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Full Length Research Paper

Postnatal development of the vagina in West African dwarf goat (*Capra hircus*)

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The postnatal developmental pattern of the vagina of WAD goat from birth to week 28 was investigated by gross and light microscopy. Forty five (45) female WAD goat kids were used in this study and were divided into nine groups of five goat kids per group. Each goat was euthanized, the vagina dissected out and studied, the length and weight measured. Data obtained were analysed by analysis of variance and Duncan's new multiple range test with values of p< 0.05 considered significant. The tissues were fixed in Bouin's fluid and routinely processed for histology. At birth, the length and weight of the vagina of the female WAD goat were 1.85 ± 0.10 cm and 0.10 ± 0.01 g, respectively. These increased significantly (p< 0.05) to 5.07 ± 0.39 cm and 4.04 ± 0.33 g at 28 weeks of age, respectively. The longitudinal folds and hymen were ill defined at birth but became increasingly prominent as the goats aged with the longitudinal folds extending into the vulva. Histologically, the epithelium in all age group was a stratified squamous type. At birth, the lamina propria-submucosa formed the cores of the longitudinal folds composed of loose connective tissue with numerous blood vessels. The tunica muscularis was ill defined. The tunica serosa/adventitia was a loose connective tissue containing blood vessels. The vagina showed increased development of its tissues with age. The histology of the vaginal tissues at week 16 was similar to older WAD goat. In all age groups, isolated lymphoid nodules were observed in the lamina propria-submucosa. The result suggests that the WAD goat probably attained puberty earlier than previously reported.

Key words: West Africa dwarf goat, vagina, Longitudinal folds, puberty, tunica muscularis.

INTRODUCTION

The vagina is that part of the reproductive duct which is situated between the uterine cervix cranially and the vestibule caudally and lies entirely within the pelvic cavity. The vagina serves as the copulatory organ of the female that receives the male penis during copulation and acts as a passageway for the foetus during parturition (Budras and Habel, 2003). It could also be used to diagnose some general and reproductive diseases and abnormalities (Abalti et al., 2006; Menzies, 2010; Goncagul et al., 2012; Yotov et al., 2013). During the embryonic stage, the vagina is formed by the fusion and subsequent cannulation of the caudal end of the paramesonephric duct and the urogenital sinus (McGeady et al., 2006; Hyttel et al., 2010). The vaginal epithelium in all adult mammals is hormone dependent. The height and degree of keratinisation of the epithelium

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vary with stage of the estrous cycle (Noakes et al., 2001). These changes can be monitored by examining stained vaginal smears from the animal thereby establishing the stage of estrous and possibly determining the timing for controlled mating or artificial insemination. Even though some authors believe vaginal smears cytology are not useful in diagnosing the stage of the estrous cycle in ruminants except in carnivores (Hafez and Hafez, 2000; Aughey and Frye, 2001), Ola et al. (2006) and Leigh et al. (2010) described successful vaginal cytology in West African Dwarf (WAD) goats.

The West African Dwarf goats, found predominantly in the coastal areas of the country are believed to be trypano-tolerant as they thrive in tsetse fly infested areas (Oni, 2002). Knowledge of the Morphological details of the age at which the WAD goat attains puberty may be of great significance in treating and handling of vagina related defects or in the routine examination by veterinarians during fertility assessment. Available literature on the reproductive organs of domestic animal is obtained from studies on sheep and cow which are mostly of exotic breeds. This is because most description of the goat reproductive anatomy is usually made as if it is identical with the sheep (Smith, 1986; Adigwe and Fayemi, 2005). Moreover, these exotic breeds may vary from our local breeds due to differences in genetic makeup, climate and weather, vegetation and feeding regimen, disease conditions, stocking density and housing. Present work aims to describe the morphology and morphometry of the vagina of the indigenous WAD goat breed during postnatal stage.

MATERIALS AND METHODS

Forty-five (45) West African Dwarf (WAD) goats were used in present study. The female goats were obtained from traditional WAD goat breeders in Nsukka Local Government Area of Enugu state, Nigeria. Dentition was criteria for determination of age as described by Dyce et al. (2002) and Chibuzo (2006). The WAD goats were purposively assigned to ten groups of five goats each including a day old, 2 weeks, 4 weeks, 8 weeks, 12 weeks, 16 weeks, 20 weeks, 24 weeks, and 28 weeks of age. The goats were acclimatized for two weeks prior to onset of the study and were provided with feed and water ad-libitum.

Each goat was weighed with a sensitive weighing balance and euthanized by intravenous injection of sodium pentobarbitone. Following death, the vaginae were dissected outfrom the rest of the reproductive tract and trimmed of extraneous tissues. The length and weight of each vagina was determined. The vaginae were opened and internal features examined and noted.

Histological preparation

Segments of the vaginae were cut and fixed in Bouin`s fluid for 24 h. Selected sections of the segments from each group were dehydrated in increasing concentrations of ethanol, cleared in xylene and embedded in paraffin wax. 5 µm thick sections were obtained using a rotary microtome and were mounted on clean glass slides. The sections were stained with hematoxylin and eosin and studied under the light microscope. Images were captured using Moticam Images Plus 2.0 digital camera.

The means and standard errors (Mean ± S.E) of the data obtained were calculated. The data were analysed by Analysis of variance (ANOVA) and Duncan New Multiple Range Test. Significance was accepted at probability level of $p< 0.05$.

RESULTS

The vagina lay between the cervix cranially and the vulva caudally in all age group. It appeared as a long tube found entirely within the pelvic cavity and thin walled compared to the uterus. The cranial end wrapped around the *Portio vaginalis* of the cervix as the vagina fornix while the caudal end joined the vestibule of the vulva at a distinct transverse ridge - the hymen. There were longitudinal lines or ridges on the vagina mucosa that ran length-wise from the cranial end of the vagina to the vestibule through to the vulva. At birth the hymen and the longitudinal ridges were not prominent but as the animal aged, the hymen and the ridges became prominent (Figures 1 and 2). The mucosa was creamy in colour at birth but became pale as the animal aged. At birth the length and weight of the vagina of the female WAD goat increased significantly ($p< 0.05$) from 1.85 ± 0.10 cm and 0.10 ± 0.01 g to 5.07 ± 0.39 cm and 4.04 ± 0.33 g at 28 weeks of age, respectively (Table 1).

Histologically, the vaginae of the female WAD goats of all age group presented a non-keratinised stratified squamous epithelium which appeared to invaginate into the underlying connective tissue of lamina propria-submucosa. The epithelium at birth (Figure 3) appeared thicker than at week 2 and week 4 (Figure 4). The epithelium in all groups appeared to rest on the papillated lamina priopria-sub mucosa which formedthe numerous longitudinal folds of the mucosa. These folds had very cellular cores made up of loose connective tissue with numerous blood vessels but lacked glands in all groups. Below the lamina priopria-submucosa was the tunica muscularis. At birth, the tunica muscularis was composed of an ill-defined thin inner circular and outer longitudinal smooth muscle bundles interspersed with loose connective tissue. With increase in age, the smooth muscle bundles of the tunica muscularis were defined (Figure 4). Between week 12 and 16 the histology of the vagina of the WAD goat appeared very similar to older WAD goat vagina (Figure 5). The tunica muscularis were well defined showing thicker smooth muscle layers. Surrounding the tunica muscularisexternally in all age group was a loose connective tissue network of tunica serosa or adventitia containing large blood vessels which increased in size with age (Figures 4 and 5). The epithelium remained stratified squamous in all age group and appeared to increase in height at week 12 which continue to vary in height with increase in age of the goat kids (Figure 6). Varying number of lymphoid nodules with resultant lymphocytic infiltration was observed in the lamina priopria-submucosa of the vaginae of all groups (Figure 6).

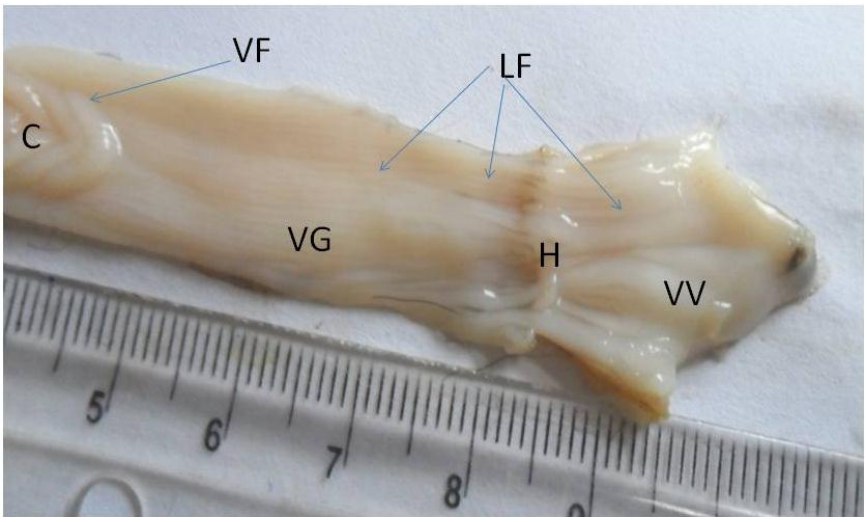

Figure 1. Gross photograph of the funnel shaped incomplete circular folds (CF) of the cervix (C), longitudinal folds (LF) of the vagina (VG) and vulva (VV)of the WAD goat at week 12. Note the hymen (H) and the fornix of the vagina (VF).

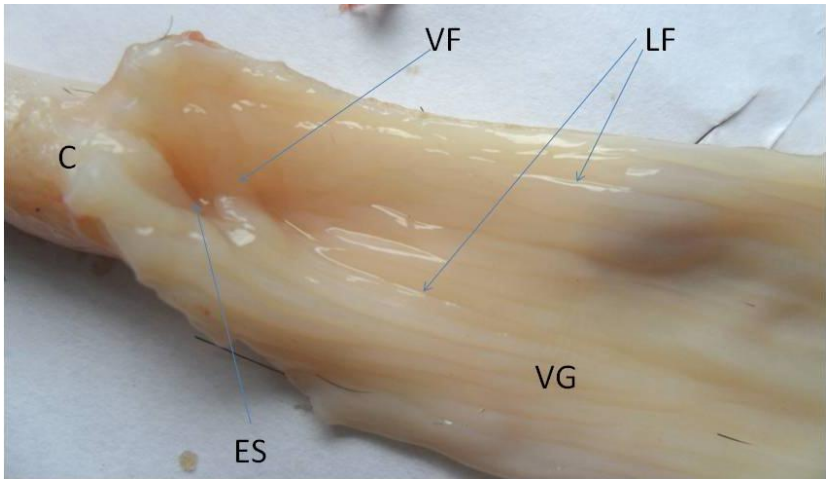

Figure 2. Gross photograph of the mucosa of the WAD goat vagina at week 28 showing longitudinal folds (LF) and the fornix of the vagina (VF). Note the external uterine ostium (ES) of the cervix (C).

Table 1. Mean length (cm) and weight (g) of wad goat Vagina during postnatal growth.

Parameter	Birth	Wk 2	Wk 4	Wk 8	Wk 12	Wk 16	Wk 20	Wk 24	Wk 28
Length (cm)	1.85 ±.10^{a}	2.14 ±.16^{b}	2.82 ±.16^{c}	3.27 ±.19^{d}	3.69 ±.21^{e}	3.85 ±.12^{e}	4.13 ±.41^{ef}	4.80 ±.33^{fg}	5.07 ±.39^{g}
Weight (g)	0.10 ±.01^{a}	0.19 ±.02^{b}	0.29 ±.02^{c}	0.95 ±.13^{d}	1.06 ±.07^{d}	1.79 ±.11^{e}	2.24 ±.24^{f}	3.59 ±.21^{g}	4.04 ±.33^{g}

Different superscripts ^{abcdef} in a row indicate significant difference ($P \leq 0.05$). Wk = Week.

DISCUSSION

Grossly, the vaginae of all age groups studied appeared similar except in absolute length and weight which statistically increased ($p < 0.05$) as the goats aged. The WAD goat vagina was a thin walled tube and functioned

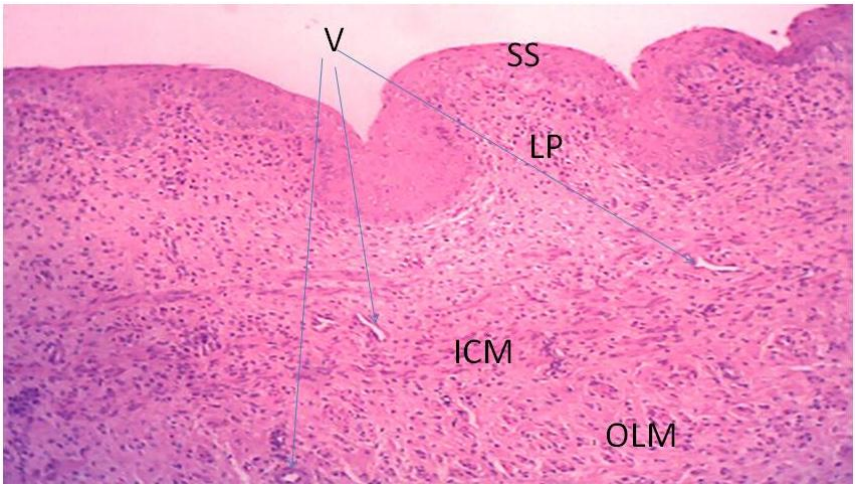

Figure 3. Cross section of vagina at birth showing papillatedlamina propria-submucosa (LP) and both inner circular (ICM) and outer longitudinal (OLM) smooth muscles. Note the blood vessels (V). H & E stain. x100.

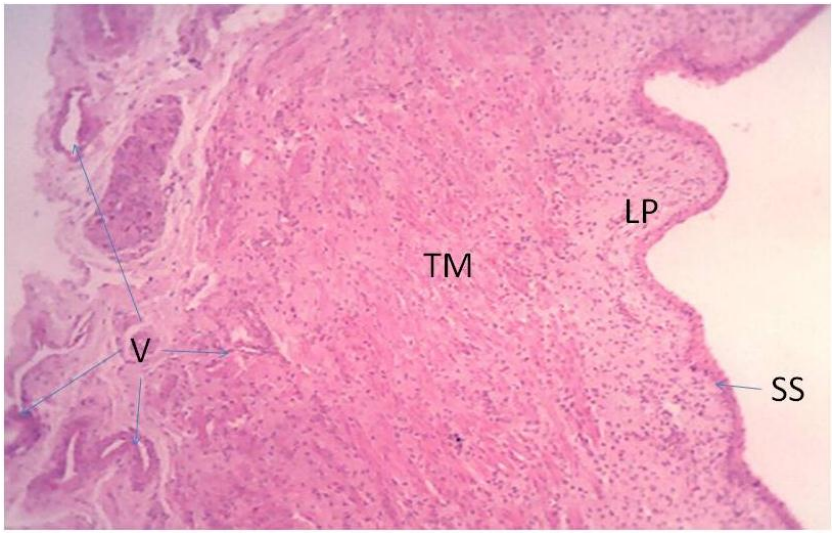

Figure 4. Photomicrograph of the WAD goat vagina at week 4 showing the lamina propria-sub mucosa (LP), the smooth muscles of the tunica muscularis (TM) and the numerous blood vessels (V) within the tunica serosa/adventitia (TA). Note the reduced height of the stratified squamous epithelium (SS). H & E. x100.

as described for ruminants (Budras and Habel, 2003; Frandson et al., 2009). The arched space of vagina fornix, the longitudinal folds and rugae of the vagina has been described by Constantinescu and Constantinescu (2010). These probably hold the secretions that facilitate lubrication for the smooth gliding of the penis during copulation and of the foetus during parturition. Moreover, the length-wise arrangement of the longitudinal folds in the WAD goat probably allows for the expansion needed during copulation and parturition. This inference is corroborated by Hafez and Hafez (2000). The distinct hymen which clearly demarcated the vagina from the vestibule in the WAD goat was similar to the ewe but differed from the indistinct hymen described in cow (Budras and Habel, 2003; Kumar, 2009).

Microscopically, the vagina of all groups of the WAD goat revealed that the wall has four tissue layers similar to the histomorphology of the vagina of ruminants (Banks, 1993; Samuelson, 2007; Bacha and Bacha, 2012). The longitudinal folds and rugae of the vagina which appeared as invaginations of the epithelium into the mucosal connective tissue probably allows for

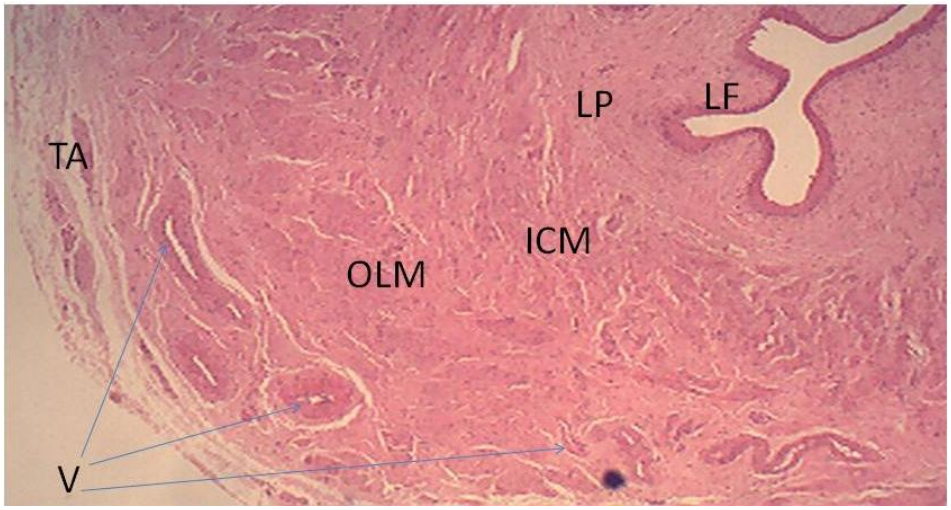

Figure 5. Cross section of vagina at week 16 showing longitudinal folds (LF) of the vagina lamina priopria-submucosa (LP)and both inner circular (ICM) and outer longitudinal (OLM) smooth muscles. Note the large blood vessels (V) within the tunica serosa/adventitia (TA).H & E x40.

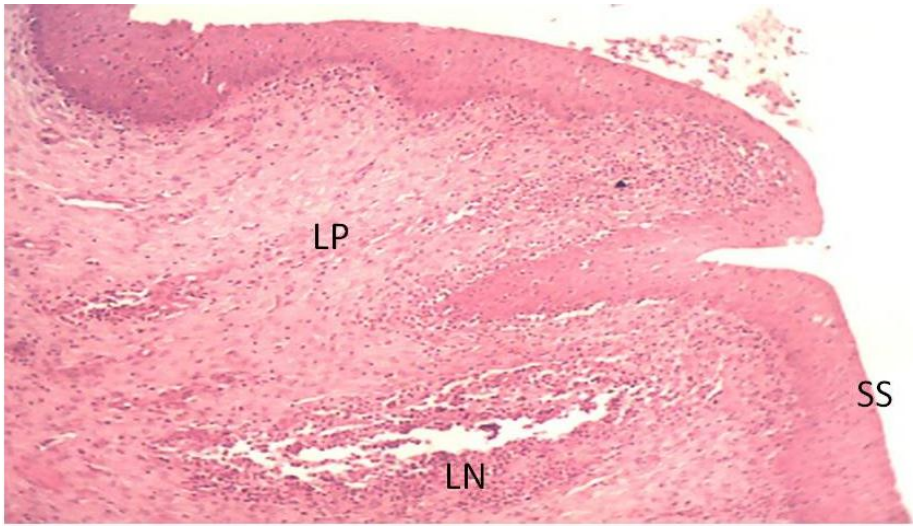

Figure 6. Photomicrograph of vagina at week 20 showing the stratified squamous epithrlium (SS), lymph nodule (LN) within the lamina priopria-submucosa (LP). Note the massive lymphocytic infiltration. H & E stain. x100.

expansion of the vagina during copulation and parturition as reported by Hafez and Hafez (2000). The non keratinised stratified squamous epithelium in WAD goat was probably an early adaptation to help protect the mucosa of the vagina from abrasion during coitus and parturition (Dyce et al., 2002; Samuelson, 2007).

Changes in the vaginal epithelium are gonadotrophin dependent (Banks, 1993). The greater height of the epithelium at birth than at week four suggests that the kids before birth were exposed to higher level of oestrogen which is known to induce proliferation of the vagina epithelium. This inference is supported by reports that foetal reproductive organs are exposed to high level of maternal gonadotrophins which may be essential for normal foetal reproductive development and thus plays an important role in programming the foetus for reproductive capacity in adult life (Mellin et al., 1966; Brooks et al., 1995). This may also explain the lower height of the epithelium observed weeks after birth being due to reduced level of gonadotrophins as a result of the immaturity of the goat kids. However, at week 12 the increased height of the epithelium suggests a resumed

proliferation which may be likened to the oestrogen controlled proliferative stage seen during oestrous cycle (Aughey and Frye, 2001). The resumption of epithelial proliferation at week 12 may be evidence of early attainment of puberty in WAD goats. Although Akusu et al., (1986) reported that first estrus in WAD goats occur at 5-7 months of age, more recent authors (Wang et al., 1991; Jainudeen et al., 2000) have shown that the goat may attain puberty as early as 3-4 months of age.

The non-glandular nature of the lamina propria-submucosa which contained numerous blood vessels has been described in literature (Aughey and Frye, 2001; Samuelson, 2007; Bacha and Bacha, 2012). Lubrication of the vaginal wall during coitus and parturition may be by endometrial secretions, mucus secretions from the cervix, fluid exudates from the blood vessels and lymphaticsin the walls of the vagina (described as a labyrinthine pathway) which seeps through the stratified squamous epithelium and secretions from the vulva (Papka and Williams, 1998; Hafez and Hafez, 2000; Jannini et al., 2005).

The vagina is generally known as the female organ of copulation (Dyce et al., 2002). Contaminants can easily enter the vagina during coitus, artificial insemination and through migration from the external genitalia. This may account for the varying number of lymphoid nodules and the lymphocytic infiltration observed in the lamina propria-submucosa and the epithelium. These structures act to produce immunological protection against invading organisms that might be harmful to the foetus and the reproductive system. This view agrees with report that local production of antibodies which seem to prevent microbial infection and antibodies against spermatozoa takes place in the vaginasince it is more exposed to sperm antigen than other parts of the reproductive tract (Hafez and Hafez, 2000).

The tunica muscularis of the vagina in all groups comprised the inner circular smooth muscle layer and an outer longitudinal smooth muscle layer. The tunica muscularis probably aids in the contraction of the vagina when stimulated during coitus to expand and accommodate the penis and possibly aid in causing exudation of the blood vessels within the lamina propria-submucosa. It may also aid parturition and involution.

Conclusion

The result showed that the WAD goat, just like other ruminants had developed some morphological adaptation to aid the function of the vagina. The increased development of the tunica muscularis, the blood vessels and the epithelium with increase in age suggests early attainment of puberty in WAD goats than earlier reported.

Conflict of interest

The authors did not declare any conflict of interest.

REFERENCES

Adigwe PI, Fayemi O (2005). A Biometric study of the reproductive tract of the Red Sokoto (Maradi) goats of Nigeria. Pak. Vet. J. 25(3):149-150.

Akusu MO, Osuagwuh AIA, Akpokodje JU, Egbunike GN (1986). Ovarian Activities of the West African Dwarf Goat (Capra hircus) during oestrus. J. Reprod. Fertil. 78:459-462. http://dx.doi.org/10.1530/jrf.0.0780459

Aughey E, Frye LF (2001). Comparative Veterinary Histology. Manson Publishing, London. pp. 183-214. http://dx.doi.org/10.1201/b15184-13

Bacha Jr JW, Bacha ML(2012). Colour Atlas of Veterinary Histology, 3rd ed. Wiley - Blackwell. United Kingdom. pp. 243-265.

Banks WJ (1993). Applied Veterinary Histology, 3rd ed. Mosby Incorporated, Missouri. pp. 446-468.

Brooks AN, McNeilly AS, Thomas GB (1995). Role of GnRh in the ontogeny and regulation of the feto-hypothalamo-pituitary axis in sheep. J. Reprod. Fertil. 49:163-175

Budras K, Habel RE (2003). Female genital organ in: Bovine Anatomy, an illustrated text. SchluterscheGmBH& Co. KG. Hannover, Germany. pp. 86-88.

Chibuzo AG (2006). Ruminant Dissection Guide: A regional approach in goat. 2nd ed. Beth-Bekka Academic Publishers, Maiduguri, Nigeria. pp. 59-60.

Constantinescu GM, Constantinescu IA (2010). Functional anatomy of the goat, in: Solaiman GS. (Ed) Goat Science and Production. Blackwell Publishing, Iowa. pp. 89-137.

Dyce KM, Sack WO, Wensing CJG. (2002). Veterinary Anatomy, 3rd ed. W. B. Saunders Company, Philadelphia. pp. 637-639.

Frandson RD, Wilke WL, Fails AD (2009). Anatomy of the Female Reproductive System in: Anatomy and Physiology of Farm Animals. 7th edition. pp. 421-427.

Goncagul G, Seyrek IK, Kumru IH, Seyrek ID (2012). Prevalence and accompanying signs of pneumovagina and urovigina in dairy cows in Southern Marmara region. Tierarztl Prax Ausg G Grosstiere Nutztiere 40(6):359-366.

Hafez B, HafezESE.(2000). Anatomy of female reproduction, in: Hafez ESE, Hafez B (Eds). Reproduction in farm animals.7th ed. Lippincott Williams and Wilkins, Philadelphia. pp. 13-29.

Hyttel P, Sinowatz F, Vejlsted M (2010). Development of the urogenital system in: Essentials of Domestic Animal Embryology. Saunders Elsevier. Sydney. pp. 252-284.

Jainudeen MR, Wahid H, Hafez ESE (2000). Sheep and Goats in: Hafez ESE, Hafez B. (Eds), Reproduction in Farm Animals. 7th ed. Lippincott Williams and Wilkins, Philadelphia. pp. 170-181.

Jannini EA, d'Amati G, Lenzi A (2005). Histology and immunohistochemical studies of female genital tissues in: Goldstein I, Meston CM, Davis S, Traish A. (Eds) Women's sexual function and dysfunction: study, diagnosis and treatment. CRC Press ebook. pp. 125-133. http://dx.doi.org/10.1201/b14618-19

Kumar P (2009). Applied Veterinary Gynaecology and Obstetrics. International Book Distribution Co. India. pp. 3-20.

Leigh OO, Raheem AK, Oluwadamilare OJA (2010). Improving the reproductive efficiency of the goat: Vaginal cytology and vulvar biometry as predictors of synchronized estrus/breeding time in west african dwarf goat. Int. J. Morphol. 28(3): 923-928. http://dx.doi.org/10.4067/S0717-95022010000300042

McGeady TA, Quinn PJ, FitzPatrick ES, Ryan MT, Cahalan S. (2006). Male and Female Reproductive Systems in: Veterinary Embryology. Blackwell Publishing. pp. 244 -267.

Mellin TN, Erb W, Estergreen VLJ (1966). Urinary excretion of oestrogen by the bovine before and after parturition. J. Anim. Sci. 25:955-957.

Menzies PI (2010). Control of important causes of infectious abortion in sheep and goats. Vet. Clin. Food Anim. 27:81-93. http://dx.doi.org/10.1016/j.cvfa.2010.10.011

Noakes DE, Parkinson TJ, England GCW (2001). Arthur's Veterinary Reproduction and Obstetrics.8th ed. Saunders Elsevier, Philadelphia. pp. 3-51.

Ola SI, Sanni WA, Egbunike GN.(2006). Exfoliative vaginalcytology during the oestrus cycle of West African dwarf goats. Reprod. Nutr. Dev. 46:87-95. http://dx.doi.org/10.1051/rnd:2005067

Oni OO (2002). Breeds and Genetic Improvement of Small Ruminants (Sheep and Goats), in: Lakpini C.A.M., Adamu A.M., Ehoche, O.W. and Gefu J.O. (Eds.) Manual for small ruminant production in Nigeria.
Papka ER, Williams JS (1998). Vagina, in: Ernest K, Jimmy DN. (Eds). Encyclopedia of Reproduction. Academic Press, San Diego California. Vol. 4. pp.961-968.
Samuelson AD (2007). Textbook of Veterinary Histology. Saunders, Missouri. pp. 443-486.
Smith MC (1986). Caprine Reproduction, in: Marrow DA. (Ed).Current Therapy in Theriogenology. W. B. Saunders. Philadelphia, USA. pp. 577-579.
Wang J, Duan E, Huang Q, Hao Z, Wu H (1991).Reproductive Performance of the Saanen goat in china. Proceedings of the final co-ordination meeting, Perth, Australia, 20–24 February 1989 on improving sheep and goat productivity with the aid of nuclear techniques, International Atomic Energy Agency, Vienna, Austria.
Yotov S, Atanasov A, Antonov A, Karadaev M (2013). Post-oestral vaginal prolapsed in a non-pregnant heifer (a case report). Trakia J. Sci.1: 95-101.