Nigerian J. Anim, Sci. 2024, 26 (3): 83-92

Plasma Concentration of Cortisol and Progesterone During Periparturient Period in West African Dwarf Goats Reared in Nigeria.

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Target Audience: Students, Researchers, goat farmers.

Abstract

In goat, progesterone (P_4) aids implantation process and maintenance of pregnancy. Cortisol may assist in parturition because it aids in activating Prostaglandin F2α (PGF2a). This study aimed at determining the periparturient plasma P_4 and cortisol concentration in pregnant West African Dwarf (WAD) does. A total of fourteen (14) cycling and healthy WAD does were used. Blood samples were collected from them in the morning prior to feeding and emptied into a sterile tubes containing Ethylene Diamine-Tetra-Acetic Acid (EDTA). The sampling was done four weeks prior to the expected day of kidding and four weeks after kidding. The collected blood samples were centrifuged to recover plasma and frozen at -20 for hormonal assay. Enzyme-linked immunosorbent assay was used for the P_4 and cortisol concentrations determination. The data analyses were carried out using SPSS v.20.0. The comparison among the different physiological periods showed that P_4 concentrations during prepartum phase is higher ($P<0.05$) compared to its concentrations during puerperium phase. During prepartum period, the levels of P_4declined consistently from 2.49 ng/ml in week four to 2.15 ng/ml in the last week before parturition. P_4decline from (1.66 ng/ml) in the first week of post parturition, thereafter, remained steady (1.65 ng/ml) until third week and declined to 1.42 ng/ml in the fourth week post-partum. The results showed non-significant ($P>0.05$) differences in plasma cortisol among the different physiological periods. It was concluded that, progesterone is necessary for maintenance of pregnancy and the decline aids parturition in WAD does.

Keywords: WAD goat; pregnancy; progesterone; cortisol

1. Description of problem

The West African Dwarf (WAD) goat is a small-sized breed of goat. However, its morphology is commensurable to that of larger dairy goats (1). These breeds of goat have been reported to be polyestrous throughout the year (2) and (3). Among other credits, they are highly prolific and have the ability to breed throughout the year (4, 5, 6, 7). The gestation length reported for WAD goats ranges from 145 to 148 days which is similar to the gestation period for Boer goat doe (7). According to (8), pregnancy period of 149 days is normal in the goat and this varies between 144 and 150.8 days.

Pregnancy or period of gestation in goats is

the period between conception and parturition. Gestation period has been reported to be affected by breed, litter weight, environment, and parity (9). In goats, progesterone is the main hormone that aids implantation process (10), maintenance of pregnancy and it is secreted by corpus luteum (11). According to (12, 13, 14, 15), there is need for continuous secretion of progesterone by the corpus luteum (CL) throughout pregnancy because corpus luteum is the only source of progesterone for the physiological maintenance of pregnancy in goats unlike in ewe were the placenta secrete progesterone. Abortion always occurs once there is a regression of the CL during pregnancy, this is so because of decline in progesterone secretion (11; 15). In addition, (13) reported that parturition or pathological abortion follows after the regression of the CL as a result of a decline in circulating progesterone concentrations. The progesterone decrease occurs whenever there is a withdrawal of maternal pituitary luteotrophin which occurs as a result of hypothalamic `timing' (13). According to (9), there is a drastic decline in progesterone occurring 12–24 hours before kidding. High number of corpora lutea will lead to more progesterone secretion, this in turn enhances stimulation of mammary gland growth in goats carrying twin fetuses (16). Not only does progesterone aids implantation and maintenance of pregnancy, together with estrogen they help in mammary gland development during pregnancy (17,18,19,20). Pregnancy and lactation are physiological state that are able to induce stress in animals and are associated with neuroendocrine fluctuations aiming at ensuring fetal and mammary glands development (21, 22, 23). Periparturient period of pregnancy is associated with rapid development of the mammary gland, start of milking (24) and fetal expulsion at parturition. During periparturient event, there is high cortisol concentrations because of an increased fetal adrenal sensitivity to adrenocorticotropic stimuli (25). The circulating levels of cortisol which suggest stress level has been observed to be high during parturition, peak with the expulsion of the first kid and greater in goats with dystocia and retrained placenta (26; 27). According to (28), cortisol may assist in converting progesterone to estrogen at the time of kidding. Additionally, cortisol assists in secretory activation, ample milk synthesis (29), maintaining homeostasis and animal adaptation (30).

In our recent work, we studied the lactation performance of West African Dwarf goats in terms of milk yield and milk composition when intramuscularly injected with exogeneous oxytocin. It was observed that oxytocin injection increased milk yield, fat content and total solid component of the milk (31). According to (32), changes in plasma progesterone hormone during pregnancy and around the time of kidding varies between specie. In addition, (33) stated that large differences exist in concentration of plasma progesterone among ruminant species during pregnancy. In cows (34) and goats (14) for instance, plasma progesterone concentration increases almost immediately after mating thereafter, it is nearly consistence until approaching kidding. In the present study, we try to investigate progesterone concentrations prior and after parturition in an attempt to understand how this hormone fluctuate between these periods in West African Dwarf goats. Also, cortisol concentration was measured in other to

understand if the stress responses experienced by WAD goat prior to parturition differs from that experienced during lactation and the time of uterine involution.

Materials and methods

Experimental Site

The experiment was carried out at the Ruminant Unit of Directorate of University Farms, (DUFARMS) Federal University of Agriculture, Abeokuta, South-West, Ogun State, Nigeria. The farm geographical location lies within latitude 7°10'N; Longitude 3°2'E (Google earth, 2020) at an altitude 76 mm above sea level. It is located within the derived Savannah zone of South-Western Nigeria. It has a humid climate with mean annual rainfall of 1037 mm with a mean annual temperature of 34.7°C.

Experimental Animals and Management

A total of fourteen (14) cycling and healthy West African Dwarf goats in (DUFARMS) were used for this experiment. The animals were identified with numbered ear tags and were individually housed in an open-sided pen with corrugated aluminum roofing sheet and a wooden slatted floor to ensure cross ventilation through the period of the experiment. The pen and its environment were properly cleaned and disinfected before the arrival of the goats. The does were naturally mated with a fertile and healthy buck after which fertilization was confirmed as the mated does did not show signs of heat in the next estrus cycle.

Experimental animals' feeding

The experimental does were raised in a semi-intensive system. They were allowed to graze in the morning and concentrates fed to them in the evening at 3% of their body weight daily. Clean water was provided *ad-libitum* throughout the experimental period.

Blood sampling and processing

A 2ml syringes were used for blood samples collection from the 14 does once a week throughout the periparturient periods. The blood samples were collected from external jugular venipuncture in the morning between 08:00 to 09:00 h prior to feeding because circadian rhythm affect cortisol and cortisol levels change throughout the day. The collected blood samples were transferred immediately into sterile sampled tubes containing Ethylene Diamine-Tetra-Acetic Acid (EDTA). The blood samples were collected four weeks prior to the day of expected kidding and also four weeks after kidding. The blood samples were immediately centrifuged at 1500 rpm (Revolution Per Minutes) for 20 minutes using (800-1 Centrifugal Machine, China) to separate blood plasma and then kept frozen at -20°C or hormone assay.

Hormone Assays

Plasma concentrations of progesterone were measured using ELISA kit (Goat Progesterone ELISA Kit (Colorimetric) by (Novus Biologicals, LLC 10771 E Easter Ave Centennial, CO 80112, USA). The assay was carried out in accordance with manufacturer protocol. Plasma concentrations of cortisol were measured using ELISA kit (Elecsys, Roche Diagnostics, Meylan, France). The assay was carried out according to manufacturer protocol.

Statistical analysis

The data from progesterone and cortisol were expressed as means ± SD using SPSS for

Windows v.20.0 (IBM Corp., NY, 2011). Significant differences among group means were separated using Tukey's Studentized Range (HSD) Test as contained in the software and considered statistically significant at lower than P<0.05. The experimental design for this experiment is a general linear model appropriate for a completely randomized design with the progesterone and cortisol levels as the dependent variables and week (four weeks before parturition and four weeks after parturition) as the independent variable.

Statistical Model:

$Y_{ij} = \mu + T_i + £_{ij}$

Where

$Y_{ij=}$progesterone and cortisol levels

μ = population mean

$T_{i=}$fixed effect of week of peripartum

$£_{ij=}$ random error

Results

The mean ± SD of circulating progesterone (P_4) concentrations measured during different physiological phases (pre-parturient and puerperium) from four weeks prepartum to four weeks post-partum in WAD goats are shown in Tables 1.

Table 1 Circulating progesterone concentrations (mean ± SD) in different physiological periods of 14 West African Dwarf goats.

Parameter	p value	Pre-parturient	Puerperium
Progesterone(ng/ml)	<0.0086	2.28± 0.83[a]	1.60±0.61[b]

[a,b] means with different superscripts differ significantly within a column ($P < 0.05$), ng/ml (nanograms per milliliter).

The comparison among the different physiological periods showed that P_4 concentrations during pre-parturient phase is higher ($P<0.05$) compared to its concentrations during puerperium phase. During prepartum period, the levels of P_4 declined consistently from 2.49 ng/ml in week four to 2.15 ng/ml in the last week before parturition as shown in figure 1.

There is a sharp decline in P_4 concentration (1.66 ng/ml) in the first week of post parturition, thereafter it remained steady (1.65 ng/ml) until the third week and declined to (1.42 ng/ml) in the fourth week postpartum.

The mean ± SD of circulating cortisol concentrations measured during different physiological phases (preparturient and puerperium) from four weeks prepartum to four weeks post-partum in WAD goats are shown in Table 2.

The result showed non-significant (P>0.05) differences in plasma cortisol among the different physiological periods. However, plasma cortisol started to increased consistently from week 4 (1.00 ng/ml) to week 2 (1.10 ng/ml) and decline thereafter in week 1 (1.08 ng/ml) during prepartum. The cortisol concentration increased during post-partum from week 1 (1.17 ng/ml) to

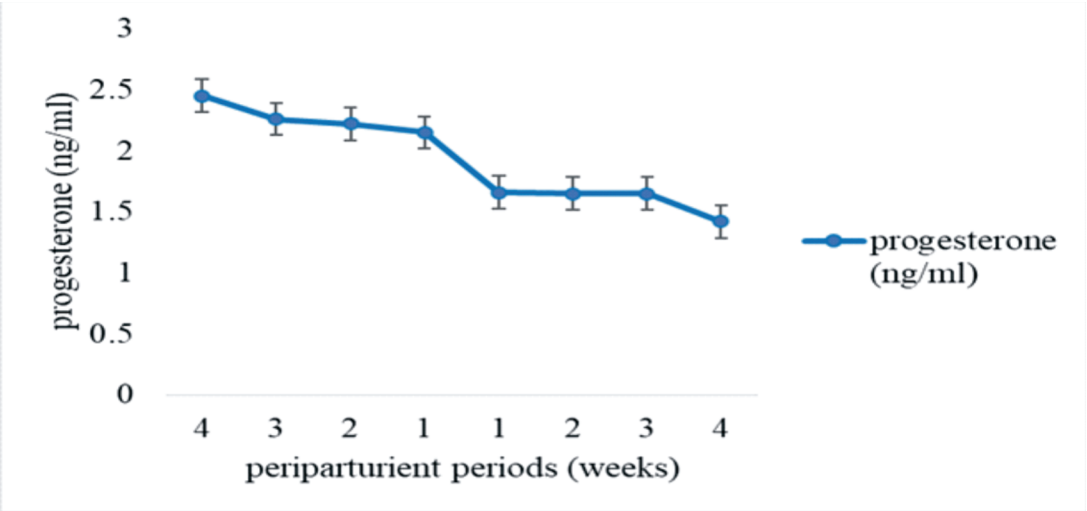

Fig 1: Circulating profiles of progesterone during preparturient and puerperium periods, four weeks before parturition and four weeks after parturition in WAD goats reared in Nigeria.

Table 2 Circulating cortisol concentrations (mean ± SD) in different physiological periods of 14 West African Dwarf goats.

Parameter	p value	Preparturient	Puerparturient
Cortisol(ng/ml)	0.3231	1.06 ± 0.29	1.15 ± 0.34

[a,b] means with different superscripts differ significantly within a column ($P < 0.05$). ng/ml, nanograms per milliliter.

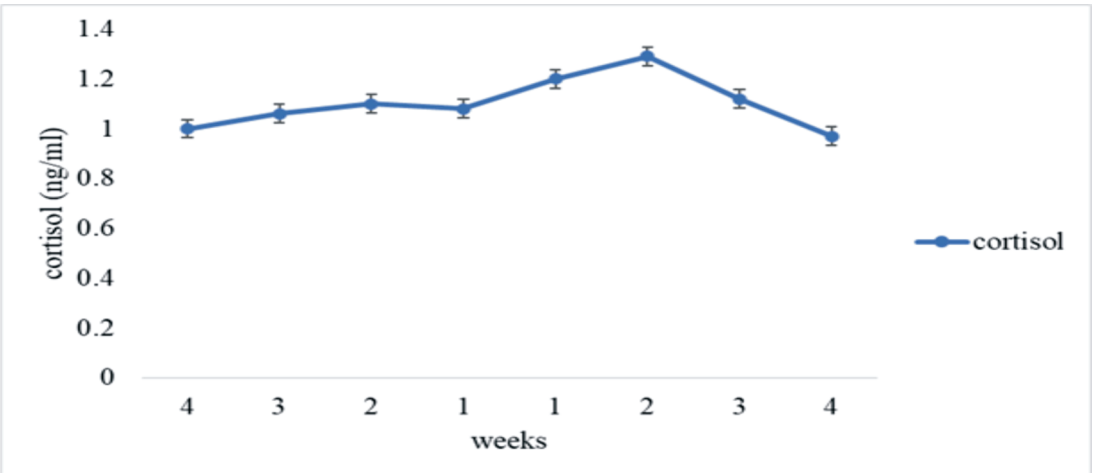

Fig 2 Circulating profiles of cortisol during preparturient and puerperium periods, four weeks before parturition and four weeks after parturition in WAD goats reared in Nigeria.

Discussion

The overall mean of progesterone recorded in this study is in line with that reported by (35) during late pregnancy in goats. Similarly, the overall mean of cortisol recorded in the current work is in accordance with the findings of (35) during pregnancy and lactation in Nicastrese goat. In the present study, it can be seen that the decline of progesterone is essential for parturition to occur in goats. In goats, progesterone is the main hormone that aids implantation process (10), maintenance of pregnancy and it is secreted by corpus luteum (11). The result of present study therefore, agreed with the hypothesis that for parturition to occur, the inhibition of progesterone has to be removed from the myometrium (37). The result supports the observation of (11) that a decline in the does progesterone is necessary for induction of parturition in goats. It is therefore important that the maternal progesterone decreases because high concentration towards parturition may hinder progressive contraction of the myometrium and cervical dilation and this will be fatal for the kid survival. The result of the periparturient decline in plasma progesterone observed in the present experiment is also in line with observations of (38, 14) in goats. Comparing the progesterone concentration during prepartum with postpartum in the present study, we found significantly highest values of P_4 during prepartum and this may be as a result of active production by corpus lutem. The higher concentration of P_4 during prepartum may be linked to the preparation of the reproductive system for the expulsion of foetus and mammary gland development (17, 18, 19, 20). On the other hand, the significant ($P>0.05$) decrease in P_4 during post-partum may reflect reduction in ovarian activities during lactation.

Although no significant ($P>0.05$) were recorded in the circulating cortisol concentrations measured during different physiological phases (preparturient and puerperium) in WAD goats. However, pregnancy and lactation are physiological state that are able to induce stress in animals causing increase in the level of maternal cortisol. The result demonstrated highest plasma cortisol levels in week 2 of lactation. Thus, cortisol may be necessary for development and histological differentiation of the mammary gland and can support prolactin. Therefore, high cortisol concentrations are helpful to keep up intense milk synthesis and secretion during lactation. Apart from acting as a stress indication hormone, cortisol also, induces the degradation and release of glucose, amino acid, and fat in the liver, muscle and adipose tissue (39). It also, helps to mobilize the animal's energy reserves, positively affecting the metabolism of carbohydrates, lipids, electrolytes and water (40). The result of current work is in line with work of (36) who reported no significant difference in cortisol concentrations measured during different physiological phases (non-pregnancy, pregnancy, and lactation) in Nicastrese goats. In sheep, secretion of Adrenocorticotropic hormone from the fetal pituitary increases in last stage of pregnancy to aid fetal adrenals growth and this leads to rise in the levels of cortisol. These elevated levels enter the maternal blood and induce parturition by activating Prostaglandin $F_{2\alpha}$ (PGF2a) and coordinating the endocrine profile of the animal (41, 42). The PGF2α in turn causes increase level of oxytocin which provides myometrial contractions increases (43).

Earlier works on sheep agreed with the result of the present study that there were no significant differences in serum cortisol levels in the prepartum period between single and twin pregnant ewes (44), before and after pregnancy (45) in ewes.

Conclusion and application

1. The results contribute to understanding the possible changes in progesterone and cortisol levels during the prepartum and puerperium periods in WAD goats. Progesterone declined consistently towards parturition which showed that progesterone is necessary for induction of parturition in goats. This result will provide an understanding of what happens to the progesterone production during periparturient period in WAD goat.
2. It is important that the maternal progesterone decreases because high concentration towards parturition may hinder progressive contraction of the myometrium and cervical dilation and this will be fatal for the kid survival. The monitoring of the concentration of these hormones is necessary because it may provide reasons for delayed parturition and situation of dystocia.
3. The concentration of cortisol was the same for both prepartum and puerperium , however, higher level was seen in week 2 post parturition which showed that cortisol may support lactogenesis processes in WAD goats.

Acknowledgment

We are thankful to Professor I. J. James, who made it possible that we had access to the goats in the (DUFARMS) for the study.

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