NIGERIAN VETERINARY JOURNAL
ISSN 0331-3026
Nig. Vet. J., September 2021 Vol 42 (3): 197 – 210.
https://dx.doi.org/10.4314/nvj.v42i3.3 ORIGINAL ARTICLE

Prepartum and Postpartum Evaluation of Internal Genitalia of Red Sokoto Goat Does Using Digital Rectal Palpation Technique

Bello, A.A.[1]*; Voh.Jr. A.A,[2]; Ogwu, D.[1]; Ayo, J.O.[3]

[1]Department of Theriogenology and Production, Faculty of Veterinary Medicine, Ahmadu Bello University Zaria.[2]National Animal Production Research Institute, Shika, Ahmadu Bello University Zaria.[3]Department of Veterinary Physiology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria
*Corresponding author: Email: adehabello@abu.edu.ng; Mobile:+ 234 803 615 348 3

SUMMARY
Study was aimed at determining prepartum and postpartum transrectal palpability of segments of internal genitalia of Red Sokoto Goat (RSG) does using digital rectal palpation technique. Weekly transrectal palpation of 50 does was performed prepartum for nine weeks using digital rectal palpation (DRP) technique with index finger to determine prepartum transrectal palpability. Transrectal measurement of width and length of genital segments was carried out on 26 does using DRP technique with index finger that had predetermined width and length. Twenty eight does that were cycling and with normal reproductive tract were selected and divided into artificial insemination (n = 14) and natural service (n = 14) groups indicating the method of breeding used. Body condition score (BCS) was measured. Determination of postpartum transrectal palpability and measurement of width and length of genital segments was performed on 26 does that kidded using DRP technique with index finger that had predetermined width and length. Evaluation was carried out on day 7, 14, 21 and 28 postpartum to palpate, measure genital segments and assess uterine involution. Length of index finger was 9.0 cm. Prepartum palpability of vagina, cervix, uterus, oviduct and ovary was 449 (100%), 433 (96.4%), 401 (89.3%), 0 (0.0%) and 207 (46.2%), respectively. Detection of uterus and ovary decreased with increasing BCS with $P < 0.05$ association. Mean values for width and length of uterus was 2.67 ± 0.25 cm and 5.22 ± 0.49 cm, respectively. Postpartum palpability of vagina, cervix and uterus was 104 (100%) day 7, 14, 21 and 28. Width and length of uterus on day 28 postpartum was 2.70 ± 0.08 cm and 6.21 ± 0.60 cm, respectively. Conclusion: vagina, cervix, uterus and ovary were transrectally palpable prepartum and postpartum using DRP technique with index finger; postpartum width and length of uterus on day 28 indicate completion of postpartum uterine involution in RSG does.

Keywords : prepartum; postpartum; genital segments; digital rectal palpation; goat; does.

INTRODUCTION
Gynaecological examination of reproductive tract of goats and small ruminants generally to determine anatomical, physiological and pathological features, aimed at diagnosis of normal physiological and disease conditions and improving reproduction, has been a great challenge. This is, apparently, connected with the small size of the species and small pelvic cavity, which make insertion of hand through the rectum for rectal

examination difficult. Pregnancy diagnosis using digital rectal palpation (DRP) or bimanual palpation has been reported in sheep and goats (Kutty, 1999; Abou-El-Roos and Shawki, 2003) and in goat (Bello, 2019).

Prepartum length and weight of some genital segments of the goat doe has been reported and are variable. Cervix (4 to 7 cm), uterus (15 to 20 cm), oviduct (10 to 12 cm) and ovary weighs 0.5 to 3 grams depending on the stage of the reproductive cycle (Wildeus, 2008).

The Red Sokoto (Red Maradi) goat has two varieties - the red and black coat types, and both have the same production performances (AU, 2015). The breed constitutes about 70 % of the total population of goats in Nigeria (Ozung, et al., 2011; Omontese, 2015) and also found in the South-West of Zinder in Niger. However, range of dispersion of the breed extends throughout the sub-region, either for crossbreeding or in pure breeding, in countries such as Burkina Faso, Mali, Senegal, Togo and Benin (AU, 2015). The RSG possesses a skin of high quality known as Morocco in the tannery trade (Omontese, 2015), and breeds all year-round, with age at first oestrus ranging from 120 to 170 days. Twinning is very common and milk yield is about 0.5 to 0.6 litres per day (Akusu, 2003; AU, 2015). Postpartum completion of uterine involution ranges from 24 to 28 days, and first postpartum resumption to ovarian cyclicity ranges from 19 to 30 days (Kawu, et al., 2003). Weight at birth ranges from 1.5 to 2.0 kg and reaches 12.0 kg at weaning age of 3 months under good management (Adeyinka and Mohammed, 2006).

Evaluation of the genitalia prepartum and postpartum for general gynaecological purposes in small ruminants using digital rectal palpation (DRP) technique has not been published. However, recently Bello (2019) reported similar findings in the Red Sokoto goat that segments of the female genitalia are palpable with DRP technique except for the oviduct; and that the technique may be useful in breeding and pregnancy diagnosis. This report on detail prepartum and postpartum evaluation of the genitalia of the Red Sokoto goat does using DRP technique may provide base-line data, increase current knowledge of transrectal palpation and improve productivity in the species and small ruminants in general.

MATERIALS AND METHODS

Location

The study was carried out at Small Ruminant Research Programme of National Animal Production Research Institute, Shika-Zaria, Nigeria. An initial total of 100 pluriparous Red Sokoto goat (RSG) does were selected using breeding records and kept for an observatory period of three months for oestrus detection and monthly ballottement for pregnancy diagnosis. After three months, pregnant and non-cycling does were eliminated and 50 does were finally selected for transrectal palpation experiment. During the observatory period, visit was made to small ruminant slaughter slab where gross samples of RSG genitalia (n = 57) were collected and evaluated.

Prepartum evaluation

Fifty does, aged between 18 to 36 months and weighed between 20 to 40 kg, were confined and fed concentrate and hay (*Digitaria smutsi)*. Ration was fed twice daily at 09:00 h and 16:00 h, at a feeding regime of 50:50 ratio of grass to concentrate. The goats were given access to water and mineralised salt lick *ad libitum*.

Prepartum transrectal palpation of genital segments was carried out on the 50 does using digital rectal palpation technique with the index (first) finger to determine palpability of the segments. Palpation was performed weekly between 07:00 to 09:00 h and for nine weeks. Of the 50 does, 26 with normal and complete detected genital segments were selected for transrectal

measurement. Prepartum transrectal measurement of length and width of genital segments was carried on the 26 does using digital rectal palpation technique with the index (first) finger to determine their size. Body condition score, weight, height, chest girth, external pubic symphysis length and duration per palpation were measured following each weekly palpation.

Postpartum evaluation

Out of the 50 does evaluated prepartum, 28 (26 with transrectally measured length and width inclusive) cycling and with normal genital segments were selected and divided into two groups: artificial insemination (AI; n = 14) and natural service (NS; n = 14). Does were bred by AI and NS breeding methods. Pregnancy was diagnosed using ultrasonography and confirmed by kidding (n = 26). Postpartum transrectal palpation and measurement of genital segments was carried out using digital rectal palpation technique on day 7, 14, 21 and 28, in the 26 does that kidded.

Measurement of gross genitalia

Red Sokoto goat does (n = 57), adults and aged between 18 to 30 months and weighed 15.5 to 25.0 kg slaughtered at the small ruminant slaughter slab were used for gross genital segments measurement. Complete genitalia were carefully excised and laid on a table; and the vulva, vagina, cervix, uterus, oviduct and ovary were positively identified visually. Broad ligament was teased and stretched out placing the genitalia with dorsal intercornual ligament and greater curvature of uterus dorsally. Thread was gently placed over the vulva longitudinally to determine the length; same thread length was laid on a flexible measuring tape to determine the vulva length (cm). The process was repeated on the vulva, but the thread was placed horizontally across the vulva lips to determine the width (cm). Same procedure was repeated for vagina, cervix, uterus and oviduct to determine their respective lengths and widths. Circumference of the ovary was measured using the same procedure and divided into two to determine the diameter.

Animal restraint

Restraint of animals for digital rectal palpation technique to detect and measure segments of genitalia and for measurements of certain body parameters was carried out by an attendant with doe restrained in standing position, between legs and holding the head. Restraint for measurement of external pelvic symphysis length (EPSL) was on dorsal recumbency on a cradle with limbs secured while for weight was by carrying the doe upward and held at level of the chest by an attendant standing on birth room weighing scale. Weight of doe was obtained by subtracting weight of attendant from total weight of attendant and doe.

Measurement of index finger

Index (first) finger (right hand; n = 1) was measured. Hand with index finger was laid on a table with palm dorsally. Flexible measuring tape was place longitudinally on the first phalanx directly to determine the length (cm). Same process was repeated but with the flexible measuring tape placed horizontally at the middle across first phalanx to determine the width (cm). The procedure was repeated for second and third phalanx. The length of the first, second and third phalanx was added to give the length of the index finger (Fig. 1). The index finger was used for transrectal palpation and measurement of genital segments.

Digital rectal palpation technique

Digital rectal palpation (DRP) technique was carried out as reported by Kutty (1999) with some modifications of using the right index finger and sitting on the left side of the animal for examination. As examiner, sitting at the level of pelvic region on the left side of the animal, tail of doe was raised with left hand, index (first) finger of gloved and lubricated right hand

was inserted into the rectum and feacal pellets were removed. Tail was released and same left hand was moved to the pelvic region of posterior abdomen to evacuate a distended urinary bladder by gentle recto-abdominal pressure and to stabilize the internal genitalia within the pelvic cavity, resulting in a bimanual examination. The left palm was held vertically, with the finger tips touching the ventral floor of the posterior abdomen; it was then lifted upwards to move abdominal organs anteriorly. Then, using regulated forward, upward and backward movements, the cervix as land-mark structure was identified and fixed with the finger. Examination was performed per rectum using the index finger assisted by the fingers of the left hand (Fig. 2). Using the cervix as a land-mark for identification of segments of the genitalia, the palpability, length, width, size, shape, consistency and surface characteristics of the vagina, cervix, uterus and ovary were assessed (Kutty, 1999).

Measurement of genital segments and pubic symphysis

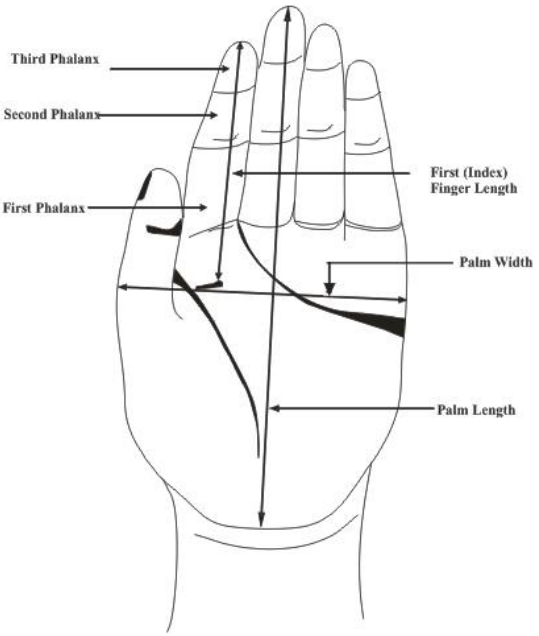

Figure 1: Schematic representation illustrating measurement of the index (first) finger

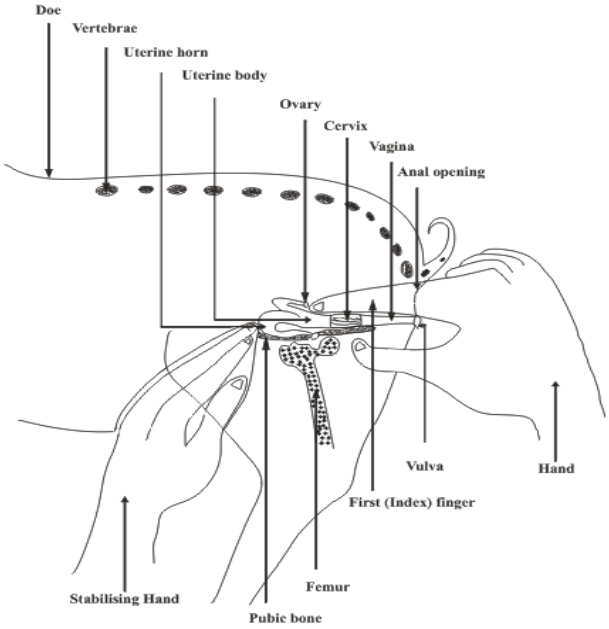

Figure 2: Schematic representation of digital rectal palpation technique in Red Sokoto goat doe

Vulva

Measurement of vulva was carried out using small ruminant vaginal speculum and flexible measuring tape that were disinfected with Purit® (Chlohexidine; Saro LifeCare Ltd, Apapa, Lagos, Nigeria) and lubricated with slipiel® lubricant (Intervet Company, France). Using flash light, vaginal speculum was inserted into the vagina until os-cervix externa was visible, and position maintained. Flexible measuring tape was inserted into the vulva (vestibule) to the anterior end of vestibule identified by circularly oriented fibres of the vestibule smooth muscle, that terminate caudal to urethral orifice, to measure the length of the vulva. The urethral orifice opens at a junction where the vestibule and the vagina meet identifiable by the hymenal ridge on the floor of the vagina. The length from cranial to caudal ends of vestibule determined length of vulva. Width of the vulva was measured by placing the

flexible measuring tape horizontally across the vulva lips following removal of the vaginal speculum. The length from left lateral to right lateral ends of vulva lips determined width of vulva.

Vagina

Transrectal palpation of the vagina was carried out using digital rectal palpation (DRP) technique. The vagina was located at the posterior part of the pelvic floor. Measurement of length of the vagina was carried out first by detecting the anterior and posterior ends of vagina at first cervical ring and anterior end of the vulva at the level of ischiatic tubercle, respectively. Transrectal measurement of vagina was performed using right hand index finger with pre-determined length and width of first, second and third phalanx. The left hand was held vertically at posterior abdomen at the level of the pelvic brim to stabilize the genitalia within the pelvic cavity; then the third phalanx tip of the right index finger was gently and longitudinally placed caudal to first cervical ring just at the point of end of anterior vagina, and the position maintained. Length of first, second and third phalanx from beginning of vagina at the level of ischiatic tubercle to first cervical ring over the vagina, determined the length of vagina. Width of the vagina was also measured with the index finger. The third phalanx of the index finger with pre-determined width was moved caudally from anterior vagina at the point of the first cervical ring to locate the midpoint of the vagina; and was then gently and longitudinally placed over the midpoint of vagina and carefully moved laterally from left to right to determine the width of the vagina.

Cervix

Transrectal palpation and measurement of the cervix was performed in similar manner. However, the cervix was located at middle of pelvic floor. Measurement of length of cervix covered three to four cervical rings from anterior end of vagina to beginning of uterus. Third cervical ring was palpated with the index finger; the tip of third phalanx of right index finger was gently and longitudinally placed at cranial end of third cervical ring and directed caudally to caudal end of third cervical ring, and the position maintained. Length of second and third phalanx over the cervical rings, determined the length of cervix. Width of the cervix was measured with third phalanx. The third phalanx gently and longitudinally placed over the middle of cervix (second ring) and carefully moved laterally from left to right, determined width of the cervix.

Uterus

Transrectal palpation and measurement of the uterus was performed in similar manner. The uterine body and horns was located at anterior part of pelvic floor close to pelvic brim. Measurement of length of uterus covered uterine body and horns from anterior end of cervix (third cervical ring) to end of uterine horn, and measured in two parts: first, from end of third cervical ring to point of dorsal intercornual ligament; and second, from point of dorsal intercornual ligament to end of uterine horn. Dorsal intercornual ligament was palpated with the index finger; the tip of third phalanx of right index finger was gently and longitudinally placed at the level of dorsal intercornual ligament and directed caudally to third cervical ring, and the position maintained. Length of second and third phalanx corresponding to the length from cervix to point of dorsal intercornual ligament determined length of first part of the uterus. Length of second part was measured by using width of third phalanx; and carried out by gently placing third phalanx on uterine horn at point of dorsal intercornual ligament and moved laterally to the right (right horn) to the end of uterine horn. The total number of third phalanx width corresponding to length from point of dorsal intercornual ligament to the end of uterine horn, determine length of the second part. Length of first and second parts was added to obtain total length of uterus. Similarly, width of the uterus was measured with width of third phalanx and measurement was at point of dorsal intercornual ligament. Third phalanx

was gently and longitudinally placed over and at boundary of left uterine horn at point of dorsal intercornual ligament and carefully moved laterally from left to right to the boundary of right uterine horn at same point of dorsal intercornual ligament. Total number of third phalanx width corresponding to length from left uterine horn to right uterine horn determined width of uterus.

Ovary

Transrectal palpation and measurement of the ovaries was performed in the same manner. Ovaries were located at end of coils of uterine horns within broad ligament, lateral to midline and slightly caudal to pelvic brim at level of third cervical ring. Once the uterine horns were palpated, the ovaries were easily located and palpated lateral to the center of the coils as small oval bodies on each side by pressing the index finger against the left fingers (Kutty, 1999). Measurement was by using width of third phalanx of the index finger. Ovary was gently palpated and carefully moved ventrally until in contact with pelvic floor and position maintained; third phalanx was gently and longitudinally placed on dorsal surface of ovary with width horizontally exerting gentle pressure. Width of third phalanx was moved over ovary laterally from left to right to determine diameter of the ovary.

Internal pelvic symphysis length

Similarly, internal pelvic symphysis length (IPSL) from the point of vulva to pelvic brim was measured transrectally with index finger with a pre-determined length. Pelvic symphysis length was measured by palpating pelvic brim using third phalanx; tip of third phalanx of the right index finger was gently and longitudinally placed at dorsal midpoint of pelvic brim at point of pubic symphysis and directed caudally to the point of ventral commissure of vulva lips, and the position maintained. Length of first, second and third phalanx corresponding to the length from pelvic brim to ventral commissure of vulva lips determined length of IPSL.

Measurement of certain body parameters

Body condition score (BCS), weight (kg), height (cm), chest girth (cm), external pubic symphysis length (EPSL; cm) and duration (min) per transrectal palpation were taken weekly following each palpation during the study period. Body condition score (BCS; scale: 1.0 – 5.0) was performed visually as described by Pullan (1978) and Voh Jr. (1996) to determine association with genital segments palpability. Weight was taken using a bathroom weighing scale (CAMRY; Number: P/1211/003003/CN/CRI), where weight of each animal was obtained by subtracting from the weight of a person carrying a doe. Height was measured as length from hoof of forelimb at ground level to the highest point at withers with doe standing using a flexible measuring tape. Chest girth was measured as circumference of the chest at the level of caudal border of scapula using flexible measuring tape with animal standing. External pubic symphysis length (EPSL) was measured from point of pelvic brim posterior to mammary gland to ventral commissure of vulva lips using flexible measuring tape with animal restrained on dorsal recumbency for comparison with internal pubic symphysis length and length of index finger. Duration per palpation was measured using a digital stop watch.

Certain precautions were observed before carrying out transrectal palpation and measurement with digital rectal palpation technique procedure: non-circling and pregnant animals were eliminated (*prepartum evaluation*); examination was carried out before feeding and watering; feacal pellets were evacuated from the rectum; urinary bladder was emptied before examination.

Oestrus synchronization and detection

Oestrus was synchronized using prostaglandin F_2-alpha ($PGF_2\alpha$; Dinoprost tromethamine, Lutalyse®) in 28 does. The animals were treated with 12.5 mg per animal by deep i/m at gluteal region using double injection, 12 days apart, protocol (Voh Jr., 1996; Bello, 2019). Two mature bucks (one per group) that demonstrated high libido

were apronised and used for oestrus detection.

Breeding of animals

Artificial insemination (AI) group (n = 14): Artificial insemination was carried out using Vaginal Speculum Method. Does were restrained standing by an assistant with hind quarters raised, and a lubricated small ruminant vaginal speculum inserted into the vagina (Leethongdee and Ponglowhapan, 2014; Farin, 2015). A flash light was used to locate the *os-cervix externa* for entry and manipulation into the cervix to deposit the semen. Size 0.5 ml AI gun was used to inseminate the does. Insemination was done 12 h after observed standing heat. The site for semen deposition was intracervical. Double insemination protocol (0.5 ml per insemination), 12 h apart was adopted (Leethongdee and Ponglowhapan, 2014; Farin, 2015).

Control group (n = 14): Breeding of does was by natural service using hand mating breeding method following detection of standing heat; twice, 12 h apart, and does were monitored until mating was confirmed by observing ejaculatory thrust.

Pregnancy diagnosis

Ultrasonography (Sonostar Laptop-C5®, 5 MHz Curvilinear Probe, China) was carried out to diagnose pregnancy on day 21 post-breeding. The perineal area cranial to the mammary gland of posterior abdomen was shaved and animal restrained on dorsal recumbency on cradle on a table. An aquasonic gel was applied on shaved area and using transcutaneous probe pregnancy was diagnosed by scanning for embryo.

Data collection and analyses

Data on index finger, genitalia, body condition score, weights, measurements (length, width, height, diameter and circumference) and duration per palpation were collected and properly recorded for each animal. The data were subjected to one-way analysis of variance (ANOVA) and GraphPad Prison Version 5.0. Values of $P < 0.05$ were considered significant (SPSS, 2011).

Ethical clearance

Approval of Ethical Clearance on Bioethics and Animal Use was obtained from Ahmadu Bello University Ethical Clearance Committee with approval number: ABUCAUC/2019/004, before the experiment was carried out.

TABLE I: Gross postmortem measurement of genital segments of Red Sokoto Goat does (n = 57).

Segments of genitalia	Dimension	Post-mortem measurement (cm) Mean + S. E.
Vulva	*Length*	2.27 ± 0.11 (1.0 – 3.0)
	Width	2.11 ± 0.02 (0.7 – 2.0)
Vagina	*Length*	6.36 ± 0.28 (6.0 - 10.0)
	Width	2.37 ± 0.19 (0.8 – 2.2)
Cervix	*Length*	3.10 ± 0.10 (1.2 - 5.0)
	Width	1.99 ± 0.57 (1.2 – 2.2)
Uterus	*Length*	19.38 ± 0.61 (12.2 - 36.0)
	Width	6.88 ± 0.32 (4.0 – 10.0)
Oviduct	*Length*	16.42 ± 0.44 (11 - 22.5)
	Width	0.30 ± 0.10 (0.1 – 0.3)
Ovary	*Diameter*	1.71 ± 2.05 (0.5 - 2.5)

TABLE II: Prepartum and postpartum palpability of segments of internal genitalia of Red Sokoto Goat does using digital rectal palpation technique

Structure	Palpability (%) of genital segments						Remark
	Prepartum (n = 50).		Postpartum (n = 26)				
	Palpable	Not Palpable	Palpable				
			Day 7	Day 14	Day 21	Day 28	
Vagina	449 (100)	0 (0.0)	104 (100)	104(100)	104 (100)	104 (100)	Intra-pelvic
Cervix	433 (96.4) [a]	16 (3.6) [b]	104 (100)	104 (100)	104 (100)	104 (100)	Intra-pelvic
Uterus[1]	401 (89.3)	48 (10.7)	104 (100)	104 (100)	104 (100)	104 (100)	Intra-pelvic
Oviduct[2]	0.0 (0.0)	450 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Ovary	207 (46.1)	292 (58.5)	0 (0.0)	0 (0.0)	5 (19.2)	13 (50.0)	CL; 9 (2.0)

Note: [1]Parts of uterus palpated included body and horns; [2]Oviduct considered without regards to the side (right or left); CL: *corpus luteum*; [ab]Different letter superscription indicates significant (P < 0.05) difference between palpability and non-palpability.

TABLE III: Relationship between prepartum palpability of segments of internal genitalia and body condition score using digital rectal palpation technique in Red Sokoto goat does.

S/N	Genital Segment Palpability (P)	Body Condition Score (BCS)							Total
		1.5	2.0	2.5	3.0	3.5	4.0	4.5	
1	Vagina: P	2 (100)	67 (100)	157 (100)	157 (100)	50 (100)	14 (100)	2 (100)	449 (100)
2	Cervix: P	2 (100)	64 (95.5)	149 (96.9)	152 (96.8)	50 (100)	14 (100)	2 (100)	433 (96.4)
3	Uterus*: P	2 (100)	63 (94.0)	146 (93.0)	141 (89.8)	35 (70.0)	12 (85.7)	2 (100)	401 (89.3)
4	Ovary*: P	2 (100)	52 (78.2	79 (44.9)	62 (39.9)	10 (21.0)	0 (0.0)	0 (0.0)	205 (46.6)

Note: Percentage (%) in parentheses, P: palpability. *Significant (P < 0.05) association between BCS and Uterus; and between BCS and ovary palpability.

TABLE IV: Prepartum and postpartum measurement of genital segments of Red Sokoto Goat does (n = 26 each).

Segment of genitalia	Dimension	Measurement (cm); Mean + S. E.				
		Prepartum	Postpartum			
			Day 7	Day 14	Day 21	Day 28
Vulva	*Length*	2.77 ± 0.65[a] (0.5 - 2.0)	2.91 ± 0.34[b] (1.5 – 3.9)	2.81 ± 0.22[c] (1.2 – 3.5)	2.78 ± 0.10 (1. – 3.2)	2.77 ± 0.11 (1.0 – 3.0)
	Width	2.02 ± 0.10[d] (0.5 – 1.5)	2.61 ± 0.67[e] (1.5 – 3.5)	2.40 ± 0.50[f] (1.0 – 3.0)	2.15 ± 0.20 (1.0 – 2.5)	2.00 ± 0.56 (0.5 – 2.0)
Vagina	*Length*	6.25 ± 0.25[g] (6.0 - 8.0)	6.95 ± 2.44[h] (6.7 - 11.0)	6.90 ± 1.20[i] (6.5 - 10.5)	6.50 ± 0.31 (6.5 - 10.0)	6.36 ± 0.28 (6.0 - 9.5)
	Width	2.12 ± 0.26[j] (0.5 – 1.5)	3.01 ± 1.28[k] (1.5 – 3.0)	2.62 ± 1.10[l] (1.0 – 2.5)	2.39 ± 0.25 (1.0 – 2.0)	2.17 ± 0.19 (0.5 – 2.0)
Cervix	*Length*	3.28 ± 0.11[m] (2.5 - 4.0)	4.55 ± 1.41[n] (3.5 - 6.0)	4.01 ± 0.50[o] (3.0 - 5.0)	3.50 ± 0.32 (2.5 - 5.0)	3.30 ± 0.10 (2.5 - 4.5)
	Width	1.72 ± 0.33[p] (1.0 - 2.0)	2.73 ± 0.57[q] (1.5 – 2.5)	2.23 ± 0.51[r] (1.5 – 2.5)	1.81 ± 0.43 (1.0 – 2.5)	1.76 ± 0.02 (1.0 – 2.5)
Uterus	*Length*	5.22 ± 0.49[s] (3.0 - 5.0)	14.13 ± 0.54[t] (7.0 - 12.0)	10.02 ± 0.54[u] (5.0 - 10.0)	7.67 ± 1.01[v] (3.5 - 7.5)	6.21 ± 0.60 (3.0 - 6.0)
	Width	2.67 ± 0.25[w] (2.0 - 3.5)	7.46 ± 0.10[x] (5.0 – 8.0)	5.96 ± 0.16[y] (3.0 – 5.0)	3.73 ± 0.12[z] (2.5 – 4.0)	2.70 ± 0.08 (2.0 – 3.5)
Oviduct	*Length*	-	-	-	-	-
	Width	-	-	-	-	-
Ovary	*Diameter*	1.06 ± 0.22 (0.5 – 1.5)	-	-	1.58 ± 1.69 (1.0 – 1.5)	1.15 ± 1.32 (1.0 – 1.5)

Note: [a-z]Different letter superscription indicates significant (P < 0.05) difference between prepartum and postpartum length and width of vulva, vagina, cervix and uterus.

TABLE V: Means ± S.E. of certain body parameters measured prepartum in Red Sokoto Goat does.

S/No	Parameter	Means ± S.E	
		N	Mean
1	BW (kg)	450	23.10 ± 0.25 (12.0 – 38.0)
2	BCS	449	2.76 ± 0.02 (2.0 – 4.5)
3	HGT (cm)	450	63.46 ± 0.15 (55.0 – 72.0)
4	GL (cm)	450	69.71 ± 0.18 (60.0 – 89.0)
5	EPSL (cm)	449	10.09 ± 0.05 (7.0 – 13.0)
6.	IPSL (cm)	26	8.25 ± 6.13 (7.5 – 9.0)
7.	DUR. (minutes)	448	1.97 ± 0.03 (0.3 – 4.4)

Note: BCS: body condition score, BW: body weight, DUR: duration, EPSL: external pubic symphysis length, GL: girth length, HGT: height at withers, IPSL: internal pubic symphysis length

RESULTS

Index finger – *Length* values were 4.5 cm (first phalanx), 2.5 cm (second phalanx), 2.0 cm (third phalanx) and 9.0 cm (total); *width* was 2.5 cm (first phalanx), 2.1 cm (second phalanx), 1.8 cm (third phalanx).

Table I shows gross post-mortem measurements of genital segments. Average length values of genital segments: lowest - 2.3 cm (vulva), highest - 19.4 cm (uterus) and total 47.5 cm; while ovary diameter was 1.7 cm. Width, lowest - 0.3 cm (oviduct) and highest - 6.9 cm (uterus).

Table II shows prepartum and postpartum palpability of segments of internal genitalia of Red Sokoto goat does. Vagina (prepartum; day 21 and 28 postpartum) was identified as soft cylindrical tubular structure posterior to the cervix lying on posterior floor of pelvic cavity. There was no tension on the vagina. Palpability was 499 (100 %) and 104 (100 %) prepartum and postpartum, respectively. Day 7 and 14 postpartum vagina was palpable located at posterior floor of pelvic cavity and there was tension on the vagina. Palpability was 104 (100 %). Cervix (prepartum; day 21 and 28 postpartum) was identified as a firm, cylindrical, three to four nodular or ring-like structure lying on the floor and middle of pelvic cavity. Apart from the bony structures, the cervix was relatively the firmest structure in the pelvic cavity. The cervix was used mainly as a landmark for locating other structures of the internal genitalia; and stabilised pelvic cavity. They varied in sizes (0.5 to 1.5 cm in diameter), depending on the palpability was 433 (96.4 %) and 104 (100 %) prepartum and postpartum, respectively. Cervix palpability and non-palpability prepartum had $P < 0.05$. Day 7 and 14 postpartum cervix was palpable, located at anterior part of pelvic cavity on the pelvic floor. There was tension on the cervix and palpability was 104 (100 %). The uterus (prepartum; day 21 and 28 postpartum) was detected as a flaccid, coiled and muscular structure lying on anterior floor of pelvic cavity. It was retractable and freely moveable with the two uterine horns, connected by dorsal and ventral intercornual ligaments at point of bifurcation clearly identifiable as they taper to the anterior coiling caudally to a blind end. Application of a gentle pressure dorsally, gave a soft tender feeling on palpation. Palpability was 401 (89.3 %) and 104 (100 %) prepartum and postpartum, respectively. Day 7 and 14 postpartum, uterus was palpable (body only) but non-retractable and oedematous located at pelvic brim and into posterior abdominal cavity. Palpability was 104 (100 %). Oviduct palpability prepartum and postpartum was 0 (0 %). Ovaries (prepartum; day 21 and 28 postpartum) were found just a few centimeters lateral to the mid-line within the pelvic cavity at the point of bifurcation of uterine horns at the same level or slightly before the level of the pelvic brim, especially for the older adult does. They were located by tracing the uterine horns of a supported age of the animal and their shapes were generally oval. Palpability was 209 (46.1 %)

and 13 (50.0 %) prepartum and postpartum, respectively. Day 7 and 14 postpartum ovary was not palpable; and palpability was 0 (0.0 %).

Table III shows relationship between prepartum palpability of segments of internal genitalia and body condition score (BCS). Palpability of vagina, cervix, uterus and ovary in does with BCS of 1.5 to 4.5 was 449 (100%), 433 (96.4%), 401 (89.3%) and 209 (46.1%), respectively. Uterus and BCS; and ovary and BCS had association value of $P < 0.05$. Palpability of uterus and ovary decreased with increasing BCS.

Table IV shows prepartum and postpartum measurement of genital segments of Red Sokoto goat does. Prepartum values for segments were 2.77 ± 0.65 cm (length) and 2.02 ± 0.10 cm (width) for vulva, 6.25 ± 0.25 cm (length) and 2.12 ± 0.26 cm (width) for vagina, 3.28 ± 0.11 cm (length) and 1.72 ± 0.33 cm (width) for cervix, 5.22 ± 0.49 cm (length) and 2.67 ± 0.25 cm (width) for uterus, and ovary was 1.06 ± 0.22 cm (diameter). Postpartum values were between 2.77 ± 0.11 to 2.91 ± 0.34 cm (length) and 2.00 ± 0.56 to 2.61 ± 0.67 cm (width) for vulva day 7, 14, 21 and 28; 6.36 ± 0.28 to 6.95 ± 2.44 cm (length) and 2.17 ± 0.19 to 3.01 ± 1.28 cm (width) for vagina day 7, 14, 21 and 28; 3.30 ± 0.10 to 4.55 ± 1.41 cm (length) and 1.76 ± 0.02 to 2.73 ± 0.57 cm (width) for cervix day 7, 14, 21 and 28; 6.21 ± 0.60 to 14.13 ± 0.54 cm (length) and 2.70 ± 0.08 to 7.46 ± 0.10 cm (width) for uterus 7, 14, 21 and 28; and 1.15 ± 1.32 to 1.58 ± 1.69 cm (diameter) for ovary day 21 and 28. The difference between prepartum and postpartum length and width of vulva, vagina and cervix for day 7 and 14 postpartum was $P < 0.05$; and difference between prepartum and postpartum length and width of uterus for day 7, 14 and 21 postpartum was $P < 0.05$. Postpartum values for genital segments decreased from day 7 to 28. Prepartum (5.22 ± 0.49 - length; 2.67 ± 0.25 - width) and postpartum (6.21 ± 0.60 – length; 2.70 ± 0.08 - width) values on day 28 for uterus were similar.

Table V shows means of certain body parameters measured prepartum in Red Sokoto does. Average values were 23.10 ± 0.25 kg (body weight), 2.76 ± 0.02 (body condition score), 63.46 ± 0.15 cm (height), 69.71 ± 0.18 cm (girt length), 10.09 ± 0.05 cm (external pubic symphysis length), 8.25 ± 6.13 cm (internal pubic symphysis length) and 1.97 ± 0.03 min (duration).

DISCUSSION

Measured index finger enabled detail transrectal evaluation of genitalia of red Sokoto goat (RSG) doe using digital rectal palpation (DRP) technique, especially with the use of length and width of phalanx for the evaluation; and this appear to open a small window for great application in the breed in the area of breeding and pregnancy diagnosis. Index finger measured approximately the same as average internal and external pubic symphysis length of the doe; and this explains the metric determination of normal lengths and widths of genital segments prepartum and postpartum. This may further enhance its usefulness in the field for breeding by artificial insemination and diagnosis of physiological (pregnancy) and pathological (tumour) conditions as reported by Bello (2019) and Kutty (1999). It may also be used postpartum to assess uterine involution (as in this report) and resumption of ovarian cyclicity.

Study of the gross structure of segments of genitalia of the red Sokoto goat (RSG) enabled acquaintance, comparison and establishment of knowledge of the local breed's genitalia. The lengths and widths of post-mortem segments of genitalia of RSG does findings agree with the reports of AU (2015) in the breed and that of Wildeus (2008) and Karadaev (2015) in goats. The postmortem study and measurements assisted in identifying genital segments ante-mortem during examinations to determine palpability and metric measurements by clearing ambiguity and guided expectations on size, lengths and widths of structures. This assisted greatly that sizes of the RSG genital segments prepartum, especially cervix, uterus and ovary were vivid.

Palpability of segments of the internal genitalia of red Sokoto goat (RSG) does prepartum and postpartum by digital rectal palpation (DRP) was high for vagina, cervix and uterus, except for ovary (low); and oviduct (not palpable). Significantly, the cervix as landmark for transrectal palpation and recto-vaginal artificial insemination; uterus as site for implantation and foetal development enabling pregnancy diagnosis by transrectal palpation; and ovary for determination of cyclical activities and functional ovarian structures, were detected prepartum and postpartum at high percentges. Notably was the palpability of ovary prepartum and on day 21 and 28 postpartum had similar values. Also, Bello (2019) reported similar finding with 100 % detection of vagina, cervix and uterus prepartum in the breed using the same technique. The percentages obtained show high potentials for gynaecological examinations, breeding by digital recto-vaginal artificial insemination (AI) and pregnancy diagnosis in the breed. More so, the prepartum and postpartum detection of ovary and *corpus luteum* is significant and of interest, suggesting that further work may enable full detection of all functional structures of the ovary, which may facilitate complete transrectal evaluation of cycling does, oestrus synchronisation and breeding, especially by AI. Variation in detection of cervix, uterus and ovary may be attributed to skills, small size, the single finger, restraint, fatty nature of does, docility, full rumen, and activeness of individual ovary as observed with paired body organs generally. However, Kutty (1999) and Abou-El-Roos and Shawki, (2003) reported higher values for ovary detection in does and ewes, respectively, during ante-mortem pregnancy diagnosis. The detection rate may be improved upon, especially that the present study was the first report. The ability to palpate the organs prepartum using DRP indicates that the internal genitalia of the doe can be gynaecologically examined to determine anatomical, physiological and pathological conditions of the reproductive tract. The findings were consistent with reports on transrectal palpation in large animals, especially in the bovine (Voh Jr., 1996). Non-detection of the oviduct, size was thought to be responsible, especially with the single finger. This was experienced even in large animal rectal examination, when the whole hand was used. Detection of the ovary generally has not been easy even in the bovine and other large animals. Experience and skills are necessary, as seen in established practice. The consistent and regular weekly palpation enabled the detection of the organs, resulting in the present findings, which agree with the reports of Bello (2019) in RSG; and of Abou-El-Roos and Shawki, (2003) that used 15 days interval in ewes and reported similar findings. The transrectal detailed evaluation prepartum and postpartum and its comparison and correlation appear to be reported for the first time in the breed and in goat.

Results showed an association between body condition score (BCS) and some palpable segments of the genitalia. Detection of ovary and uterus was found to decrease with increasing BCS, and the association was significant. This finding may have clinical implications since higher BCS is apparently not favoured by palpable segments and or structures of the genitalia during transrectal palpation in the breed; implying that breeders have to guard against weight gain in does when planning for breeding especially when rectal examination is involved. Palpability of uterus was highest at BCS of 1.5 to 3.0, while ovary was at 1.5 to 2.0 BCS. Relation of transrectal palpability and BCS reported in this report is for the first time in RSG. Differences in palpability of vagina, cervix, uterus and ovary may be attributed to skills, small size, the single finger, restraint, fatty nature of does, docility, full rumen, and activeness of individual ovary as observed with paired body organs generally.

Measurements of prepartum and postpartum average lengths and widths of genitalia of the red Sokoto goat (RSG) does with index finger using digital rectal palpation (DRP) technique made comparison of prepartum and postpartum genital segments possible.

Measurement also enabled comparison of genital segments with internal pubic symphysis length (IPSL), external pubic symphysis length (EPSL) and index finger used in the palpation process. Results show that IPSL, EPSL, index finger and length of genital segment from vagina to cervix prepartum and postpartum (day 21 and 28) approximately have the same length; thus explaining the midpoint position or location of the cervix at floor of the pelvic cavity in the breed. It equally explains the detection of the short body of the uterus prepartum and postpartum (day 21 and 28) at pelvic brim especially for the older does, as the uterine horns coils caudally tapering to a blind end terminating laterally at middle of the pelvic floor where the ovaries are located, hence, ovary detection. Days 7 and 14 postpartum, the uterus lengths and widths were higher than that of days 21 and 28, indicating that involution was still continuing and uterine horns were located cranial to pelvic brim at posterior abdominal cavity; while on days 21 and 28 postpartum metric values were similar to prepartum indicating completion of uterine involution postpartum confirming earlier reports. Ovaries were not detected on days 7 and 14 postpartum except day 21 and 28 where metric values were similar to prepartum. These are significant findings. The results numerically further show why DRP technique with index finger is possible in goats and confirms the reports of earlier authors that used the technique in does and ewes. The clinical application of these findings may be in the areas of gynaecological examination, breeding by recto-vaginal artificial insemination, pregnancy diagnosis and assessment of postpartum involution as in the present report. The transrectal metric measurement and the findings using the index finger in RSG does reported in the present study is for the first time to the best of our knowledge, and the novelty of this work.

The average values for certain body parameters determined were within the reported ranges for the breed and species (Akusu, 2003; Yakubu et al., 2011). The average time taken for each palpation was short (approximately 2 minutes). The time was short and beneficial, indicating that many does may be examined within short time; thus, with increasing skills and perfection the time may even be shorter. This finding is also the first report of timing of a DRP technique in RSG does.

CONCLUSIONS

It was concluded that the vagina, cervix, uterus and ovary as segments of the internal genitalia of red Sokoto goat (RSG) does were transrectally palpable with digital rectal palpation technique using the index finger with high (89.3 – 100 %) palpability. Transrectal prepartum and postpartum metric measurements of segments of genitalia of the RSG does with index finger using digital rectal palpation (DRP) technique was possible, with prepartum and postpartum values on day 21 and 28 to be similar indicating completion of postpartum uterine involution. Duration of transrectal palpation measured was found to be short (1.97 ± 0.03 min).

ACKNOWLEDGEMENTS

We acknowledge the Executive Director, National Animal Production Research Institute, Shika, Ahmadu Bello University, Zaria, for permission and support to carry out the work in the Institute.

REFERENCES

ABOU- EL- ROOS, M. and SHAWKI, G. (2003). Clinical approach for assessment of the reproductive status in ewes. *Zagazig Veterinary Journal.* **31**(1): 1-1 0.

ADEYINKA, I. A. and MOHAMMED, I. D. (2006). Accuracy of body weight prediction in Nigerian Red Sokoto goats raised in North Eastern Nigeria using linear body measurement. *Pakistan Journal of Biological Sciences*. **9**(15): 2828-2830.

AFRICAN UNION. (2015). The red Maradi goat (*Capra hircus*). Interafrican Bureau for Animal Resources.

https://www.google.com.ng/search?q=African+Union++The+Maradi+goat&rlz=; (accessed 17 February, 2018).

AKUSU, M. O. (2003). Reproductive performance of goats for maximum animal production in Nigeria. *Inaugural Lecture, 2002/2003, University of Ibadan Nigerian*. 6-7.

BELLO, A. A. (2019). Digital rectal palpation as a technique for gynaeacological examination, artificial insemination and pregnancy diagnosis in red Sokoto goat does. *Ph.D. Thesis, Ahmadu Bello University, Zaria, Nigeria*. 83-128.

FARIN, C. E. (2015). Artificial insemination and embryo transfer in goats. https://meatgoats.ces.ncsu.edu/wp-content/uploads/2015/10/Goat-AI-ET.pdf?fwd=no,; (accessed 25 January, 2019).

IBM CORP. (2011). IBM SPSS Statistics for Windows, version 20.0. Armonk, NY: IBM Corp; Released 2011.

KARADAEV, M. (2015). Pregnancy diagnosis techniques in goats – A Review. *Bulgarian Journal of Veterinary Medicine*. **18**(3): 183-93.

KAWU, M. U., EDUVIE, L. LAKPINI, C., AYO, J. O. and MOLOKWU, E. C. I. (2003). Preliminary observation on oestrus synchronisation and early rebreeding using synchromate-B in red Sokoto (Maradi) goat. In: *Proceedings of the 28th Annual Conference of Nigerian Society for Animal Production, Ibadan*. 30-36.

KUTTY, C. I. (1999). Gynaecological examination and pregnancy diagnosis in small ruminants using bimanual palpation technique: a review. *Theriogenology*. **51**(8): 1555-1564.

LEETHONGDEE, S. andPONGLOWHAPAN, S. (2014). Artificial Insemination in Goats: An Update. *Thai Journal of Veterinary Medicine*. **44(**Suppl.1): 73-77.

OMONTESE, B. O. (2015). Influence of buck exposure, progestagen treatment and season on reproductive responses in goat. *Ph.D. Thesis, Ahmadu Bello University, Zaria, Nigeria*. 72-99.

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 Journa of Animal and Veterinary Resource.* **3**(1): 33-37.

PULLAN, N. V. (1978). Condition scoring of White Fulani cattle. *Tropical Animal Health And Production*. **10**: 118-20.

VOH JR., A. A. (1996). Fertility and embryonic mortality rates of zebu cows following oestrus synchronisation and artificial insemination. *Ph.D. Thesis, Ahmadu Bello University, Zaria, Nigeria.* 119-133.

WILDEUS, S. (2008). Reproductive management of the meat goat. Goatwolrd. http://www.goatworld.com/reproductive-management/meatgoat/(accessed 10 September, 2018).

YAKUBU, A., SALAKO, A. E. and IMUMORIN, I. G. (2011). Comparative multivariate analysis of biometric traits of West African dwaft and red Sokoto goat. *Tropical Animal Health and Production*. **43**: 561-566.