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ORIGINAL RESEARCH ARTICLE

Physiological response of gestating and non-gestating Jersey cows to a humid tropical environment

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ABSTRACT

In order to determine the physiological response of Jersey cows to the tropical environment of Ibadan, four Jersey cows aged 24.0±2.0 months at gestating and non-gestating phases were studied for their rectal temperature, pulse, heart and respiratory rates. Blood samples were also taken at both phases for haematological and serum biochemical analysis. Parameters were taken twice daily before and after grazing. Ambient temperature and relative humidity were recorded for 5 months. There were no significant differences (P>0.05) in pulse rate, heart rate and rectal temperature of Jersey cows during gestation and non-gestating period. Pulse rate, heart rate and rectal temperature for gestating periods were 58.4 beats/min, 57.24 beats/min and 38.4 ºC respectively while that of non gestating were 57.3 beats/min, 57.94 beats/min and 38.3 ºC respectively. However, respiratory rate was significantly (P<0.05) higher during gestation (52.2 beats/min) than non-gestating period (48.2 beats/min). Packed cell volume (PCV), haemoglobin concentration (Hb) and red blood cell count (RBC) did not vary significantly (P > 0.05) between the two periods although mean corpuscular volume (MCV) and white blood cells (WBC) were significantly lowered (P<0.05) during gestation compared to the non-gestating period. Values for MCV were 45.49 and 60.30 fl and WBC, 5.99 and 9.20 x 10^3/µl during gestation and non-gestating periods respectively. There were no significant (P > 0.05) differences in total protein and albumin concentration in the serum while globulin, albumin/globulin ratio, alanine amino transferase (ALT), aspartate amino transferase (AST), urea and glucose levels varied significantly. Total protein values were 6.38 and 5.23 g/dl; urea, 16.75 and 11.88 mg/dl; glucose, 60.95 and 45.40 mg/dl for gestating and non-gestating periods respectively. The results showed that the health of Jersey cows at Ibadan was not compromised by the tropical environment or physiological state of the animal.

Keywords: Jersey cows, Gestation, thermoregulation, haematology, serum biochemistry.

INTRODUCTION

The development of the Nigerian dairy industry is limited by the low genetic potential of indigenous cattle for milk production. While the indigenous cattle breeds yield as little as 295 - 650 kg per lactation, the exotic dairy breeds may yield up to 6800 – 11000 kg per lactation (Ngere, 1985; USDA, 2009). Local milk production can improve with introduction of temperate dairy breeds or upgrading of breeds through crossbreeding programmes (Tadesse and Dessie, 2003; Fayeye *et al*., 2013). However, before any crossbreeding endeavour can be successful, the exotic breeds must be well adapted to the environment. Among the established dairy breeds, the Jersey cow is considered to be more adaptable to tropical conditions due to its small size, good grazing ability, economy of milk production and higher heat tolerance compared to other temperate breeds (Sattar *et al*., 2004; Wikipedia, 2014). Moreover, information on the adaptability of Jersey cow to a variety of tropical environment, especially the humid tropics is difficult to find. In addition Jersey cow is also known for the high fat and high protein content of its milk. This further makes it suitable for the cottage cheese and yoghurt production systems in Nigeria. In recent times, a few farms have imported the Jersey breed into Nigeria with a view to increasing local milk production (Johnson, 2014). So far, this introductions has been partly successful while others have failed. Factors responsible for failure of exotic dairy cattle in Nigeria include, poor management, high incidence of disease, inadequate understanding of basic physiological processes controlling milk production and the adverse effect of the hot tropical weather on these processes. In order to achieve greater success in handling the dairy cattle in tropical areas, there is need to study the physiological response of the exotic dairy cattle to the hot environment and use this to formulate routine management programmes for the animal. This study therefore aimed to document some

basic physiological responses of gestating and non-gestating Jersey cows to the tropical environment of Ibadan.

MATERIALS AND METHODS

Experimental site and management of animals

The study was carried out at the Dairy Unit of the Teaching and Research Farm, University of Ibadan, Nigeria. A total of 4 Jersey cows (2 years old) with weights ranging from 300- 315kg were procured from Shongai farm in Kwara state and used for the study that lasted 5 months. The animals were penned individually inside a dwarf-walled house and provided same feed throughout the experiment.

Data collection

Physiological parameters were determined twice daily throughout the experimental period and average daily record was estimated. Respiratory rate was determined by counting uninterrupted movement of the flank for 60 seconds using a stop watch. Pulse rate was also determined by counting uninterrupted rhythmic movement of the jugular vein for 60 seconds using a stop watch. The heart rate was determined with the aid of a stethoscope placed on the heart region with the beats counted for a period of 60 seconds and recorded. Rectal temperature was done by manual insertion of a digital clinical thermometer in each cow's rectum till a constant reading was obtained. Ambient temperature and relative humidity were measured with the aid of thermo-hygrometer which was suspended in the cows' pen. The temperature-humidity index was calculated from the result of the ambient temperature and relative humidity as described by McDowell *et al*. (1976) using the stated formula.

THI = (Dry bulb temperature °C) + (0.36 dew point temperature °C) + 41.2

Blood sample collection and analysis

Blood samples were collected through the jugular vein aseptically at the two different physiological stages (pre-gestation and gestation periods). Collection of blood was done early in the morning before grazing. Approximately 2mL blood was collected in heparinised vacuutainers for haematological studies while another 4 mL was collected in sterile vacuutainers.

The samples in sterile vacuutainers were allowed to clot at room temperature and centrifuged at 3000rpm for 5 minutes for biochemical studies. Blood samples with anticoagulant were used for haematological analysis viz packed cell volume, haemoglobin concentration, red blood cells, mean cell volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, platelets, white blood cells, lymphocytes, neutrophils, monocytes and eosinophils as described by Feldman *et al*. (2000). Biuret method of serum total protein determination was employed as described by Kohn and Allen (1995). Albumin was determined using bromcresol green method as described by Peter *et al.* (1982). The globulin concentration was obtained by subtracting albumin from the total protein while the albumin/globulin ratio was obtained by dividing the albumin value by the calculated globulin value. ALT and AST activity were determined using spectrophotometric method with their respective kits.

Data analysis

All data were subjected to Studentise test (t-test) to compare the means using model of SAS (1999).

RESULTS

The thermoregulatory response of Jersey cows at pre-gestation and gestation physiological states is shown in Table 1. Respiratory rate at the gestating phase was significantly ($P<0.05$) higher than at the pre-gestating phase. Pulse rate and rectal temperature were not significantly ($P>0.05$) different at the gestating phase compared with the pre-gestation. Heart rate at the pre-gestation period was apparently higher than at the gestation. The haematological indices of Jersey cows at pre-gestation and gestation phases are shown in Table 2. The Mean Corpuscular Volume at the pre-gestating phase was significantly ($P<0.05$) higher than at the gestating phase.

Table 1: Thermoregulatory response of Jersey cows before and during gestation (mean+SE)

Thermoregulatory parameters	Jersey Cows' Physiological state (THI=83.2)	
	Dry/before gestation	During gestation
Pulse rate(beats/min)	57.27±0.56	58.44±0.78
Heart rate(beats/min)	57.94±0.46	57.24±0.43
Respiratory rate(beats/min)	48.25±1.76^{b}	52.20±1.12^{a}
Rectal temperature(°C)	38.30±0.19	38.44±0.14

ab: Means on same row with different superscripts are significantly ($P< 0.05$) different
Beats/min- beats per minute. SE- Standard error

Table 2: Haematological parameters of Jersey cows at pre-gestation and gestation phases

Parameters	Pre-gestation phase	Gestation phase
Packed cell volume (%)	30.00±0.41	27.75±1.7
Haemoglobin (g/dl)	9.50±0. 37	9.95±0.64
Red blood cells ($x10^6/\mu l$)	4.76±0.19	6.10±0.20
MCV (fl)	60.30±2.36[a]	45.49±2.65[b]
MCH (pg)	19.96±1.26	16.31±0.25
MCHC (g/dl)	31.67±2.06	35.85±1.67
Platelets ($x10^3/\mu l$)	85.50±10.36	86.75±1.25
White blood cells ($x10^3/\mu l$)	9.20±1.07[a]	5.99±0.15[b]
Lymphocytes (%)	70.75±1.11	71.50±1.32
Neutrophils (%)	24.00±1.87	23.75±1.31
Monocytes (%)	1.75±0.25	2.25±0.25
Eosinophils (%)	3.50±0 .87	2.75±0.75

ab: Means on same row with different superscripts are significantly (P<0.05) different
fl- Femtolitre pg- Picogram MCV-Mean corpuscular volume MCH-Mean corpuscular haemoglobin
MCHC-Mean corpuscular haemoglobin concentration

There was no significant difference between the pre-gestating and gestating phases for the cows' haemoglobin concentration, RBC, MCH and mean corpuscular haemoglobin concentration (MCHC).

White blood cell count was significantly (P<0.05) higher at the pre-gestation phase than at the gestation. Platelets, lymphocytes, neutrophils, monocytes and eosinophils at both physiological states were not significantly (P>0.05) different. Serum parameters examined at the physiological phases of the Jersey cows are presented in Table 3. Globulin was significantly (P<0.05) higher at the gestation than the pre-gestation period while the albumin/globulin ratio was significantly (P<0.05) higher at the pre-gestation phase than that of the gestation. The AST, urea and glucose were significantly (P<0.05) higher in gestating cows compared to the non-gestating cows while ALT and cholesterol were significantly (P<0.05) higher in the non-gestating Jersey cows compared to the pregnant ones.

DISCUSSION

Elevated respiratory rates are part of the repertoire of responses used by cattle to increase heat loss in situations of heat load (Hales, 1976). An increase in respiratory rate is therefore an important thermoregulatory response to heat stress and it aids in heat dissipation via evaporative cooling (Blackshaw, 1994). The increase in respiratory rate at the gestation phase may be associated with metabolic heat production. This is supported by previous research findings (Metcalfe *et al*., 1988, Freetly *et al*., 1997). The increase in respiratory rate during pregnancy could also be related to the fact that pregnancy leads to limited movement of the diaphragm which is compensated by increase in respiratory frequency. Since the heart rate at the pre-gestation phase was about the same with that at the gestation phase, it appears that additive effects of environmental temperature and gestation could have been responsible for the higher pulse rate and rectal temperature respectively at the gestation phase. Kumar and Pachauri (2000) reported higher MCV in non-pregnant dry cows compared to pregnant cows. This observation was also made in the present study. The higher WBC count in pre-gestating cows in this study is in contrast with the reports of Sattar and Mirzar (2009); Ovais *et al*., (2013). They found out that there was no significant difference in the WBC count of pre-gestating and gestating cows. It is thought that the delicate physiological state of the gravid cows brought about a slight reduction in this parameter which was however still within the normal physiological range 4.00-12.00 **(**$x10^3/\mu l$**)** as reported by Latimer *et al*. (2003). Since maternal tissues are involved in energy production for reproductive processes during pregnancy, it is not surprising that serum glucose was significantly higher at the gestation phase. This however is in contrast with the report of Ottol *et al.* (2000) who found glucose concentration in Angoni cows to be higher at the non-gestation phase. Significant reduction in cholesterol at the gravid phase has been noted in Friesian cows (Bekeova *et al*., 1987) and goats (Krajnieakova *et al*., 2003). This is probably related to the role of the cholesterol in ovary steroidogenesis so that the total cholesterol concentrations are under control of the complex mechanism. The elevated urea value at the gravid phase is consistent with the report of El-Sherif and Assad

(2001) who noted a rise in the urea concentration from week 10 of gestation till parturition.

Table 3: Serum biochemical variables of Jersey cows at pre-gestation and gestation phases

Parameters	Pre-gestation phase	Gestation phase
Total protein (g/dL)	5.23±0.52	6.38±0.79
Albumin (g/dL)	3.50±0.15	2.02±0.14
Globulin (g/dL)	1.73±0.37[b]	4.36±0.65[a]
Alb/Glb ratio	2.02±0.40[a]	0.46±0.21[b]
AST (I.U/L)	35.34±9.85[b]	71.62±2.60[a]
ALT (I.U/L)	8.72±1.31[a]	4.17±1.16[b]
Urea (mg/dL)	11.88±3.70[b]	16.75±0.68[a]
Creatinine (mg/dL)	1.04±0.86	1.29±0.11
Cholesterol (g/dL)	93.45±12.34[a]	47.74±1.73[b]
Glucose (mg/dL)	45.40±5.27[b]	60.95±0.83[a]

ab: Means on same row with different superscripts are significantly (P<0.05) different
Alb/Glb – Albumin/Globulin

These high values could be attributed to increase in cortisol level which affected protein catabolism (Silanikove, 2000). The increased intercellular value of AST at the gestating phase could be as a result of erythropoietic activity since young blood cells are characterized by increase in activities of enzymes. No known cause was found for the ALT reduction at the gestating phase compared to the non-gravid state. High degree of globulin transfer to the mammary glands may be responsible for the higher serum globulin at the gestation phase compared to the pre-gestation. This is in conformity with the report of Pathak *et al*. (1986); however, increased protein breakdown due to gluconeogenesis is another possible cause (Lone *et al*., 2003). A high protein diet at the gestation phase may be responsible for the higher urea value compared with the pre-gestation period.

CONCLUSION

The result showed Jersey cows were stressed during gestation than at non-gestation period. The rate of heat dissipation in the animals was high enough to sustain homeostasis and better adaptation in Ibadan tropical environment. As a result of greater stress encountered by Jersey cows during pregnancy due to foetal growth combined with environmental factors, it is suggested that their special needs in terms of their nutritional, environmental and health requirements should be taken into consideration and adequate care provided.

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