Original Research Article

Physiological Changes at Different Stages of Gestation in West African Dwarf Goats in the Humid Tropics

***Shittu, O.O., Okwelum, N., Famakinde, S.A., Odeyemi, J.A., Toviesi, D.P., Yussuff, M.A. and Oluwatosin, O.A.**

Institute of Food Security, Environment Resources and Agricultural Research
Federal University of Agriculture
P. M. B. 2240 Abeokuta, Ogun State, Nigeria

*Corresponding author: lekanyemi08@gmail.com; +2348036626247

Received 7th August 2018; Accepted 23rd September, 2018; Corrected 20th November, 2018

Abstract

The physiological changes at different stages of gestation in twelve artificially-inseminated West African Dwarf goats aged 2 to 4 years, with live weight ranging from15-26 kg indigenous to the humid zone of Southwestern Nigeria were investigated for 5 months between 4th March, 2016 and 25th July, 2016. Does were raised semi-intensively throughout the duration of the experiment and were allowed to graze in paddocks sown mainly with (*Chloris gayana* and *Bracharia ruzizensis*). Supplementary concentrate feed at 4 % body weight dry matter basis daily was also given. Rectal temperature, pulse rate and heart rate in pregnant does were monitored once in two weeks for five months throughout the gestation period in the rainy season (March- July). Data obtained were analyzed by method of least squares analysis of variance (SAS, 2003) with the physiological parameters as the dependent variables and stages of gestation as independent variables. Stages of gestation had a highly significant effect (P<0.001) on all the physiological parameters measured. Rectal temperature was highest in the 5th month of gestation with the mean value of 39.28 ± 0.14^{0}C. On the other hand, heart rate value was highest in the 1st month of gestation with a mean value of 106 ± 3.75 beats per minute. Pulse rate also recorded the highest value in the 1st month of gestation with a mean of 56.33± 0.80 pulses/min. It was concluded that since West African dwarf goats undergo physiological stress during gestation especially within the 1st and 5th months of gestation, care should be taken in handling and management of pregnant does during these stages of pregnancy to avoid stress which could lead to abortion and stillbirths

Keywords: Physiological changes; stages of gestation; West African dwarf, humid tropics

Introduction

Goats and sheep are important small ruminant resources in the tropics, where they play a prominent role in the sustenance of the livelihoods of impoverished families especially in the rural areas. They are widely distributed in Africa with 31.7 % of the goats and 16.3 % of the sheep population

(Ozung *et al*., 2011). Yakubu *et al*. (2010) also reported that goats and sheep represent about 63.7 % of the total grazing domestic animals across the rainforest belt of Southern Nigeria.

During the course of pregnancy, the mammalian fetus is entirely dependent on its mother for nutrient supply and waste removal. More specifically, it is dependent on the maternal blood circulatory system. In order to supply these needs, profound changes occur in the maternal circulation as gestation proceeds. It seems likely that the extent and type of these changes will have significance for both mother and fetus (Holmes, 1980).

Livestock undergo various kinds of stress which includes chemical, physical, nutritional, and thermal stress. Factors such as properties of the skin and hair, sweating and respiratory capacity, tissue insulation, the relationship between surface area and body weight or relative lung size, hormonal profiles and metabolic heat production are known to influence heat loads (McManus *et al*., 2008). According to Silanikove (2000), almost every life form is affected in some way by high temperatures, and goats are no exception. It is not heat alone that causes stress to the goat; but it is the combination of temperature and humidity when some crucial limit has been reached, which shuts down all bodily functions other than those critical for survival.

Several factors which consist of photoperiod, geographical location, age, breed, nutrient availability, water availability, management practices, and environmental conditions affect livestock productivity (Sejian, 2012). Major components of the reproductive system have been found to be susceptible to heat stress in female animals. These include the estrus incidences, oocyte, granulosa and theca cells within the pre-ovulatory follicle, developing embryo during early stages of development, corpus luteum and uterine endometrium. Under heat stress, estrous expression is reduced and increase in loss of embryos may occur. Heat stress adversely affects the oestrous behavior which eventually leads to compromising the uterine environment in livestock (Naqvi *et al*., 2012). The tropics are characterized by high ambient temperature (22-32^{o} C or higher). The prevailing high relative humidity aggravates the heat load as it reduces the ability of the animals to loose heat through evaporative cooling (sweating) (Oladimeji, 1994). This notwithstanding, the West African Dwarf goat is hardy and survives well in the humid tropics possibly because of the inherent adaptogenic power of the animal to respond to a particular stressor (Adeloye, 1998; Adeloye and Daramola, 2004).

The physiological condition of an animal is a signal of the health status of the animal as well as its level of adaptation to its environment, plane of nutrition and disease prevalence.

Several authors (Helal *et al*., 2010; Sanusi *et al*., 2010) have indicated that the best thermo-physiological parameters to objectively check while monitoring the wellbeing of an animal in a harsh environment includes; rectal temperature, respiratory rate and blood indices. Research work with reference to how environment, plane of nutrition and diseases can alter the physiological state of an animal abound in literature (Ogebe *et al*., 1996; Otoikhian *et al*., 2009). However, there is scarcity of information on how pregnancy can mediate in altering the physiological status of

animal. This research work was therefore aimed at assessing the effect of the stages of gestation on physiological changes in West African Dwarf goats.

Materials and Methods

The study was carried out between 4th March, 2016 and 25th July, 2016 for five (5) months during the rainy season period in Nigeria at the Institute of Food Security Environmental Resources and Agricultural Research (IFSERAR) Farm, Federal University of Agriculture, Abeokuta. The region lies between latitudes 7º18′2′N and 7º18′30′N; and longitudes 3º22′10′E and 3º22′41′E. The site is within the rain forest vegetation zone of South-Western Nigeria and the climate is humid. The mean annual rainfall of the area is 1,330mm with a mean annual temperature of 29.3ºC and relative humidity of 80% respectively. Temperatures are fairly uniform with daytime values of 28–30°C during the early rainy season of the year (April–June) and late rainy season (July–September) and 30–34°C during the early dry season (October–December) and late dry season (January–March), with the lowest night temperature of around 24°C during the harmattan period between December and February. Relative humidity is high during the rainy season with values between 63% and 96% as compared to the dry season (55–84%). The temperature of the soil ranges from 24.5 to 31.0°C (source: FUNAAB, 2016).

Experimental Animals and their Management

Twelve (12) apparently healthy and disease-free West African Dwarf goats aged 2-4 years used for this study were sourced from a local market in Abeokuta, quarantined under the supervision of a veterinary doctor for 1 month and aged via dentition before the commencement of the experiment

The experiment was carried out between 4th March, 2016 and 25th July, 2016. The twelve (12) cycling multiparous West African Dwarf does with live weight ranging from 15-26kg were subjected to oestrous synchronization by administering Prostaglandin F2 alpha (PGF2α) and Gonadotropin Releasing hormone (GnRH) using the Ovsynch method. The first dose of PGF2α (0.5ml/doe) was administered to each of the goats on day zero (0) while on day 7, GnRH (0.5ml/doe) was administered. Thereafter, a second dose of PGF2α (0.5ml/doe) was administered to each of the goats 24 hours after by a certified veterinarian. Does were then artificial inseminated via intra-vaginal semen deposit following the confirmation of oestrus by males using the apron method.

Optimum health score conditions and management care were confirmed in each animal before including them in the case under trial. They were subjected to detailed gynecological examination (ultra-sound scan) for confirmed pregnancy 1 month after artificial insemination.

Animals were raised semi-intensively throughout the duration of the experiment. They were allowed to graze in paddocks sown mainly with *Chloris gayana* and *Bracharia ruzizensis*, and supplemented with concentrate feed at 4% body weight on dry matter basis daily. Water and mineral salt lick were supplied *ad libitum.*

Physiological Parameters

Physiological parameters were monitored and assessed once in two weeks at 8.00a.m in the morning throughout the duration of pregnancy which lasted for 5 months using the methods described by Oladimeji (1994) as follows. Rectal temperature was determined using a digital clinical thermometer inserted 5cm into the rectum of the animal, and allowed to stay for 1 min. before taking the reading. Heart rate was determined by auscultation with the aid of a stethoscope on the first rib of the right chest, and counting the number of beats per minute using a stop-watch. Pulse rate was determined by placing a finger on the femoral artery on the medial area of the hind limb for one minute using a stop-watch.

Temperature - Humidity Index (THI)

The temperature-humidity index which could be used as an indicator of thermal climatic conditions was determined from the data on temperature and relative humidity collected using the heat index formula reported by Marai *et al*. (2001):

$$THI = db^{o}C - \{(0.31 - 0.31\ RH)\ (db^{o}C - 14.4)\}$$

Where:

THI = Temperature – humidity index
$db^{o}C$ = Dry bulb temperature ^{o}C
RH = Relative humidity (RH %)/100

THI was rated as follows:

ahs = absence of heat stress (values < 22.2),
mhs = moderate heat stress (values between 22.2 to < 23.3),
shs = severe heat stress (values between 23.3 to < 25.6),
ehs = extreme heat stress (values from 25.6 and more)

Statistical Analysis

Data obtained were analyzed by method of least squares analysis of variance (SAS, 2003). The experimental design for this experiment was a general linear model appropriate for a completely randomized design with the physiological parameters as the dependent variables and stages of gestation as the independent variable.

Results

The analysis of variance table from this study as shown in Table 1, revealed that gestation period (pregnancy stages) had a highly significant effect ($P < 0.001$) on rectal temperature, heart rate and pulse rate.

Table 1: Analysis of variance of the effect of stages of gestation on physiological parameters

		Mean Squares		
Source of variation	**df**	**Rectal temperature**	**Heart rate**	**Pulse rate**
Stage of pregnancy	4	1.30***	2029.50***	320.38***
Error	103	0.29	278.29	50.27

***P < 0.001

Table 2: Least square means of physiological parameters as affected by stages of gestation

Physiological Parameters	**Stages of Gestation (Months)**				
	1	**2**	**3**	**4**	**5**
Rectal temperature (^{0}C)	38.61± 0.12^{c}	38.82 ± 0.11^{c}	39.05 ± 0.07^{ab}	38.80 ± 0.11^{bc}	39.28 ± 0.14^{a}
Heart rate (beats/min.)	106 ± 3.75^{a}	87.33 ± 3.81^{b}	82.50 ± 2.70^{b}	102.50 ± 3.73^{a}	98.17 ± 3.59^{a}
Pulse rate (pulses/min.)	56.33± 0.80^{a}	47.17 ± 1.46^{c}	47.83 ± 1.30^{c}	54.75 ± 2.04^{ab}	50.04 ± 1.67^{bc}

$^{a-c}$Means in the same row having different superscript differ significantly (P < 0.001)

Rectal temperature increased from the 1st to 3rd month of pregnancy, slightly decreases in the 4th month and thereafter increased in the 5th month with the highest rectal temperature value of 39.28 ± 0.14^{o}C (Table 2). Though rectal temperature values increased from the 1st to 2nd month of pregnancy, there was no significant difference in rectal temperature from the 1st to 2nd month of pregnancy. Rectal temperature range throughout the gestation period was from 38.61 ± 0.12 to 39.28 ± 0.14^{o}C with the highest rectal temperature value of 39.28 ± 0.14^{o}C recorded in the 5th month of gestation.

On the other hand, heart rate was highest in the 1st month of gestation with a mean value of 106 ± 3.75 beats/minute, and decreased sharply in the 2nd and 3rd months of gestation. Heart rate however increased sharply in the 4th month of gestation and thereafter decreased in the 5th month of gestation as shown in Table 2. Though, heart rate values in this study decreased from the 2nd to 3rd month, there was no significant difference in mean values as shown in Table 2.

Furthermore, pulse rate recorded the highest mean value in the 1st month of gestation with a mean value of 56.33 ± 0.80 pulses/minute, decreased steadily in the 2nd month, steadily increased in the 3rd and 4th month, and thereafter decrease sharply in the 5th month. Though pulse rate values increased as gestation period progressed from the 2nd to 3rd month, there was no difference in the mean values within this stage of gestation.

The analysis of variance table of the climatic variables throughout the experimental period (Table 3) showed highly significant (P<0.05) differences in the variables throughout the experiment.

The first month of gestation which fell within the month of March had the highest temperature value of 29.55 ± 0.27^{0}C (Table 4). The mean temperature decreased significantly as the stage of gestation progressed from the second month (April) to the last month of gestation (July), the mean temperature values being 29.25 ± 0.16^{0} C; 28.07 ± 0.22^{0} C; 26.65 and 26.33± 0.12^{0} C respectively.

Table 3: ANOVA on variations in climatic factors with stage of gestation

		Mean squares			
Source of variation	df	Mean temperature	Relative humidity	Wet bulb temperature	Dry bulb Temperature
Stage of gestation	4	65.23***	505.38***	27.82***	74.15***
Error	148	1.23	63.67	1.06	2.18

*** P<0.001

Table 4: Monthly variations in climatic parameters during gestation

Stages of pregnancy	**Mean temperature (^{0}C)**	**Relative humidity (%)**	**Wet bulb temperature (^{0}C)**	**Dry bulb temperature (^{0}C)**
March	29.53 ± 0.27^a	73.84 ± 1.69^b	25.56 ± 0.18^a	29.18 ± 0,26^a
April	29.25 ± 0.16^a	76.23 ± 1.75^b	25.62 ± 0.19^a	28.92 ± 6,22^a
May	28.07 ± 0.22^b	81.65 ± 0.96^a	25.11 ± 2.24^a	27.44 ± 0.33^b
June	26.65 ± 0.19^c	81.60 ± 1.46^a	23.92 ± 0.18^b	26.48 ± 0.31^c
July	26.33 ± 0.12^c	83.26 ± 1.23^a	23.57 ± 0.11^b	25.54 ± 0.19^d

$^{a-d}$ Means in the same column with different superscript differ significantly (P < 0.05)

On the other hand, relative humidity values increased progressively from the 1st stage of gestation (March) to the last month of pregnancy (July) with the highest value of 83.26 ± 1.23 % recorded in the last month of gestation (July) as shown in Table 4. The wet and dry bulb temperatures also decreased progressively with stage of gestation, with the highest mean values of 25.56 ± 0.18^{0}C and 29.18 ± 0.26^{0}C in the 1st month of pregnancy for both wet bulb and dry bulb temperatures respectively.

The temperature – humidity index (THI), shown in Table 5, was highest in the in the month of March which fell within the hot-dry season in the humid tropics.

Table 5: Temperature-Humidity index (THI) for the experimental period

Month	**THI value**
March	28.3 (ehs)
April	29.2 (ehs)
May	28.0 (ehs)
June	26.4(ehs)
July	26.1(ehs)

ahs- absence of heat stress (values < 22.2),
mhs- moderate heat stress (values between 22.2 to < 23.3),
shs- severe heat stress (values between 23.3 to < 25.6),
ehs-extreme heat stress (values from 25.6 and more)

Discussion

The high rectal temperature at the last stage of pregnancy (last trimester) in this study corroborates the findings of Imasuen and Aloamaka (2012) who reported an increase in rectal temperature from the 1st to the 5th month of gestation while assessing pregnancy-induced physiological changes in West African Dwarf does at different stages of gestation. The high rectal temperature in the 5th month of gestation which fell within the last trimester of pregnancy could be due to the fact that there was a protective mechanism of homeostasis against stress due to heat increment from the digestive process (Abegaz and Gemeda, 2002). THI values as calculated in this study showed that there was extreme heat stress throughout the experimental period. The digestive process is usually at a very high level during the last trimester of pregnancy thereby increasing metabolic rate which, in turn, increases the body temperature of the animal. This suggests that pregnancy induces varying degree of heat stress in goats.

The high pulse rate and heart rate recorded in this study especially in the 1st month of gestation could be due to increased metabolic activities during pregnancy which increases blood flow from the core to the periphery of the body.

Conclusion

It can be concluded from the study that the West African dwarf goats could undergo physiological stress during pregnancy especially within the 1st and 5th months of pregnancy (i.e first and last trimesters). Therefore, care should be taken in handling and management of pregnant does during the first and last months of pregnancy to avoid stress which could lead to abortion and stillbirths.

References

Abegaz, S. and Gemeda, D. (2002). Genetic and phenotypic parameters of Growth, Reproductive and survival performances of Harrow sheep at Balco Agricultural Research Center. Research Fellowship Report, Animal Genetic Resources group, International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia, February, 2002. Pp. 132.

Adeloye, A.A. (1998). *The Nigerian Small Ruminant Species*. Corporate Office Max: Ilorin, Nigeria. Pp 7-8.

Adeloye, A.A. and Daramola, J.O. (2004). Improving living conditions of domestic animals in Nigeria: a review. In: Amalu, U.C and Gottswald, F.T (eds.). *Studies of Sustainable Agriculture and Animal Science in Sub-Saharan Africa* (Studies in Sub-Saharan Africa Volume 1). Peter Lang Publishing Group: Berlin, Germany. Pp 99 - 115.

FUNAAB (Federal University of Agriculture Abeokuta). (2016). Annual weather and climate report of the University Environment by the Agro-meteorology Department, Federal University of Agriculture Abeokuta, Nigeria.

Helal, A., Hashem, A.L.S., Abdel-Fattah, M.S. and EL-Shaer, H.M. (2010). Effects of heat stress on coat characteristics and physiological responses of Balady and Damascus goats in Sinai, Egypt. American Eurasian Journal of Agriculture and Environmental Science, 7(1):60-69.

Holmes, J.H.G. (1980). Animal Genetic Resources in Papua New Guinea. Proceedings of a SABROA Workshop on Animal Genetic Resources in Asia and Oceania. T.A.R.C. Tsukuba, Japan .p. 439.

Imasuen, J.A. and Aloamaka, C.P. (2012). An assessment of pregnancy induced physiological changes in West African Dwarf does at different stages of gestation. *Annual Review and Research in Biology*. 2(2): 53-57.

McManus, C. Prescott, E., Paludo, G. R., Bianchini, E., Louvandini, H., Mariante, A. S. (2008). Heat tolerance in naturalized Brazilian Cattle breeds. *Livestock Science* 120 (3): 256 – 264.

Naqvi, S.M.K., Kumar, D., Paul, R.K., Seijan, V. (2012). Environmental stresses and livestock reproduction In: Seijan, V., Naqvi, S.M.K., Ezeji, T., Lakritz, J, Lal, R. (eds). Environmental stress and amelioration in livestock production. Springer Verlag publisher, New York 97-125.

Oladimeji, A. (1994). Estimation of average values for pulse rate, respiratory rate, rectal temperature and development of heat stress index for adult Yankasa sheep. *Bulletin of Animal Health and Production in Africa* 45: 105 – 107.

Ogebe, P.O., Ogunmodede, B.K., McDowell, L.R. (1996). Behavioural and physiological responses of Nigeria Dwarf goat to seasonal changes to the humid tropics. *Small Ruminant Research* 22: 213-217.

Otoikhian, C.S.O., Orheruata, J.A., Imasuen, J.A. and Akporhuarho, O.P. (2009). Physiological responses of local (White Bornu) goat breed to varied climatic conditions in South-South Nigeria. *African Journal of General Agriculture* 5(1): 1-6.

Ozung, P.O., Nsa, E.E., Ebegbulem, V.N. and Ubua, J.A. (2011). The potentials of small ruminant production in Cross River rain forest zone of Nigeria: A review. *Continental Journal of Animal and Veterinary Research* 3(1):33–37.

Sanusi, A.O., Peter, S.O., Sonibare, A.O., Ozoje, M.O. (2010). Effect of coat colour on heat stress among West African Dwarf sheep. *Nigeria Journal of Animal Production* 38(1): 28-36.

SAS. (2003). *Statistical Analysis System User's Guide*: Statistical version 8th edition. Cary Nc. SAS Institute.

Seijan, V. (2012). Environmental stresses and livestock reproduction In: Seijan, V., Naqvi, S.M.K., Ezeji, T., Lakritz, J, Lal, R. (eds). Environmental stress and amelioration in livestock production. Springer Verlag publisher, New York. Pp. 97-125.

Silanikove, N. (2000). Effects of heat stress on the welfare of extensively managed domestic ruminants. *Livestock Production Science* 67 (1-2), 1-18.

Yakubu, A., Raji, A.O. and Omeje, J.N. (2010). Genetic and phenotypic differentiation of qualitative traits in Nigerian indigenous goat and sheep populations. *ARPN Journal of Agricultural and Biological Science* 5(2):58-59.