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ORIGINAL ARTICLE

Biometry and histomorphometry of female reproductive system of Black Bengal goats of Bangladesh

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Abstract

Background: The reproductive physiology of goat is least understood compared to cattle, sheep and pig and most of the description of goat is usually made as if it is identical to sheep. The biometric and histomorphometric analyses of female reproductive system of Black Bengal goats were performed in this study.

Methods: During October 2016 to February 2019 a total of 200 female reproductive tracts (50 from each age category of ≤ 6 months (m), 7-12 m, 13-18 m and 19-24 m) were collected and examined from various slaughter houses of Kishoreganj district of Bangladesh. For biometric study the length, width and weight of different segments of female reproductive tracts were measured. In addition, the morphometry of different parts of female genitalia was analyzed at histology. One-way ANOVA with Bonferroni's Multiple Comparison Test was performed to compare between different age groups and paired organs.

Results: Overall the size of most parts of the reproductive tract of goats increased with ages and 19-24 m group had the highest values. In paired organs such as ovaries, uterine tubes and uterine horns, the right organs were significantly bigger than the left one. Similarly, at morphometric analysis, the length of all histologic parts such as cortex and medulla of ovary, tunica mucosa, tunica muscularis and tunica serosa of uterine tube, uterus, vagina and vulva increased significantly with ages and the highest values observed at age category of 19-24 m.

Conclusion: The knowledge of the biometrical and morphometric parameters of female genitalia of Black Bengal goats would help in performing artificial insemination, pregnancy diagnosis and treating infertility related problems.

Key words: Ovary; Uterine horn; Uterus; Tunica muscularis; Tunica mucosa

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Introduction

Black Bengal goats are a very important species of livestock in Bangladesh because it retained the ability to produce offspring within a short time. The goat is called the "Poor man's cow" in Bangladesh and it is the second most important livestock in Bangladesh and plays an important role in the rural economy and earning substantial amount of foreign currency by exporting skin and other byproducts (Ahmed, 2017). In the year 2017-18, there were about 26.1 million goats in Bangladesh of which about 90% were Black Bengal goats (BBS, 2019). Each year goat production provides 20400 metric tons meat, which accounts for 25% of total red meat in Bangladesh (Ferdous et al., 2012).

The reproductive physiology of goat is least understood compared to cattle, sheep and pig. Description of goat is usually made as if it is identical to sheep (Smith, 1986). To maintain a good reproductive performance, detail information about the reproductive organs of goat is essential (Gupta et al., 2011). Moreover, the knowledge of the biometric parameters of female genitalia is very important in performing artificial insemination, pregnancy diagnosis and dealing with the infertility problems and their treatment (Kunbhar et al., 2003; Kumar et al., 2004). In addition the biometry of female genital tract of Black Bengal goats could provide basic information regarding the anatomical structure of normal reproductive organs and to establish baseline data on the normal dimensions of different segments of the reproductive tract of the Black Bengal goats in Bangladesh.

Very little work has been carried out on to the biometry of genital system of goats in Bangladesh (Gupta et al., 2011). Control of diseases is also very important to ensure good health which also demands normal measurements of different reproductive tracts. Therefore, this study was aimed at providing basic information regarding the anatomical structure of normal reproductive organs and to establish baseline data on the normal dimensions of different segments of the reproductive tract of the Black Bengal goats of Bangladesh.

Materials and methods

Collection of reproductive organs

A total of 200 reproductive organs of female Black Bengal goats were collected from different slaughter houses at Sadar upazila of Kishoreganj district of Bangladesh during October 2016 to February 2019. The organs were separated into four groups based on the age of the goats such as ≤ 6 months, 7-12 months, 13-18 months and 19-24 months. Each age group contained 50 organs. After collection the organs were transported to the Department of Pathology, Bangladesh Agricultural University. The whole reproductive systems of goats were placed in a stainless steel tray, cleaned from adjacent tissues and examined.

Measurement of different biometric parameters

For biometric measurement, the length and width of the organs were measured using measuring tape, slide calipers and measuring scale. For the measurement of the weight of the ovaries, the electric balance was used following the procedure used by Gupta et al. (2011). Length of the ovary was measured as the distance between the anterior and posterior surfaces, width as the distance between the medial and lateral border of the ovaries. The length of uterine tubes was measured from the infundibulum to uterus junction and the diameter was calculated from the circumferences. Each uterine horn was incised along its dorsal surface to expose its lumen from the oviduct tubal junction to the bifurcation of the body of the uterus. The length of uterine horn was taken from the internal bifurcation to the apex of horn. The width of the lumen is the distance between the two walls of the uterine horn at its midpoint. The body of the uterus was incised and this dorsal incision continued in a straight line to the dorsal commissure of the vulva in order to fully expose the cervical canal and the vagina. The length of the body of uterus was taken as the distance between the internal cervical os and the bifurcation of the two horns. The width of the

body of uterus was taken at the middle portion from the left to right. The length of the cervix was measured from the internal os to the external os and the width of the cervix was taken at the middle portion. The length of vagina was measured as the distance from the opening of the external os to the tip of the ventral commissure of the vulva. Width was measured as the distance between the right and the left vaginal wall at 3 cm from external os of the cervix. The length of the vulva was taken from the external vulva opening to the vestibule and the width of the vulva was calculated from the circumferences.

Histomorphometry

For histomorphometry study, reproductive systems of 20 goats (5 from each age group) were analyzed by histological study. Different organs and parts of the reproductive system were collected in 10% neutral buffered formalin. Next, tissue samples were processed, sectioned and stained with routine haematoxylin and eosin staining as described previously (Luna, 1988). For histomorphometric measurement, slides were examined under the microscope (TCM 400, LABOMED, Germany) in photo micrometric methods and the length were measured in pixel unit and values were converted into micrometer (µm). In case of ovary, the length of the cortex and medulla was recorded. Similarly the length of mucosa, muscularis and serosa of Fallopian tube, uterus, vagina and vulva were measured.

Statistical analysis

Data were analyzed using the GraphPad Prism 5.0 software. One-way ANOVA with Bonferroni's Multiple Comparison Test was performed to compare between different age groups and paired organs.

Results and Discussion

Biometry of female reproductive system of Black Bengal goats

Biometry of ovary

The ovaries of mature goat were almond shaped. The length of right ovary (1.39±0.11cm at ≤ 6 m, 1.41±0.16 cm at 7-12 m, 1.59±0.07cm at 13-18 m and 1.77±0.16 cm at 19-24 m) was significantly ($p \leq 0.05$) higher than that of left ovary (1.31±0.14 cm at ≤ 6 m, 1.34±0.11 cm at 7-12 m, 1.45 ±0.06 cm at 13-18 m and 1.71 ±0.15 cm at 19-24 m) (Fig. 1a). Comparatively a lower length for both right and left ovaries of goats was reported by Islam et al. (2007) at 6 month of age in comparison to the present study; however, a higher length was reported by Mohammadpur (2007) in Iranian native goat at 19-20 m of age. The width of right ovaries were 0.54±0.05 cm at ≤ 6 m, 0.91±0.14 cm at 7-12 m 1.27±0.11cm at 13-18 m and 1.35 ±0.02 cm at 19-24 m. The width of left ovaries were 0.52±0.06 cm at ≤ 6 m, 0.80±0.10 cm at 7-12 m, 1.19 ±0.06 cm at 13-18 m and 1.33 ±0.01 cm at 19-24 m. No significant ($p \geq 0.05$) difference was found between the mean width of right and left ovaries (Fig. 1b). A comparatively lower width for both right and left ovaries of goats was reported by Islam et al. (2007) than the right and left ovaries of 7-12 m old Black Bengal goats found in this study. The reported mean width of right and left ovaries in adult Black Bengal goats (Gupta et al., 2011) were lower than that of right and left ovaries of 7-12 m aged goats we observed, however, a higher width was reported by Mohammadpur (2007) in Iranian native goat. The mean width of right and left ovaries of 24-30 m old teddy goat (Akhtar et al., 2012) were similar to the 19-24 m old Black Bengal goats found in this study. The weight of right ovary was 0.33±0.009 gm at ≤ 6 m, 0.99±0.13 gm at 7-12 m, 1.11±0.17 gm at 13-18 m and 1.41±0.08 gm at 19-24 m. The weight of left ovary was 0.32±0.01gm at ≤ 6 m, 0.85±0.11 gm at 7-12 m, 0.98±0.20 gm at 13-18 m and 1.32±0.10 gm at 19-24 m. A significant ($p \leq 0.05$) difference was found between the mean weight of right and left ovaries (Fig. 1c). The weight of right and left ovaries of adult Black Bengal goats (Gupta et al., 2011) were lower than the weight of right and left ovaries at 7-12 m old Black Bengal goats in the present study. In contrary, the weight of right and left ovaries of adult Iranian native goats (Mohammadpur, 2007) were higher than the weight of right and left ovaries of 19-24 m old Black Bengal goats.

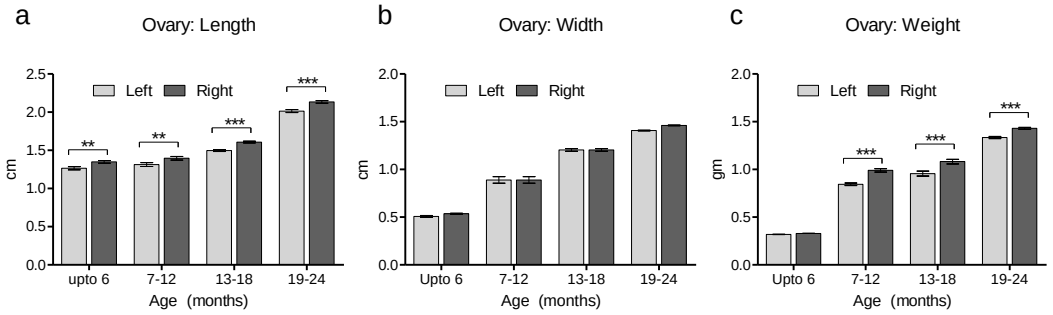

Fig. 1: Biometric measurement of ovary of Black Bengal goats. Bar diagram showing the length (a), width (b) and weight (c) of ovaries of Black Bengal goats. Data indicate mean ± SEM of 50 goats in each group. One-way ANOVA with Bonferroni's Multiple Comparison Test; **P ≤ 0.01; ***P ≤ 0.001.

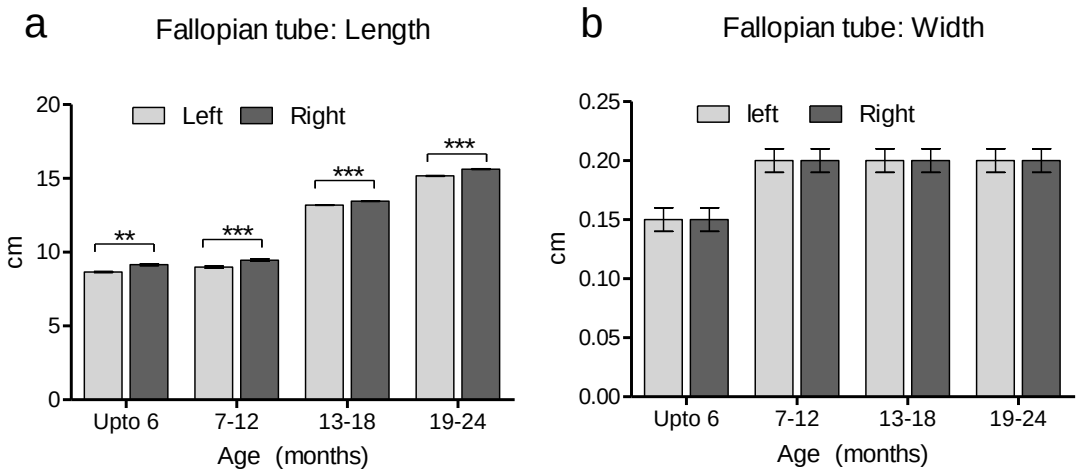

Fig. 2: Biometric measurement of fallopian tubes of Black Bengal goats. Bar diagram showing the length (a) and width (b) of fallopian tubes of Black Bengal goats. Data indicate mean ± SEM of 50 goats in each group. One-way ANOVA with Bonferroni's Multiple Comparison Test; **P ≤ 0.01; ***P ≤ 0.001.

Biometry and histomorphometry of female reproductive system

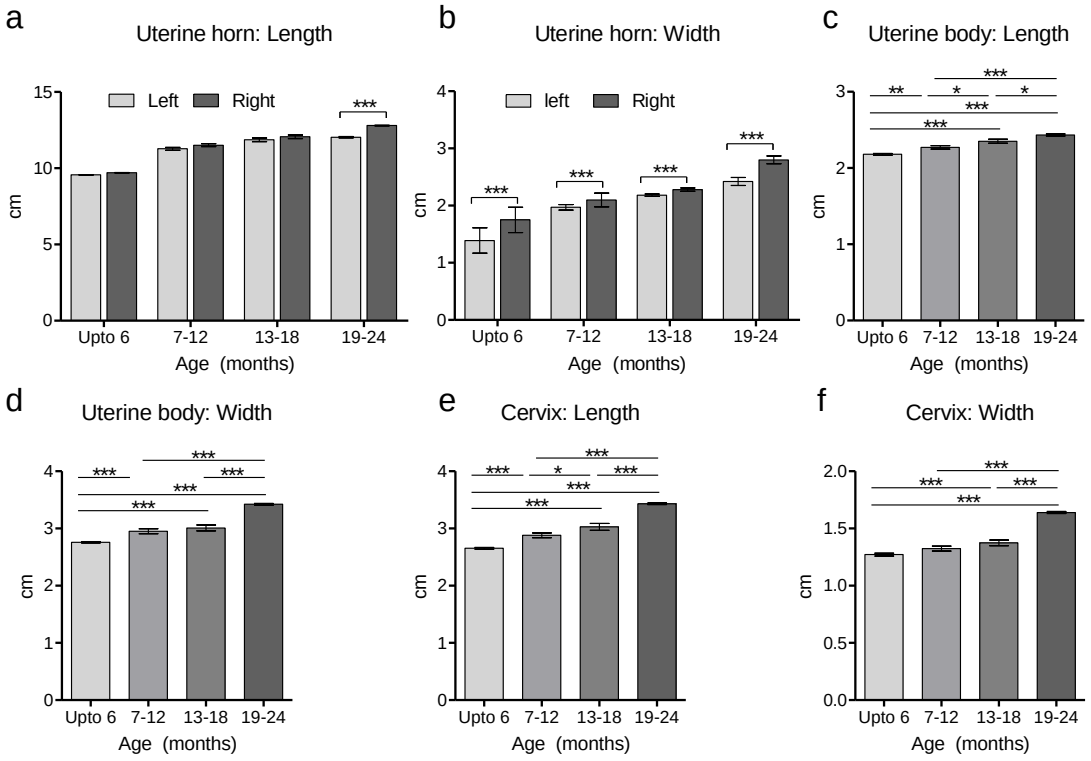

Fig. 3: Biometric measurement of uterus of Black Bengal goats. Bar diagram showing the length (a) and width (b) of uterine horns, length (c) and width (d) of uterine body and length (e) and width (f) of cervix of Black Bengal goats. Data indicate mean ± SEM of 50 goats in each group. One-way ANOVA with Bonferroni's Multiple Comparison Test; *P ≤ 0.05, **P ≤ 0.01; ***P ≤ 0.001.

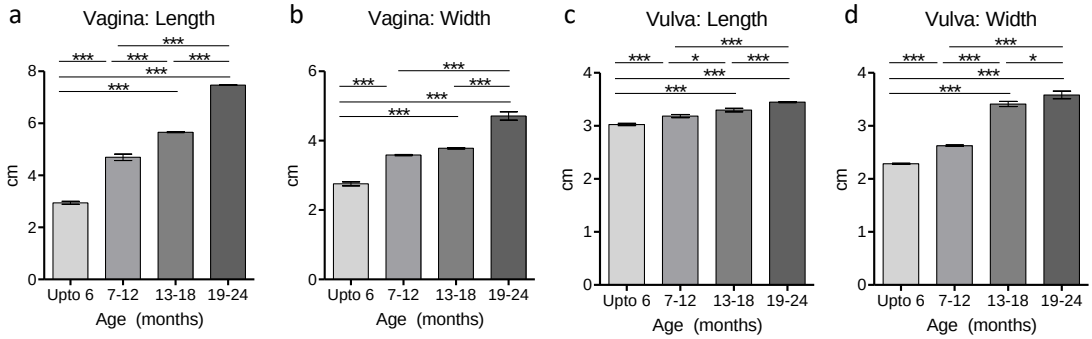

Fig. 4: Biometric measurement of vagina and vulva of Black Bengal goats. Bar diagram showing the length (a) and width (b) of vagina and (c) length and (d) of vulva of Black Bengal goats. Data indicate mean ± SEM of 50 goats in each group. One-way ANOVA with Bonferroni's Multiple Comparison Test; *P ≤ 0.05, **P ≤ 0.01; ***P ≤ 0.001.

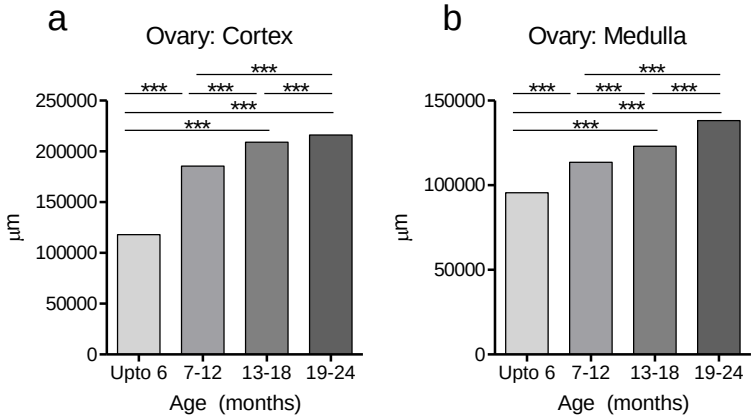

Fig. 5: Histomorphometric measurement of ovarian cortex and medulla of Black Bengal goats. Bar diagram showing the length of cortex (a) and medulla (b) of Black Bengal goats. Data indicate mean ± SEM of 50 goats in each group. One-way ANOVA with Bonferroni's Multiple Comparison Test; ***P ≤ 0.001.

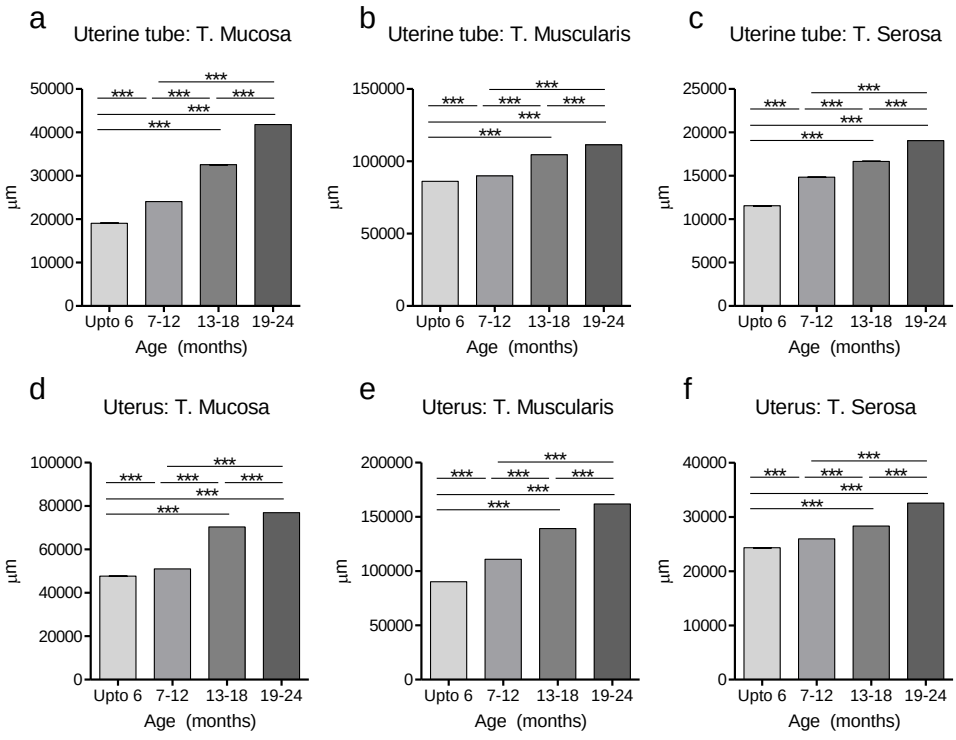

Fig. 6: Histomorphometric measurement of uterine tube and uterus of Black Bengal goats. Bar diagram showing the length of Tunica mucosa (a), Tunica muscularis (b) and Tunica serosa (c) of uterine tube; Tunica mucosa (d), Tunica muscularis (e) and Tunica serosa (f) of uterus. Data indicate mean ± SEM of 50 goats in each group. One-way ANOVA with Bonferroni's Multiple Comparison Test; ***P ≤ 0.001.

Biometry and histomorphometry of female reproductive system

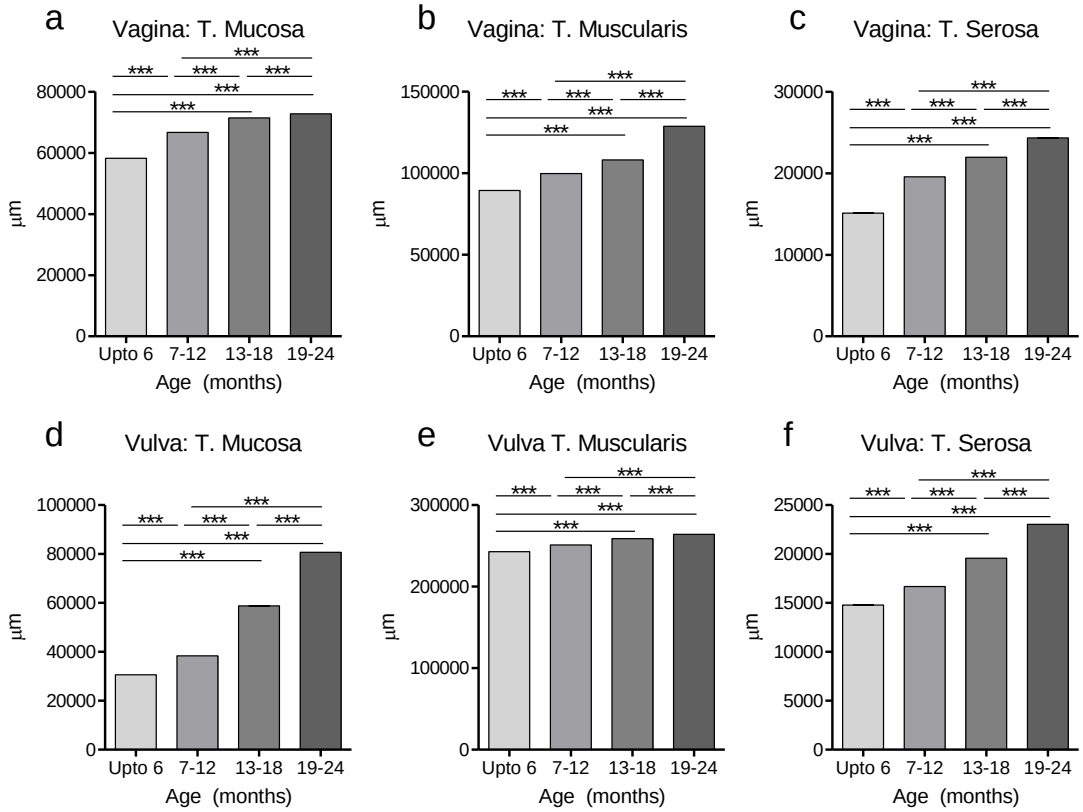

Fig. 7: Histomorphometry measurement of vagina and vulva of Black Bengal goats. Bar diagram showing the length of Tunica mucosa (a), Tunica muscularis (b) and Tunica serosa (c) vagina; Tunica mucosa (d), Tunica muscularis (e) and Tunica serosa (f) of vulva. Data indicate mean ± SEM of 50 goats in each group. One-way ANOVA with Bonferroni's Multiple Comparison Test; ***P ≤ 0.001.

Biometry of fallopian tube

The length of the fallopian tube increased with ages. The length of right fallopian tube was 9.2±0.45 cm at ≤ 6 m, 9.3±0.57 cm at 7-12 m 13.42±0.11 cm at 13-18 m and 15.61±0.20 cm at 19-24 m. The length of left fallopian tube was 8.5±0.02 cm at 6 m, 9.0±0.54 cm at 7-12 m, 13.17±0.08 cm at 13-18 m and 15.17±0.19 cm at 19-24 m. The length of right fallopian tube was significantly ($p \leq 0.05$) higher than the left one (Fig. 2a). The fallopian tube of adult Maradi goat (Talukdar et al., 2015) had similar length as of 19-24 m old Black Bengal goats.

In contrary, the width of the fallopian tube increased up 7-12 m age groups and then remained constant (Fig. 2b). The width of right fallopian tube was 0.15±0.01 cm at ≤ 6 m, 0.2±0.01 cm at 7-12 m, 0.2±0.01 cm at 13-18 m and 0.2±0.01 cm at 19-24 m. The width of left fallopian tube was 0.15±0.01 cm at ≤ 6 m, 0.2±0.01 cm at 7-12 m, 0.2±0.01 cm at 13-18 m and 0.2±0.01 cm at 19-24 m.

Biometry of uterus

The length and width of the uterine horns increased with ages (Fig. 3a, b). The length of right horn was 9.75 ±0.09 cm at ≤ 6 m, 11.2±0.53 cm at 7-12 m, 12.2±0.82 cm at 13-18 m and 12.8±0.12 cm at 19-24 m. The length of left horn was 9.5±0.09±0.09 cm at ≤ 6 m, 10.97±0.54 cm at 7-12 m, 11.87±0.69 cm at 13-18 m and 11.98±0.33 cm at 19-24 m. The length of the right horn was significantly ($p \leq 0.05$) higher than the left horn at 19-24 m age group. The length of uterine horns in Black Bangle goat was within the

range (10-12 cm) as reported by Sisson and Grossman (1972) in small ruminants. Comparatively a higher value was reported by Adigwe and Fayemi (2005).

The width of right horn was 1.75±0.22 cm at ≤ 6 m, 2.10±0.12 cm at 7-12 m, 2.28±0.03 cm at 13-18 m, and 2.80±0.07 cm at 19-24 m. The width of left horn was 1.39±0.22 cm at ≤ 6 m, 1.97±0.05 cm at 7-12 m, 2.18±0.02 cm at 13-18 m and 2.42±0.07 cm at 19-24 m. The width of the right horn was significantly ($p \leq 0.05$) higher than the left horn in all four age groups. However, the width of the uterine horn of Black Bengal goats was higher than that mentioned by Adigwe and Fayemi (2005) in Sokoto goat of Nigeria.

Both the length and width of the body of uterus increased significantly with ages (Fig. 3c, d). The length of body of uterus was 2.18±0.09 cm at ≤ 6 m, 2.27±0.16 cm at 7-12 m, 2.35±0.18 cm at 13-18 m, and 2.43 ±0.08 cm at 19-24 m. The diameter of body of uterus was 2.76±0.08 cm at ≤ 6 m, 2.95±0.31 cm at 7-12 m, 3.01±0.35 cm at 3-18 m and 3.42±0.10 cm at 19-24 m. The length of the body of uterus in Black Bangle goat was almost similar with the value reported by Sisson and Grossman (1972) but lower than that reported by Adigwe and Fayemi (2005).

Similar to the body of uterus, the length and diameter of cervix increased significantly with ages (Fig. 3e, f). The length of cervix was 2.62±0.11 cm at ≤ 6 m, 2.78±0.31 cm at 7-12 m, 2.91±0.43 cm at 13-18 m and 3.56±0.13 cm at 19-24 m. Whereas, the diameter of cervix was 1.27±0.10 cm at ≤ 6 m, 1.26±0.11 cm at 7-12 m, 1.29±0.13 cm at 13-18 m and 1.75±0.05 cm at 19-24 m. The length of cervix recorded in this study was slightly higher in age 19-24 month than the value reported by previous studies (Gupta et al., 2011; Talukder et al., 2015; Sisson and Grossmen, 1972).

Biometry of vagina and vulva

Both the length and width of the vagina increased significantly with ages (Fig. 4a, b). The length of vagina was 2.85±0.46 cm at ≤ 6 m, 4.9±0.04 cm at 7-12 m, 5.32±0.14 cm at 13-18 m and 7.49±0.09 cm at 19-24 m. The diameter of vagina was 2.66±0.47 cm at ≤ 6 m, 3.5±0.13 cm at 7-12 m, 3.98±0.98 cm at 13-18 m and 4.91±1.02 cm at 19-24 m. The length of vagina of Black Bengal goat were consistent with the result of Adigwe and Fayemi (2005) in age group 13-18 m but higher in age group 19-24 m compared to previous studies (Talukder et al., 2015; Gupta et al., 2011).

Similarly, the length and diameter of the vulva increased over time (Fig. 4c, d). The length of vulva was 2.67±0.15 cm at ≤ 6 m, 3.10±0.13 cm at 7-12 m, 3.18±0.23 cm at 13-18 m and 3.43±0.08 cm at 19-24 m. The diameter of vulva was 2.44±0.11 cm at ≤ 6 m, 2.63±0.09 cm at 7-12 m, 3.54±0.35 cm at 13-18 m, 3.77±0.51 cm at 19-24 m. The length and diameter of vulva in Black Bengal goat were found to be almost similar with the range reported by Gupta et al., (2011) and higher than that the value obtained by Adigwe and Fayemi (2005) in age group 6 m and shorter than published values of 3.6 cm for the vulva of goats (Smith, 1986) in 19-24 m age group of our study.

Histomorphometry of female reproductive system of Black Bengal goats

Histomorphometry of ovary

The length of ovarian cortex was 72.285±0.714 µm at ≤ 6 m, 97.157±0.752 µm at 7-12 m, 117.97±0.53 µm at 13-18 m and 163.172±5.057 µm at 19-24 m. The length of ovarian medulla was 62.773±0.530 µm at ≤ 6 m, 76.531±0.499 µm at 7-12 m, 86.398±0.447 µm at 13-18 m and 97.221±0.728 µm at 19-24 m. Of note, the length of the both cortex and medulla increased significantly with ages (Fig. 5). The mean values for the lengths of the cortex and medulla were recorded to be 69.359±3.68 µm and 42.067±2.12 µm (Sahu et al., 2017).

Histomorphometry of uterine tube

The length of mucosal fold of uterine tube was 138.14±1.04 µm at ≤ 6 m,145.16±0.45 µm at 7-12 m, 152.28±0.23 µm at 13-18 m and 163.46±0.28 µm at 19-24 m; the length of muscularis was 7.79±0.01 µm at ≤ 6 m,

8.18±0.13 µm at 7-12 m, 8.45±0.28 µm at 13-18 m and 9.39±0.18 µm at 19-24 m; the length of serosa was 5.08±0.05 µm at ≤ 6 m,6.11±0.08 µm at 7-12 m, 6.83±0.06 µm at 13-18 m, 7.35±0.20 µm at 19-24 m (Fig. 6a-c). The lengths of the tunica muscularis of uterine tube was recorded 7.0±4.0 µm at 6 month age of West African draft goat whereas the thickness of tunica mucosal fold was recorded as 138.20±8.80 µm (Abiaezute et al., 2017).

Histomorphometry of uterus

The lengths of uterine mucosa was 857.75±0.691 µm at ≤ 6 m, 871.85±0.946 µm at 7-12 m, 892.12±0.805 µm at 13-18 m and 917.04±5.970 µm at 19-24 m (Fig. 6d). The length of muscularis was 313.975±11.622 µm at ≤ 6 m, 411.327±0.446 µm at 7-12 m, 453.057±0.462 µm at 13-18 m and 453.057±0.460 µm at 19-24 m (Fig. 6e). The length of serosa was 24.594±0.931 µm at ≤ 6 m, 26.880±0.579 µm at 7-12 m, 29.078±0.432 µm at 13-18 m and 32.739±0.435 µm at 19-24 m (Fig. 6f). Suri and Sharma (2004) have reported higher values for perimetrium thickness in pre-pubertal and pubertal Gaddi goats. Higher values could be due to larger size and weight of Gaddi goats than Teddy goats.

Histomorphometry of vagina and vulva

The length of vaginal mucosa was 58.216±0.044 µm at ≤ 6 m, 66.682±0.008 µm at 7-12 m, 71.444±0.007 µm at 13-18 m and 72.757±.007 µm at 19-24 m (Fig. 7a). The length of muscularis was 89.469±0.048 µm at ≤ 6 m, 99.768±0.020 µm at 7-12 m, 108.227±0.011 µm at 13-18 m, and 128.851±0.012 µm at 19-24 m (Fig. 7b). The length of serosa was 15.113±0.025 µm at ≤ 6 m, 19.564±0.012 µm at 7-12 m, 21.966±0.004 µm at 13-18 m and 24.348±0.005 µm at 19-24 m (Fig. 7c).

The length of vulva mucosa was 30.63±0.044 µm at ≤ 6 m, 38.36±0.03 µm at 7-12 m, 58.75±0.016 µm at 13-18 m and 72.75±.007 µm at 19-24 m (Fig. 7d). The length of muscularis was 144.25±1.12 µm at ≤ 6 m, 213.09±1.59 µm at 7-12 m, 246.77±1.58 µm at 13-18 m, and 264.06±0.009 µm at 19-24 m (Fig. 7e). The length of serosa was 14.27±0.03 µm at ≤ 6 m, 16.67±0.007 µm at 7-12 m, 19.58±0.01 µm at 13-18 m and 23.03±0.007 µm at 19-24 m (Fig. 7f). The histological section of vagina and vulva at 6 months age categories of our study was similar with findings with Abiaezute (2015) at age group of 16 weeks in West African drawf goat.

Conclusion

The knowledge of the biometrical parameters of female genitalia would be help to perform artificial insemination, pregnancy diagnosis and treating infertility related problems. Biometrical results established the baseline data of the normal dimensions of different segments indifferent age group of the reproductive tract of the Black Bengal goats that would be help to diagnosis different abnormal conditions. More research on biometry of Jamunapari, cross breed and aged (> 2 years) goats are needed for better understanding of the reproduction in these animals.

Conflict of Interest

None to declare

Funding

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