

## Some Uterine and Ovarian Biometric Changes in Pregnant Maradi Female Goats (*Capra aegagrus hircus* L.)

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### Abstract

This study aimed to determine the changes in the biometry of the ovaries, of the uteri and its contents in the Maradi doe-goat during the three terms of pregnancy. Pregnant uteri from 28 female goats and their corresponding ovaries were used to study the biometric changes in the ovaries, gravid uteri, amniotic and allantoic fluids volumes, fetuses and placentomes during the three terms of pregnancy. The results revealed that there was no significant variation in the ovarian weight during the three terms of pregnancy. However, there were significant variations in the ovarian length (left ovary  $2.15 \pm 0.16$  cm; right ovary  $2.10 \pm 0.10$  cm) and width (left ovary  $1.77 \pm 0.19$  cm; right ovary  $1.60 \pm 0.10$  cm) in the third term of pregnancy compared to the ovarian length and width in the first term of pregnancy. The uterine weight showed significant variation in the first term, second term and in the third term of pregnancy. The uterine length of both horns also showed significant variations in the first term (left side  $31.40 \pm 1.79$  cm; right side  $28.22 \pm 0.98$  cm), second term (left side  $51.58 \pm 4.14$  cm; right side  $50.51 \pm 3.62$  cm) and in the third term (left side  $70.67 \pm 1.76$  cm; right side  $80.38 \pm 2.75$  cm) of pregnancy but only in the third term of pregnancy was a significant difference in the lengths of the left side uterine horn ( $70.67 \pm 1.76$  cm) compared to the right side ( $80.38 \pm 2.75$  cm). The number of placentomes was constant in both uterine horns throughout gestation; however the mean caruncular diameter increased progressively from the first term of gestation through the third term of pregnancy. The smallest and largest caruncles were observed on the ventral surfaces of the uterine horns, and the placentomes were observed to be aligned in a linear manner along the longitudinal axis of the uterine horns. This study shows that there are differences in the biometrics of the ovary and uterus in Maradi goats compared to some other breed.

**Keywords:** ovaries, uterus, fetus, amniotic fluid, allantoic fluid, Maradi goat

### Introduction

The domestic goat (*Capra aegagrus hircus* L.) a subspecies of goat domestication from the wild goat is a member of the Bovidae family (Jaji *et al.*, 2012). Goat husbandry is practiced in most countries of the world, however, 94% of the world goat population is found in developing countries (Devendra, 1987). About 80% of the world goat population is in the tropics (Igado *et al.*, 2011) and Tropical Africa contains a third of the world's goats, but "they have been neglected politically and scientifically" (Wilson, 1988).

The Maradi goat also known as the Red Sokoto belongs to the Savannah goat breed of the Nigerian guinea Savannah agro-forest zone (Epstein and Mason, 1971). They constitute 60% of the Nigerian goat population of about 34.5 million (Kawu *et al.*, 2007). Goats are multipurpose animals with great

economic value and the Maradi goat is particularly valued for its animal protein contribution to humans in the form of meat and milk and its hide (Igado *et al.*, 2011). The distribution of the breed ranges from southern Niger and northern Nigeria, between latitudes  $12^{\circ}$  N and  $14^{\circ}$  N and longitudes  $4^{\circ}$  and  $10^{\circ}$  E; and concentrated mostly in north eastern Nigeria in Sokoto, Zamfara, Kano, Kebbi and Katsina States (Wilson, 1991). The breed emigrated from the Middle East through Egypt to its present locale. It is a small sized breed of goat of about 60 cm height at the withers, and about 25-27 kg weight. They have a prominent forehead with spiraled horns in both sexes of medium length; the ears are relatively short and horizontal; the coat color ranges from red especially in Nigeria through different shades of brown to fawn in variants elsewhere but the males have a more darkened hue than the females (Wilson, 1991). Age and weight at first estrus is 157 days and 10.5 kg; age at first kidding is about 435 days; twining is quite common in this breed (Wilson, 1991).

Information on the biometrics of the reproductive system of livestock animals is necessary in order to improve the fertility, the reproduction and the performance as well as enabling the adoption of other assisted reproductive technologies.

Search of available literature shows knowledge gap of data on the biometrics of the reproductive system of pregnant female small ruminant livestock (Jaji *et al.*, 2012; Hyacinth *et al.*, 2016). Hence, the present study was aimed to add some new information on biometric data of reproductive system of Maradi goat. The findings of this study will be of value for veterinarians, animal biologist, pathologists as well as geneticists.

## Materials and Methods

### Sample collection

The study was performed using gravid uteri and ovarian samples collected from 28 apparently healthy pregnant Maradi goats slaughtered at Nsukka municipal abattoir, Ikpa, Nsukka Local Government Area, Enugu State, Nigeria from June 29<sup>th</sup> to July 30<sup>th</sup>, 2015. The intact gravid uteri and the adjoining ovaries were collected immediately following slaughter and transported to the Laboratory of the Department of Veterinary Obstetrics and Reproductive Diseases, Faculty of Veterinary Medicine, University of Nigeria, Nsukka where the study was conducted.

Twenty-eight gravid uteri bearing twin conceptuses one in each of the uterine horn of the uteri were selected. Each uterus was weighed and the length of both uterine horns were measured along the contour using thread and exported to a meter rule to determine the measurement. The length of the uterine horn was determined from the external line of demarcation of the body from the horn to the utero-tubal junction. The ovaries were resected and carefully trimmed of adnexa. The weights of the ovaries were determined using an electronic weighing balance (Metler® Toledo, Switzerland). The length and width of the ovaries were determined with the aid of vernier calipers. The length of ovary was noted as the distance from its anterior to the posterior end while the width was noted as the distance between its attached and free borders (Al-Baghal *et al.*, 1993).

The gravid uterine walls were incised along the intercaruncular space on the greater curvature of dorsal surface to expose the underlying fluid-filled chorio-allantois. The fetal cotyledons were carefully detached from the caruncles. The allantoic fluid and the amniotic fluid were aspirated and the volumes were determined. The fetuses were exteriorized and the fetal weight and crown-rump length (CRL) were measured and the sex was determined by visual observation of the external genitalia.

The fetal/gestational age was determined using the formula  $2.1 \times [\text{CRL (cm)} + 17]$  of Richardson *et al.* (1976). The caruncles were counted and the largest and smallest caruncular diameters were determined for each chorio-allantois using vernier calipers. The gestational age was used to differentiate the gravid uteri into first term ( $\leq 50$  days), second term ( $> 50$ ,  $\leq 100$  days) and third term ( $> 100$  days). Thereafter the absolute weight of these uteri were determined by subtracting the weight of the developing conceptuses (this includes the fetuses, fetal membranes and fetal fluid) from the weight of the gravid uteri.

### Statistical analyses

Data generated were subjected to one-way analysis of variance (ANOVA) and student's t-test. Variant means were separated by the least significant difference (LSD) method. Statistical significance was accepted at probability of less than 0.05 and the results are presented as means  $\pm$  standard error (SE).

## Results

The average of the weight and length of the uteri progressively and significantly increased across the different terms of gestation, likewise the mean absolute uterine weight up to the second term of gestation (Table 1). There were no significant variations in the left side uterine length compared to the right side per term, except the mean length in the third term of gestation in which the left side uterine length was significantly shorter than that of the right side (Table 1).

The fetal weight and the crown-rump length (CRL) in the left and right horns increased progressively and significantly from the first term of gestation through the second to the third term of gestation, and there was no significant difference in these parameters in the left horn compared to that of the right horn (Table 2).

The amniotic and allantoic fluid volumes in the first term of gestation were significantly lower than that of the other terms (Table 2). However, in the third term of gestation, the amniotic and allantoic fluid volumes in the right and left horns respectively were significantly higher than that in the second term of gestation (Table 2). There was no variation in the values of the left and right fetal weight, CRL, amniotic and allantoic fluid volumes; except in the third term when the allantoic fluid volume of the left horn was significantly higher than the right one (Table 2).

Regarding the ovarian length, there was no significant variation across the terms of gestation except in the right ovary where its length during the third term of gestation was significantly higher than that of the first term (Table 3). The ovarian width at the third term of gestation was significantly wider than that of the other terms, but there was no significant variation in the ovarian weights across the terms of gestation (Table 3). In some of the ovaries, the corpus luteum was observed to bulge out while other was non-protruding.

Regarding the left and right number of placentomes, there was no significant variation across the terms of gestation (Table 4). The smallest caruncular diameter at the first term of gestation was significantly lower than other terms except for the second term of gestation (Table 4). The largest caruncular diameter in the first term of gestation was significantly lower than other terms while that of the third term of gestation was significantly higher than other terms; and the largest caruncular diameter in the right horn was higher when compared to that of the left horn (Table 4). The largest and smallest caruncular diameters were observed on the ventral surface of the uterine lumen in all the cases, however, while the larger caruncle were located around the mid region of the uterine horn, the smaller caruncle were observed to at the terminal ends of the uterine horns. The placentomes were observed to be arranged in a linear manner along the longitudinal axis of the ventral and dorsal surface of the uterine horns.

Table 1. The mean biometrics of pregnant uteri of Maradi doe goat per-term

| Uterine body<br>(Mean $\pm$ SE) | Gestational age                 |                                   |                                   |
|---------------------------------|---------------------------------|-----------------------------------|-----------------------------------|
|                                 | First term<br>(days 0-50)       | Second term<br>(days 51-100)      | Third term<br>(days 101-150)      |
|                                 | n = 6                           | n = 14                            | n = 4                             |
| Weight (g)                      | 314.00 $\pm$ 28.81 <sup>a</sup> | 1285.50 $\pm$ 198.56 <sup>b</sup> | 3712.20 $\pm$ 378.83 <sup>c</sup> |
| Absolute weight (g)             | 138.17 $\pm$ 7.12 <sup>a</sup>  | 325.56 $\pm$ 87.27 <sup>b</sup>   | NA                                |
| Length (cm)                     | n = 6                           | n = 13                            | n = 3                             |
| Left side                       | 31.40 $\pm$ 1.79 <sup>a</sup>   | 51.58 $\pm$ 4.14 <sup>b</sup>     | 70.67 $\pm$ 1.76 <sup>ca</sup>    |
| Right side                      | 28.22 $\pm$ 0.98 <sup>a</sup>   | 50.51 $\pm$ 3.62 <sup>b</sup>     | 80.38 $\pm$ 2.75 <sup>ca</sup>    |

<sup>a,b,c</sup> Different letters indicates significant differences across gestation terms ( $p < 0.05$ ).Asterisk (\*) within a column indicates significant differences between the left and right values ( $p < 0.05$ ).

Table 2. The mean fetal biometrics of pregnant Maradi goats per term

| Fetal biometrics (Mean $\pm$ SE) | Gestational length            |                                 |                                  |
|----------------------------------|-------------------------------|---------------------------------|----------------------------------|
|                                  | First term<br>(days 0-50)     | Second term (days 51-100)       | Third term<br>(days 101-150)     |
|                                  | n = 6                         | n = 8                           | n = 4                            |
| Fetal weight                     | n = 6                         | n = 8                           | n = 4                            |
| Left side                        | 7.33 $\pm$ 1.54 <sup>a</sup>  | 184.88 $\pm$ 75.52 <sup>b</sup> | 346.00 $\pm$ 40.14 <sup>c</sup>  |
| Right side                       | 6.67 $\pm$ 1.23 <sup>a</sup>  | 167.62 $\pm$ 47.14 <sup>b</sup> | 304.47 $\pm$ 54.00 <sup>c</sup>  |
| Crown-rump length                | n = 6                         | n = 14                          | n = 4                            |
| Left side                        | 6.27 $\pm$ 0.54 <sup>a</sup>  | 16.25 $\pm$ 1.93 <sup>b</sup>   | 40.00 $\pm$ 0.91 <sup>c</sup>    |
| Right side                       | 6.22 $\pm$ 0.54 <sup>a</sup>  | 16.02 $\pm$ 1.72 <sup>b</sup>   | 39.33 $\pm$ 1.86 <sup>c</sup>    |
| Fetal fluid parameters           | n = 6                         | n = 10                          | n = 4                            |
| Amniotic fluid volume            |                               |                                 |                                  |
| Left horn (ml)                   | 49.17 $\pm$ 6.47 <sup>a</sup> | 177.30 $\pm$ 33.04 <sup>b</sup> | 209.67 $\pm$ 73.78 <sup>b</sup>  |
| Right horn (ml)                  | 46.00 $\pm$ 6.51 <sup>a</sup> | 141.50 $\pm$ 14.35 <sup>b</sup> | 220.00 $\pm$ 15.28 <sup>c</sup>  |
| Allantoic fluid volume           |                               |                                 |                                  |
| Left horn (ml)                   | 55.50 $\pm$ 4.85 <sup>a</sup> | 126.40 $\pm$ 23.67 <sup>b</sup> | 275.00 $\pm$ 25.66 <sup>ca</sup> |
| Right horn (ml)                  | 50.80 $\pm$ 0.80 <sup>a</sup> | 193.33 $\pm$ 63.86 <sup>b</sup> | 216.67 $\pm$ 22.05 <sup>ba</sup> |

<sup>a,b,c</sup> Different letters indicates significant differences across gestation terms ( $p < 0.05$ ).Asterisk (\*) within a column indicates significant differences between the left and right values ( $p < 0.05$ ).

Table 3. The mean ovarian biometrics of pregnant Maradi doe goats in per term

| Ovarian parameters (Mean $\pm$ SE) | Gestational length           |                               |                              |
|------------------------------------|------------------------------|-------------------------------|------------------------------|
|                                    | First term (days 0-50)       | Second term (days 51-100)     | Third term (days 101-150)    |
|                                    | n = 8                        | n = 12                        | n = 8                        |
| Ovarian length (cm)                |                              |                               |                              |
| Left ovary                         | 1.86 $\pm$ 0.13 <sup>a</sup> | 1.93 $\pm$ 0.09 <sup>a</sup>  | 2.15 $\pm$ 0.16 <sup>a</sup> |
| Right ovary                        | 1.82 $\pm$ 0.11 <sup>a</sup> | 1.99 $\pm$ 0.09 <sup>ab</sup> | 2.10 $\pm$ 0.10 <sup>b</sup> |
| Ovarian width (cm)                 |                              |                               |                              |
| Left ovary                         | 1.40 $\pm$ 0.08 <sup>a</sup> | 1.44 $\pm$ 0.05 <sup>a</sup>  | 1.77 $\pm$ 0.19 <sup>b</sup> |
| Right ovary                        | 1.41 $\pm$ 0.06 <sup>a</sup> | 1.39 $\pm$ 0.07 <sup>a</sup>  | 1.60 $\pm$ 0.10 <sup>b</sup> |
| Ovarian weight (g)                 |                              |                               |                              |
| Left ovary                         | 1.39 $\pm$ 0.17 <sup>a</sup> | 1.48 $\pm$ 0.11 <sup>a</sup>  | 1.57 $\pm$ 0.28 <sup>a</sup> |
| Right ovary                        | 1.42 $\pm$ 0.19 <sup>a</sup> | 1.38 $\pm$ 0.23 <sup>a</sup>  | 1.62 $\pm$ 0.22 <sup>a</sup> |

<sup>a,b,c</sup> Different letters indicates significant differences across gestation terms ( $p < 0.05$ ).

Table 4. The mean placentomal biometrics of Maradi doe goats per term gestation

| Placentomal parameters<br>(Mean $\pm$ SE) | Gestational length            |                               |                               |
|---|-------------------------------|-------------------------------|-------------------------------|
|   | First term<br>(days 0-50)     | Second term<br>(days 51-100)  | Third term<br>(days 101-150)  |
|   | n = 6                         | n = 14                        | n = 6                         |
| Number of placentomes                     |                               |                               |                               |
| Left uterine horn                         | 62.33 $\pm$ 2.16 <sup>a</sup> | 64.93 $\pm$ 3.16 <sup>a</sup> | 57.00 $\pm$ 3.61 <sup>a</sup> |
| Right uterine horn                        | 56.67 $\pm$ 3.30 <sup>a</sup> | 62.75 $\pm$ 2.09 <sup>a</sup> | 57.33 $\pm$ 2.40 <sup>a</sup> |
| Smallest caruncular diameter (cm)         |                               |                               |                               |
| Left uterine horn                         | 0.35 $\pm$ 0.09 <sup>a</sup>  | 0.47 $\pm$ 0.06 <sup>ab</sup> | 0.60 $\pm$ 0.15 <sup>b</sup>  |
| Right uterine horn                        | 0.30 $\pm$ 0.05 <sup>a</sup>  | 0.58 $\pm$ 0.11 <sup>b</sup>  | 0.75 $\pm$ 0.15 <sup>b</sup>  |
| Largest caruncular diameter (cm)          |                               |                               |                               |
| Left uterine horn                         | 1.64 $\pm$ 0.19 <sup>a</sup>  | 2.57 $\pm$ 0.31 <sup>b</sup>  | 3.53 $\pm$ 0.41 <sup>ca</sup> |
| Right uterine horn                        | 2.06 $\pm$ 0.25 <sup>a</sup>  | 3.03 $\pm$ 0.37 <sup>b</sup>  | 4.60 $\pm$ 0.60 <sup>ca</sup> |

<sup>a,b,c</sup> Different letters indicates significant differences across gestation terms ( $p < 0.05$ ).Asterisk (\*) within a column indicates significant differences between the left and right values ( $p < 0.05$ ).

## Discussion

The progressive and significant increase in the length and weight of the uteri across gestation is obviously due to increase in the dimension and mass of the developing conceptuses. The values of the uterine weight and length for the first and second terms of gestation were similar to that reported by Jaji *et al.* (2012) for the Sahelian doe-goat, but the uterine weight in the third term of gestation was higher in the present study. However, the report of uterine weight and length by Hyacinth *et al.* (2012) for pregnant Kano brown goats were lower than that observed in this study.

Significant increases in the fetal weights, CRL and volumes of the amniotic and allantoic fluids across gestation could be attributed to increase in the mass of the developing conceptus due to growth and development and this collaborate with the significant increases across gestation in the uterine weight and length

The ovary is a very dynamic tissue and the dimension is greatly influenced by the structures present on it (Noakes, 2001). In gravid doe-goats, the dimension of the ovary is influenced mostly by the corpus luteum since pregnancy anaestrus puts a negative feedback, block via progesterone inhibition the development of ovarian follicle to the preovulatory follicles (Noakes, 2001). Furthermore, in the doe-goat the corpus luteum may be protruding or embedded in the ovary to varying degrees (Els, 1983; Rowell *et al.*, 1993) thus accounting for the variability in ovarian dimensions which was also observed in this study. For the female goat the corpus luteum is dependent unlike for the female sheep in which there is a feto-placental switch (Sherwood *et al.*, 2012) for the production of progesterone and for the maintenance of pregnancy. Hence the lack of variation in the ovarian weights observed in this study suggests that by this point in the life of the corpus luteum verum steroid biosynthetic activity may have peaked. This finding of lack of significant variation in the ovarian weight across gestation is supported by similar findings by Jaji *et al.* (2012) in Sahelian doe-goats. Ovarian dimension measured in this study are similar with studies reported by Hyacinth *et al.* (2016) for Kano brown doe-goats, Ramsingh *et al.* (2013) for Andhra Pradesh goats, Gupta *et al.* (2011) for Bengal goats; and the length of the ovaries were similar to that reported by Adigwe and Fayemi (2005) for Maradi goats. In contrast, the ovarian width noted in this study was higher than the values described by the above authors.

The placentomes refers to the structures formed by the union of the fetal cotyledon and maternal endometrial caruncle in ruminants (Igwebuike and Ezeasor, 2013) and is responsible for the supply of fetal metabolic/nutrient requirements for growth and development. The number of placentomes counted in this study was similar with those reported by Abd-Elnaeim (2008) for individual uterine horn ( $64 \pm 5$ ) and with those reported by Igwebuike and Ezeasor (2013) for both horns of the WAD doe goat (95-153). The lack of variation in the number of placentomes at each term of gestation observed in this study agrees with the reports of Igwebuike and Ezeasor (2013). However, the progressive increase in the diameter of the caruncles vis-à-vis placental size suggests that the developing conceptus responds to increasing nutritional and metabolic demands of gestation by increase in the size of placentomes rather than number (Igwebuike and Ezeasor, 2013). The preponderance of large-sized placentomes and the number of placentomes in general on the ventral aspect of the uterine

lumen might indicate an adaptation to a better vascular supply to the developing conceptus since the ventral aspect of the uterus is more vascularised. Variations in the distribution pattern of placentomes from irregular or scattered (Igwebuike and Ezeasor, 2013) to regular longitudinal (Abd-Elnaeim, 2008) have been reported for different species of goat.

## Conclusions

This study showed that there are differences in the biometrics of the reproductive system of different breeds of goats. Also placentomes is very dynamic and adjusts to the nutritional demands of the fetus per term of gestation. We thus suggest that there is need for further studies to correlate these findings with the fertility and reproductive potentials per term in this particular breed of goat.

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