its application in measuring the tympanic membrane temperature is a recent veterinary procedure with apparent several advantages, including accuracy, convenience and economics (Bergen and Kennedy, 2000; Stavem et al., 2000). As ITT can produce results that can vary significantly from the gold standard rectal thermometry, it can be proposed that ITT and rectal temperature should not be interpreted as the same. Normal values for ITT should be established. However, the probable difference of ITT readings from RT does not down play its relevance and high potential for use in the veterinary field.

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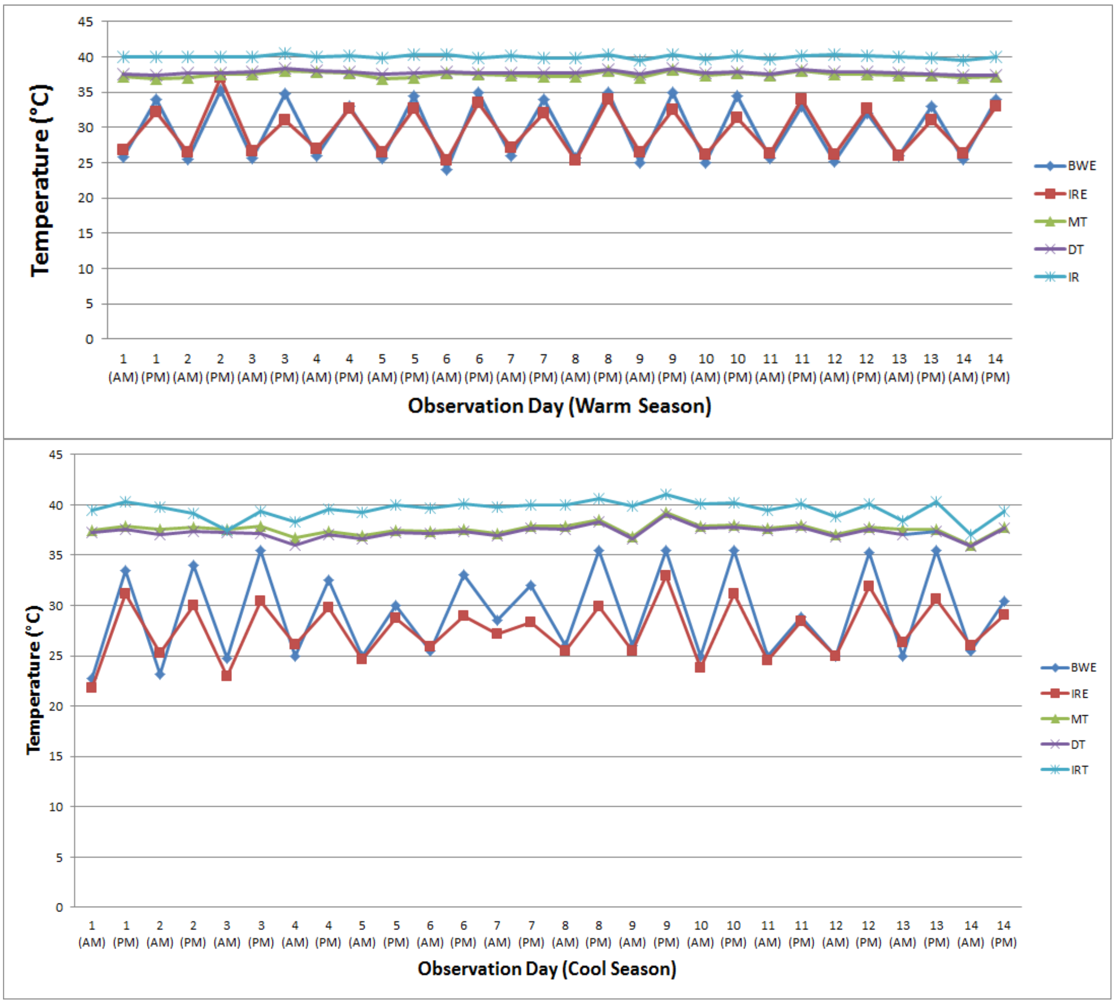
Figure 1. Ambient temperature and body temperatures of Bulgarian Murrah Buffaloes (n=9) monitored for 14 days during warm and cool seasons in the Philippines



(Legend: DT=Body temperature using digital thermometer, MT=Body temperature using mercury-in-glass thermometer, IRT=Tympanic temperature using infrared thermometer, BWE=Ambient temperature using beechwood thermometer, IRE= Ambient temperature using infrared thermometer)

Table 1. Correlation of ambient temperature with body temperatures of lactating Bulgarian Murrah buffaloes (n=9) using different methods:

Season	**Parameters**	**Morning**			**Afternoon**			**Morning and Afternoon**		
		Pearson R	**Linear Regression**		**Pearson R**	**Linear Regression**		**Pearson R**	**Linear Regression**	
			P value	**R square**		**P value**	**R square**		**P value**	**R square**
Warm	BWE and MT	-0.12	0.679	0.015	0.16	0.577	0.03	0.32	0.097	0.10
	BWE and DT	-0.02	0.949	0.000	0.22	0.452	0.05	0.35	0.072	0.12
	BWE and IR	-0.13	0.650	0.018	0.11	0.698	0.01	0.33	0.09	0.11
	IRE and MT	0.01	0.977	7.14E-05	0.15	0.601	0.02	0.33	0.09	0.11
	IRE and DT	0.07	0.814	0.005	0.00	0.995	3.6E-06	0.31	0.11	0.10
	IRE and IR	0.00	0.993	6.08E-06	-0.04	0.902	0.00	0.30	0.09	0.11
Cool	BWE and MT	-0.23	0.422	0.055	0.37	0.194	0.14	0.56	0.002	0.32
	BWE and DT	-0.12	0.689	0.014	0.26	0.377	0.07	0.56	0.002	0.31
	BWE and IR	0.10	0.722	0.011	0.33	0.245	0.11	0.54	0.003	0.30
	IRE and MT	-0.39	0.173	0.149	0.53	0.050	0.28	0.52	0.005	0.27
	IRE and DT	-0.43	0.121	0.189	0.47	0.091	0.22	0.50	0.006	0.27
	IRE and IR	-0.01	0.969	0.000	0.47	0.089	0.22	0.52	0.005	0.27

(Legend: BWE=Ambient temperature using beechwood thermometer, IRE=Ambient temperature using infrared thermometer, MT=Body temperature using mercury-in-glass thermometer, DT=Body temperature using digital thermometer, IRT=Body temperature using infrared thermometer)