



# Comparative Evaluation of Electrocardiographic Parameters of Red Sokoto Goat at Different Reproductive Stages

BASHIR SAIDU<sup>1\*</sup>, F.B.O MOJIMINIYI<sup>1</sup>, C.B.I. ALAWA<sup>2</sup>, CHINEDU ONWUCHEKWA<sup>1</sup>

<sup>1</sup>Usmanu Danfodiyo University, Sokoto, Nigeria; <sup>2</sup>University of Abuja Nigeria.

**Abstract** | Pregnancy and parturition are normal physiological conditions that bring about changes in some physiologic parameters, hence the need to establish the electrocardiographic (ECG) parameters and possible changes at different reproductive stages of red Sokoto goat. The research was carried out using twenty red Sokoto goats with a mean age of  $2 \pm 0.17$  years. The does were assessed for pregnancy using ultrasonography. Oestrous synchronisation was conducted using controlled internally drug release CIDR<sup>(R)</sup> and natural mating was allowed. Bright (B) mode real time ultrasound scanning was conducted using 2.5 MHz sector transcutaneous probe of Vet image 201 ultrasonographic machine of Recorders and Medicare Systems (RMS) (P) LTD to ascertain pregnancy. A single channel electrocardiograph (EDAN VE 100) with a 25 mm/s paper speed and 10mm/mV was used to take the ECG in the standard limb leads (I,II and III) and the augmented limb leads (aVR, aVL and aVF). Comparison of different waves in all the Leads between the periods revealed statistically significant differences in P-wave Amplitude in Leads II, III, aVR, and aVF with postpartum animals having highest records in Leads III, aVR, and aVF, while highest in pregnant animals in Lead II. The P wave duration also differ significantly in the augmented limb leads (aVR, aVL and aVF) with all the records highest in postpartum. There was statistically significant difference in T wave duration in Leads II, III, aVR, aVL and aVF, with highest record in postpartum period in Leads II, III and aVR, while highest records in aVL and aVF were recorded during pregnancy. T wave Amplitude also differs significantly in Leads I, III, aVR, and aVF with highest records in postpartum period in all the significant leads. The QRS interval show statistically significant difference in Leads I, III and aVF with highest record in postpartum period in Leads I and aVF, while highest record during pregnancy was obtained in lead III. Reproductive stages have variable effect on electrocardiographic parameters of the Red Sokoto goat.

**Keywords** | Electrocardiogram, Red Sokoto goat, Pregnant, Postpartum, Parameters

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**\*Correspondence** | Bashir Saidu, Usmanu Danfodiyo University, Sokoto, Nigeria; **Email:** dr.bashvet1@gmail.com

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## INTRODUCTION

The circulatory efficiency is critical for effective reproductive processes as it transports hormones and nutrients to coordinate and improve the various processes properly. This could not be achieved without active cardiac function. Understanding the functional architecture of the cardia is a key to successful breeding program as it reveals the functional ability of the heart to pump adequate blood volume to support pregnancy and sustain lactation. The electrocardiogram (ECG) is a graphical record of the direction and magnitude of the electrical activity generated

by the depolarization and repolarization of the heart that provides relevant information in the diagnosis of conduction abnormalities (Luthra, 2012). The northern region of Nigeria plays an important role in goat production in the African continent and the world in general (Njidda et al., 2013). The Red Sokoto goat is the predominant and most famous breed of goat found mainly in Sudan and Sahel savanna zone or the Sokoto province, North-western zone of Nigeria (Obua et al., 2012). This breed plays a vital role in the economic life of many families (Abdalla et al., 2009). The qualities of the Red Sokoto goat that led to its popularity and demand worldwide include its adaptability, qual-

ity of meat and leather produced and the ability to thrive well under extensive semi-arid climatic conditions (Nsoso et al., 2004). Pregnancy and lactation are physiological processes associated with a series of changes in most systems, including the circulatory system. It is conceivable that these changes could trigger alterations in the electrical activities of the heart. However, this is yet to be investigated in this breed. The study is aimed at establishing the effect of pregnancy and lactation on ECG parameters of the Red Sokoto goat and to establish the period which has the most effect by correlation.

## MATERIALS AND METHOD

A total number of twenty goats with a mean age of  $2.0 \pm 0.17$  and a mean weight of  $35.0 \pm 0.54$  kg were used in this study. The goats were housed in the small ruminant pen of the Faculty of Veterinary Medicine, Usmanu Danfodiyo University, Sokoto, Nigeria. The animals were conditioned for two weeks and were fed on bean husk, wheat bran and hay. Both the feed and water were supplied *ad libitum*. The animals were assessed for pregnancy using ultrasonography as described by Streeter (2007).

### OESTROUS SYNCHRONISATION

Oestrous synchronisation was conducted using controlled internal drug release (CIDR<sup>(R)</sup>) as described by Islam (2011). The animal was restrained in a standing position with the tail raised and the perineum wiped with a paper towel. The CIDR<sup>(R)</sup> was lubricated using the KY jelly, a normal cellulose lubricant. Following the gaping of the lateral commissures of the vulva, the mounted applicator was inserted and the plunger of the applicator was pressed to release the CIDR<sup>(R)</sup> into the vagina. The CIDR<sup>(R)</sup> was removed after three weeks, and the animals were monitored for signs of oestrous. Natural mating was allowed and after four weeks the does were assessed for pregnancy using ultrasonography as described by Streeter (2007).

### ULTRASONOGRAPHY

The animals were fasted overnight by withdrawing feed as a preparation for ultrasonography. The inguinal region was shaved and cleaned with chlorhexidine. The animal was placed in the standing position, and the acoustic gel was applied to the shaved area. Bright (B) mode Real Time ultrasound scanning was conducted using 2.5 MHz sector transcutaneous probe of Vet image 201 ultrasonographic machine of Recorders and Medicare Systems (RMS) (P) LTD Panchkula Haryana India.

### ECG RECORDING

ECG recordings were taken with the animals in the standing position as described by Upadhyay and Sud (1997) with slight modification. A single channel electrocardiograph

(EDAN VE 100) Shekou, Nanshan Shenzhen, China with a 25 mm/s paper speed and 10 mm/mV was used for the recording. The animals were kept in the standing position on a rubber mat and the alligator clip electrodes were fixed to the skin above the elbow joint on the forearm and above the stifle joint on the hind limb. The site of clip attachment was shaved and alcohol was sprayed to enhance contact. The standard limb leads (I, II and III) and augmented limb leads (aVR, aVL and aVF) were recorded. The amplitudes and duration of P, R and T waves were measured manually in millivolts and seconds respectively. QRS complex interval was measured in seconds from the electrocardiographic record manually.

### DATA ANALYSIS

Data generated were analysed using SPSS for Windows Version 22. ANOVA was used to analyse the various waves at different stages of the pregnancy, while Tukey post hoc test was used to determine the mean difference between the periods, ( $P > 0.05$ ) was considered statistically significant.

## RESULTS

The result of the ECG parameters of the Red Sokoto goat is before, during and after pregnancy is presented in Table 1. The ECG parameters before pregnancy revealed the highest amplitude and duration of P-wave recorded in leads III and I respectively. The R and T durations were highest in Lead I while R and T amplitudes were highest in Lead III. The QRS duration was highest in aVR. Electrocardiographic parameters of the pregnant Red Sokoto goat revealed that P and R durations were highest in Lead I while P and R amplitudes were highest in Leads II and III respectively. The T duration was highest in aVF while the highest record of T amplitude was obtained in Leads I and II. The QRS duration was highest in aVL. The values of ECG parameters of the postpartum Red Sokoto goat revealed that P duration and amplitude were highest in aVF, while the value of R duration was the same in all the Leads. However, R amplitude was highest in Lead II. The T duration and amplitude were highest in Leads II and aVR, respectively. QRS duration was highest in Lead I. Comparison of the different ECG waves between the three periods, i.e. before, during and after pregnancy revealed a statistically significant difference in the P wave duration in aVR, aVL and aVF. The P duration was highest during the postpartum period and lowest during pregnancy in aVR, aVL and aVF. Statistically, a significant difference was established in P-wave amplitude in Leads II, III, aVR and aVF. The P-amplitude was higher during pregnancy but lowest before pregnancy in Lead II. Higher P-amplitude was recorded postpartum but lower during pregnancy in Leads III and aVR. The P amplitude was also higher during postpartum but lower before pregnancy in aVF. T duration differs significantly in Lead II, III, aVR, aVL and

**Table 1:** ECG wave parameters before, during and after pregnancy in Red Sokoto Goat

Lead	Period	P Duration	P Amplitude	R Duration	R Amplitude	T Duration	T Amplitude	QRS Duration
I	Before Pregnancy	0.037±0.002	0.065±0.003	0.088±0.014	0.268±0.011	0.042±0.002	0.061±0.003 <sup>a</sup>	0.070 ±0.003 <sup>a</sup>
	Pregnant	0.097±0.05	0.070±0.01	0.060±0.01	0.260±0.2	0.130±0.09	0.080±0.01 <sup>b</sup>	0.070 ±0.01 <sup>b</sup>
	Postpartum	0.037±0.00	0.070±0.01	0.040±0.00	0.450±0.06	0.060±0.01	0.140±0.05 <sup>ab</sup>	0.190 ±0.10 <sup>ab</sup>
II	Before Pregnancy	0.034±0.001	0.062±0.003 <sup>a</sup>	0.038±0.002	0.156±0.008	0.031±0.001 <sup>a</sup>	0.052±0.003	0.062 ±0.002
	Pregnant	0.037±0.00	0.093±0.01 <sup>ab</sup>	0.040±0.01	0.210±0.08	0.040±0.01 <sup>b</sup>	0.080±0.01	0.060 ±0.01
	Postpartum	0.033±0.00	0.065±0.02 <sup>b</sup>	0.040±0.00	0.470±0.09	0.070±0.01 <sup>ab</sup>	0.170±0.04	0.072 ±0.00
III	Before Pregnancy	0.035±0.001	0.077±0.003 <sup>a</sup>	0.034±0.001	0.285±0.013	0.033±0.002 <sup>a</sup>	0.073±0.003 <sup>a</sup>	0.064 ±0.002 <sup>a</sup>
	Pregnant	0.040±0.01	0.036±0.01 <sup>ab</sup>	0.040±0.00	0.290±0.06	0.040±0.01 <sup>a</sup>	0.070±0.01 <sup>b</sup>	0.070 ±0.01 <sup>a</sup>
	Postpartum	0.037±0.00	0.085±0.00 <sup>b</sup>	0.040±0.00	0.330±0.02	0.040±0.00 <sup>a</sup>	0.095±0.00 <sup>ab</sup>	0.070 ±0.00
aVR	Before Pregnancy	0.032±0.001 <sup>a</sup>	0.062±0.004 <sup>a</sup>	0.038±0.001	0.201±0.010	0.037±0.002 <sup>a</sup>	0.070±0.003 <sup>a</sup>	0.072 ±0.003
	Pregnant	0.010±0.00 <sup>ab</sup>	0.050±0.01 <sup>b</sup>	0.020±0.00	0.500±0.2	0.070±0.03 <sup>a</sup>	0.050±0.01 <sup>b</sup>	0.050 ±0.01
	Postpartum	0.033±0.01 <sup>b</sup>	0.093±0.01 <sup>ab</sup>	0.040±0.00	0.260±0.05	0.050±0.01	0.180±0.05 <sup>ab</sup>	0.050 ±0.01
aVL	Before Pregnancy	0.034±0.002 <sup>a</sup>	0.072±0.004	0.037±0.001	0.256±0.014	0.030±0.002 <sup>a</sup>	0.046±0.004	0.064 ±0.003
	Pregnant	0.016±0.00 <sup>ab</sup>	0.065±0.01	0.028±0.00	0.200±0.03	0.148±0.04 <sup>ab</sup>	0.065±0.00	0.072 ±0.03
	Postpartum	0.040±0.00 <sup>b</sup>	0.060±0.02	0.040±0.00	0.320±0.03	0.045±0.01 <sup>b</sup>	0.105±0.03	0.085 ±0.01
aVF	Before Pregnancy	0.034±0.001 <sup>a</sup>	0.065±0.003 <sup>a</sup>	0.034±0.001	0.169±0.009	0.022±0.002 <sup>a</sup>	0.042±0.006 <sup>a</sup>	0.060 ±0.003 <sup>a</sup>
	Pregnant	0.028±0.00 <sup>ab</sup>	0.070±0.01 <sup>b</sup>	0.020±0.00	0.230±0.05	0.160±0.04 <sup>ab</sup>	0.078±0.02 <sup>a</sup>	0.041 ±0.01 <sup>ab</sup>
	Postpartum	0.040±0.00 <sup>b</sup>	0.095±0.01 <sup>ab</sup>	0.040±0.00	0.300±0.3	0.040±0.00 <sup>b</sup>	0.100±0.00 <sup>a</sup>	0.085 ±0.01 <sup>ab</sup>

Means with the same superscript down the column within the same Lead differ significantly (P<0.05)

The T duration was highest during postpartum but lowest before pregnancy in Leads II and III. The T duration was also highest during pregnancy but lowest before pregnancy in aVR, aVL and aVF. The T amplitude differs significantly in Leads I, III, aVR and aVF. The T amplitude was highest during postpartum and lowest before pregnancy in Leads I and aVF. The T-amplitude was also highest during postpartum but lowest during pregnancy in Leads III and aVR. The QRS duration showed a statistically significant difference in Leads I, III and aVF. Highest QRS duration was recorded during postpartum but lowest before pregnancy in Lead I. Lead III record revealed the highest QRS dura-

tion during pregnancy but the lowest record before pregnancy. The duration was also highest during postpartum but lowest during pregnancy in aVF.

## DISCUSSION

Comparison of the various waves between the Leads revealed highest P-wave duration in the postpartum period in Leads aVR, aVL and aVF. This could be due to changes in potassium levels during lactation and is similar to the finding of Zarifi et al. (2012). The P-wave amplitude was highest during pregnancy in Lead II which could be due

to change in the volume of the abdominal cavity due to uterine enlargement as a result of foetal development that could influence electrical conduction and distribution to the body surface. This conforms with the findings of Jafari-Dehkordi et al. (2012). The P-wave amplitude was also discovered to be higher in the postpartum period in Leads III, aVL and aVF. This could be due to changes in blood flow to the mammary tissue to supply the nutritional requirements for milk production, which results in increased heart rate and enhanced cardiac output. This conforms to the findings of (Santarosa et al., 2016; Samimi et al., 2018). The T-waves duration was highest in postpartum in Leads II, III and aVR, but was highest during pregnancy in Leads aVL and aVF. While T-wave amplitude was highest in Leads I, III, aVR, aVL, this could be due to changes in the level of some hormones such as thyroid hormones, pregnancy and lactation are associated with a series of physiological changes in most systems including increase serum levels of metabolic hormones such as thyroid hormones thyroxine ( $T_4$ ) and triiodothyronine ( $T_3$ ) (Baxter and Webb, 2009) which affect cellular differentiation, growth, and metabolism of protein, lipids and carbohydrate (Mullur et al., 2014) to enhance the provision of nourishment to the fetus (Ceylan et al., 2009) and are involved in the overall metabolic rate and oxygen consumption of the body (Mullur et al., 2014). Changes in cardiovascular parameters could indicate the likelihood of changes in electrocardiographic (ECG) parameters such as changes in T-waves. Similarly increased cardiac output is required to enhance uterine and mammary circulation in pregnant and postpartum animals; this largely depends on increased stroke volume enhanced by increased myocardial contractility, which could affect ECG amplitudes.

## CONCLUSION

Pregnancy and lactation affect electrocardiographic parameters of Red Sokoto goat. The effect is more pronounced during lactation.

## CONFLICT OF INTEREST

The authors have no conflict of interest

## AUTHORS CONTRIBUTION

All authors contributed equally.

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