The Pharma Innovation Journal 2022; SP-11(7): 2673-2679

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(7): 2673-2679

www.thepharmajournal.com
Received: 14-05-2022
Accepted: 18-06-2022

Mahendra Kumar Saini
Department of Veterinary Anatomy, College of Veterinary and Animal Science, Navania, Department of Veterinary, Anatomy Shekhawati Veterinary College, Sikar, Rajasthan, India

Sanjeev Joshi
Department of Veterinary, Anatomy, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India

Pankaj Kumar Thanvi
Department of Veterinary, Anatomy, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India

Aruna Panwar
Department of Veterinary, Anatomy, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India

Devendra Singh
Department of Veterinary, Anatomy Shekhawati Veterinary College, Sikar, Rajasthan, India

Sanwarmal
Department of Veterinary, Anatomy Shekhawati Veterinary College, Sikar, Rajasthan, India

Raj Kumar Siyag
Department of Veterinary Anatomy, Apollo College of Veterinary Medicine, Agra Road, Jamdoli, Jaipur, Rajasthan, India

Corresponding Author
Mahendra Kumar Saini
Department of Veterinary Anatomy, College of Veterinary and Animal Science, Navania, Department of Veterinary, Anatomy Shekhawati Veterinary College, Sikar, Rajasthan, India

Gross anatomical study on the testes of camel (*Camelus Dromedarius*)

Mahendra Kumar Saini, Sanjeev Joshi, Pankaj Kumar Thanvi, Aruna Panwar, Devendra Singh, Sanwarmal and Raj Kumar Siyag

Abstract
The present study was conducted on 6 pairs (left and right) of testes of recently dead animals. The testes were small in size, oval in shape and were white in color. The epididymis was highly convoluted tubule, pinkish white in color, situated on the lateral aspect of dorsal border of testis. The average parameters of weight, length, width at cranial extremity and circumference of left testes were significantly higher than the right testes and other parameters of testes were non-significant.

Keywords: Gross, anatomy, testes, camel

Introduction
The camel is known to be a seasonal breeder, the male camel shows sexual activity during specific days of the year (breeding or rutting period), and have some aspects of the seasonal changes in the testis (Pasha *et al*. 2013) [19]. The male genital organs include the testes, the epididymis, the Ductus deferens, the ejaculatory ducts and the penis, together with certain accessory sex glands out of which the testes are the major and prime organ of male genital system (Bello and Umarub 2013) [4]. The testes of camels are ovoid in shape and are usually descended at birth but are very small. They increase in size at the onset of puberty but there has been a wide variation in the dimensions reported (Bello and Umaru 2020) [3]. The function of the testes is to produce both sperm and testosterone. Testosterone is an essential hormone for development and maintenance of male sexual characteristics and normal functioning of the accessory reproductive glands (Naggar and Rath 1990) [18].

Materials and Methods
The present study was conducted on 6 pairs of testes along with epididymis. The samples of testes were procured from TVCC (Training Veterinary Clinical complex) CVA'S RAJUVAS Bikaner, immediately after death of camels.
For the gross anatomical studies whole of genitalia was carefully dissected out in recently dead animal (Figs 1 and 2), and the measurements for various physical parameters like weight, length, width, thickness, circumference, volume and density of individual components were carried out on both the left and right testis. Weight was taken in GMS with the help of an electrical digital balance (Fig 3), Length and Width at three different regions i.e. on the cranial extremity, middle and caudal extremity and Thickness were measured by digital vernier's caliper. The volume was measured by water displacement method with the help of measuring cylinder (Fig 4), and circumference was measured at the middle portion of testis by a cotton thread. The density of left and right testis was calculated by the following formula.

$$D = \frac{Weight}{Volume} = gm/c.$$ (Where, 1ml=1cc).

All recorded data were computed in tubular form. The data was analyzed by standard statistical method for mean (x), standard error (± SE) and paired "t" test used for depicting significant and non-significant correlation of data. The correlation between each parameter was calculated at 5% level of the significance for conclusion.

.

Results and Discussion

I. Location, Color, Shape and size of testis

The testes of camel were located in the scrotum lie obliquely, in high perineal region with their long axis running cranio-ventrally (Fig 5). Which was in approximation with the findings of Naggar and Rath (1990) [18] reported in camel, Mahmud *et al*. (2015a) [15] explained in one-humped camel, but the long axis of testes was vertical in both UDA ram and red sokoto buck, Sikarwar *et al*. (2018) [25] mentioned in Large White Yorkshire Pig and Bello and Umaru (2020) [3] resemble in camels.

The result was contrary with Sisson and Grossman (1953) [25] mentioned that testes were suspended in the scrotum by the spermatic cords and the left testis hang somewhat lower, Raghavan (1964) [22] noted that testicles were placed in a vertical direction, a little in front of the inguinal region, and were suspended in the scrotum by the spermatic cord in the ox, Miller *et al*. (1965) [16] analyzed that in normal position, the testis was situated obliquely, with long axis running dorso-caudally located within the scrotum in dog, Singh and Bharadwaj (1978a) [26] described that the testes were situated in the perineum in the camels, Smuts and Bezuidenhout (1987) [28] stated that the testes were situated 40-60 mm below the anus in the pigmented scrotum usually the one testis was situated slightly higher than the other and there long axis directed caudodorsally, Ismail (1988) [11] found that the testes were located, as in the dog in the scrotum in an oblique perineal position one-humped camels, Sellnow (1996) [24] said that the scrotal sacs lie on either side of the penis in the stallions, Bravo *et al*. (2000) [6] investigated that the testes were found in the scrotum in a perineal position, as in the dog and pig in the Camelidae, Hafez and Hafez (2001) [9] found during their research scrotum was located caudal to the thighs and caudal and ventral to the ischiatic arch, high in the perineal region as in the boar or tom, not pendulous as in the bull or ram testis lies obliquely to the vertical axis in the camel, Belloa and Umarub (2013) [4] delineated that the testes of the camel were located in the perineal region, in a position similar to that of the dog or boar in camel, Pasha *et al*. (2013) [19] designed that the lie obliquely to the vertical axis in the one-humped camel, Andrabi (2014) [2] resemble that of the scrotum of the river buffalo had a distinct neck and was pendulous and in scrotum of the swamp buffalo the neck was not distinct, Pathak *et al*. (2014a) [21] further stated that the long axis of testes oriented vertically in goat, Jacob (2015) [12] described testes were located along the chicken's back, near the top of the kidneys in the male chicken, Khan *et al*. (2016) [14] found during their research the testicles were situated in the prepubic region, enclosed in pendulous structure termed as scrotum in male goat, Saleem *et al*. (2017) [23] revealed that the testis was intra-abdominal, located in the body cavity just caudal to the respective lungs at the cranial end of the kidneys in the bird, Dawood *et al*. (2019) [7] said that the paired testes of the tom cat located outside of the body between the thighs covered with tunica albuginea, tunica vaginalis and externally by secrotum. The longitudinal axis of the testes was horizontal and Bhagyalakshmi *et al*. (2020) [5] stated that the testes were located within the scrotum in dog.

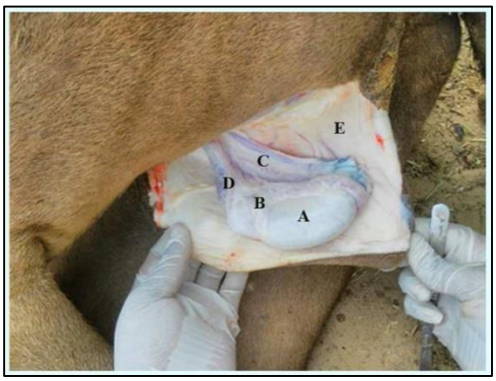

Fig 1: Lateral surface of left testis (A) of camel in situ, epididymis (B), Vas deferens (C), spermatic cord (D), and scrotum (E).

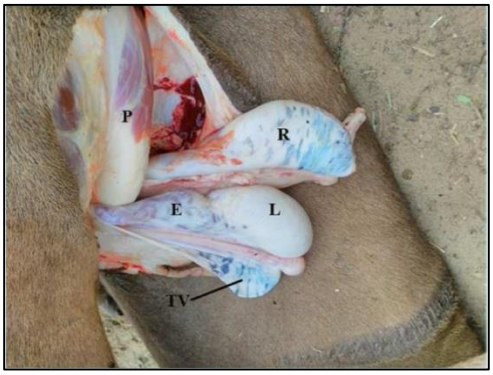

Fig 2: The left testis (L), right testis (R) of camel in situ, tunica vaginitis (TV), penis (P), and spermatic cord (D).

Fig 3: Photograph depicting measurement of weight of the left and right testis of camel

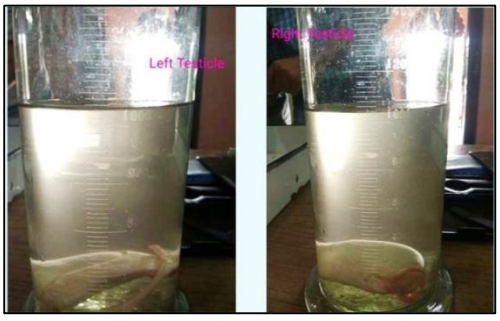

Fig 4: Photograph depicting of measurement of volume of the left and right testis of camel

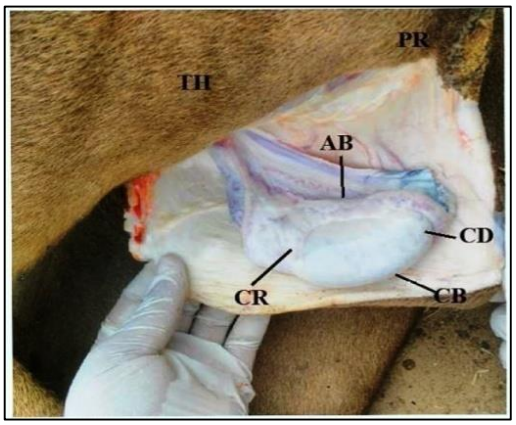

Fig 5: Photograph of the left testis of camel in situ showing, location of testis, thigh of left leg (TH), and perineal region (PR).

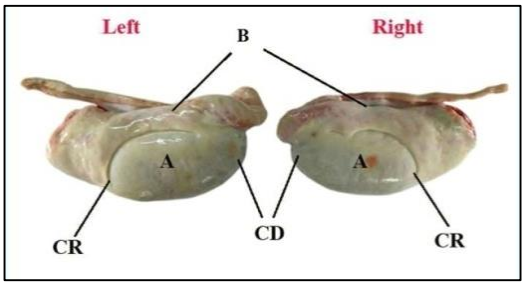

Fig 6: Photograph of the left and right testis of camel, lateral surface (A), cranial extremity (CR), and caudal extremity (CD).

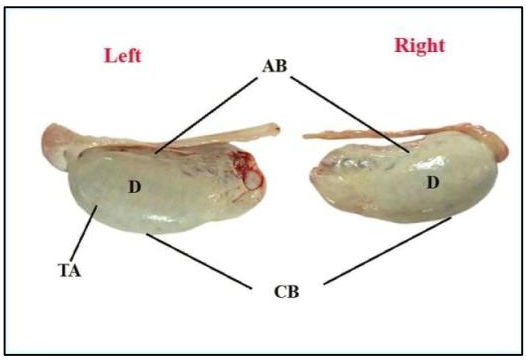

Fig 7: Photograph of the left and right testis of camel showing, medial surface (D), tunica albuginea (TA), Antero-dorsal border (AB) and caudal border (CB).

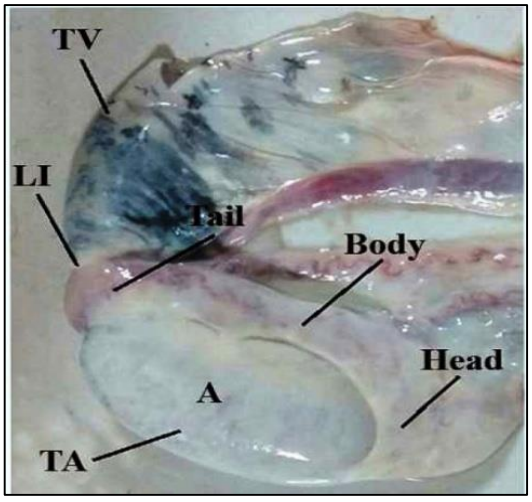

Fig 8: Photograph of the right testis with epididymis showing, lateral surface (A), tunica albuginea (TA), tunica vaginitis (TV), and ligament (LI).

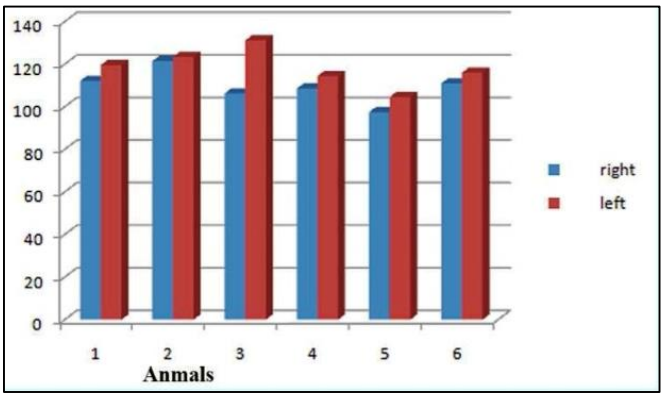

Fig 9: Bar diagram depicting weight of right and left testes in different animals

The testes of camel were white, with brown color parenchyma (Fig 5). However Singh and Bharadwaj (1978a) [26] investigated that the testes had a dark gray color in the camels, Smuts and Bezuidenhout (1987) [28] noted that the parenchyma was light in colour in the immature organ, but darkens with age and was dark brown in the mature male camel, Pasha *et al*. (2013) [19] reported that the parenchyma of mature camels was brown, Mahmud *et al*. (2015a) [15] stated that the testes was dark-brown in the one-humped camel bull, whitish yellow in the UDA ram and white to red in the red sokoto buck, Jacob (2015) [12] elucidate that the testes were light yellow in the male chicken, Khan *et al*. (2016) [14] explained that the testis were light pink while the parenchyma was found Gray in color in male goat, Sikarwar *et al*. (2018) [25] mentioned that the parenchyma of testis was reddish grey colour in large white Yorkshire pig, Dawood *et al*. (2019) [7] said that the testes of the tom cat had a white color and Bhagyalakshmi *et al*. (2020) [5] stated that the testes were reddish- white in colour in dog.

The testes of camel were found small, and oval in shape (Figs 7 and 8). These findings were In agreement with that of Smuts and Bezuidenhout (1987) [28] in camel, Ismail (1988) [11] in one-humped camels, Naggar and Rath (1990) [18] in Camel, Sellnow (1996) [24] in the stallion's, Bravo *et al*. (2000) [6] in Camelidae, Hafez and Hafez (2001) [9] in camel. Pasha *et al*. (2013) [19] in one-humped camel, Mahmud *et al*. (2015a) [15] in one-humped camel bull, UDA ram and red sokoto buck and Khan *et al*. (2016) [14] in the testis of male goat.

The finding was in partial harmony with the findings of Bello and Umaru (2020) [3] resemble that in camel and Bhagyalakshmi *et al*. (2020) [5] stated that in dog. Whereas Pathak *et al*. (2014a) [21] described that in goat both testes were elongated, Jacob (2015) [12] elucidate that in the male chicken the testes were elliptical and Dawood *et al*. (2019) [7] said that the paired testes of the tom cat had an oval shape.

Normally the left testis was larger and longer than the right (Figs 6 and 7). This result was in congruence with Raghavan (1964) [22] in the ox, Naggar and Rath (1990) [18] in camel, Bravo *et al*. (2000) [6] in the testes of Camelidae, Andrabi (2014) [2] in the river buffalo and the swamp buffalo, Saleem *et al*. (2017) [23] in the testis of the bird and Sikarwar *et al*. (2018) [25] mentioned that in large white yorkshire pig.

While Smuts and Bezuidenhout (1987) [28] stated that about size and weight vary considerably during the deferent season in camel, Khan *et al*. (2016) [14] explained that the morphologically no considerable difference were found in right and left testicle in male goat, Karimi *et al*. (2019) [13] claimed the all parameters of left testes higher than those of

their paired right testes in all measures in Ghezel rams and Bhagyalakshmi *et al*. (2020) [5] stated that the morphometric values of the left testis were higher than the right testis in dog.

II. External and internal structure

Each testis of camel presented two surfaces, two borders and two extremities. The lateral surface was convex and medial surface was less convex (Figs 6 and 7). The antero-dorsal border was slightly straight and caudal border was free and convex (Fig 7). These finding were in consonance with the Khan *et al*. (2016) [14] in male goat and in partial harmony with that of Bello and Umaru (2020) [3] resemble that in camel.

However Sisson and Grossman (1953) [27] dealt with the gross structure of testes of different animals, the anterior, medial and lateral surfaces and the extremities of the testis were convex, free and smooth, Ismail (1988) [11] investigated that the anterior border was nearly straight and was connected to the epididymis. The posterior border was free and convex, and the proximal and distal poles were rounded in one-humped camels, Hafez and Hafez (2001) [9] described that ventral edge was protruded, upper edge was straight, and the outer edge was nearly straight and linked to the epididymis in camel, Belloa and Umarub (2013) [4] found that the posterior border of the camel testis was convex and free. The anterior surface was flattened, except where the epididymis attaches to the anterior-dorsal point in camel and Pathak *et al*. (2014a) [21] mentioned that convex laterally and relatively flat along the medial surfaces. The epididymis and vas deferens were attached along its posterior border. The anterior border was free and rounded. Dorsal and ventral extremities were covered with caput and cauda of the epididymis in goat.

The epididymis was attached to lateral side of dorsal border of the testis head curving around cranial extremity (Fig 8). The result was confirming the finding with Smuts and Bezuidenhout (1987) [28] in camel, Zayed (2012) [32] in one-humped camel, Belloa and Umarub (2013) [4] in camel, Pasha *et al*. (2013) [19] in one humped camel.

Whereas Sisson and Grossman (1953) [27] reported the epididymis lies along the lateral part of the posterior border in testes of different animals, Raghavan (1964) [22] observed that the epididymis was elongated from above downward and was curved, overlapping a narrow area of its lateral surface in ox, Ismail (1988) [11] said that the epididymis was connected the anterior border and runs along the anterior border of the testis, extending from the ventral pole to a point slightly above the level of the proximal pole of testes in one-humped camels, Sellnow (1996) [24] explained the epididymis was lightly attached to the upper surface of each testis in stallion's testes, Bravo *et al*. (2000) [6] reported that the epididymis was located on the anterior edge of the testis and extends from the interior extremity to just above the upper edge in testes of Camelidae, Hafez and Hafez (2001) [9] resemble that the epididymis formed on the anterior edge of the testis, extending from the inferior extremity to just above the upper edge in testes of camel, Utiger (2008) [30] recorded that the epididymis lies on the top surface of the testis, the body was attached to the anal side of the testis and extends the length of the gland in humans, Pathak *et al*. (2014a) [21] examined that the epididymis and vas deferens were attached along the posterior border of testes in goat, Khan *et al*. (2016) [14] designed that epididymis attached to free borders were cranial and caudal position in the testis of male goat, Dawood *et al*. (2019) [7] said that the epididymal border was lateral in tom cat and Bello and Umaru (2020) [3] resemble that epididymis attaches to the anterior-dorsal point anterior surface in camel.

The cranial extremity was thicker, rounded and occupied by head of epididymis whereas caudal extremity was rounded, thinner and occupied to the tail of epididymis (Fig 6). This result was in accordance with the Ismail (1988) in testes of one-humped camels and Khan *et al*. (2016) [14] in male goat.

While Sisson and Grossman (1953) [27] analyzed that the extremities of the testis were convex in different animals, Raghavan (1964) [22] pointed that the head of epididymis was curved over the proximal extremity and tail closely attached to the ventral extremity of the testicle, Zayed (2012) [32] found that the epididymal head was attached to the head extremity and tail was attached to the tail extremity of the testis in one-humped camel, and Pathak *et al*. (2014a) [21] explained that dorsal and ventral extremities were covered with caput and cauda of the epididymis in goat.

Both the testes were covered by the connective tissue capsule, the tunica albuginea and tunica vaginalis (Figs 7 and 8). This was in uniformity with Sisson and Grossman (1953) [27] in different animals, Raghavan (1964) [22] in the ox, Miller *et al*. (1965) [16] in dog, Sellnow (1996) [24] in the stallion's testes, Utiger (2008) [30] in humans, Pasha *et al*. (2013) [19] in one-humped camel, Mahmud *et al* (2015a) [15] in one humped camel, UDA ram and red sokoto buck, and Khan *et al*. (2016) [14] in male goat.

Whereas Ismail (1988) pointed out the tunica albuginea of the camel testis was very thick and Dawood *et al*. (2019) [7] said that the paired testes of the tom cat were covered with tunica albuginea, tunica vaginalis and externally by secrotum.

III. Biometry of the testes

Weight of testes (GM)

The average weight of the right and left testis, including epididymis of camel were 109.48±3.20gm and 118.20±3.65gm, respectively (Table 1). The weight in left testis was significantly higher than the right testis, which represents that left testis was heavier than right testis (Fig 9). Whereas Raghavan (1964) [22] explained that the testicle of an adult bull weighed about 280 to 336gm in ox, Miller *et al*. (1965) [16] elucidate that the fresh organ weighs 7.8 to 8.2gm in a 25 pounds dog, Singh and Bharadwaj (1978a) [26] pointed that the weight ranged from 32 to 225 g, The maximum weight of the left testis in 12-year old camels during the winter months, Tingari *et al*. (1984) [29] mentioned that the testicular weight was minimal during summer, while the maximum weight attained during the coldest months from November until March in camel, Smuts and Bezuidenhout (1987) [28] explained that a mature testis was weighted as much as 225 g in breeding season and as little as 66 g in the interim period in camel, Ismail (1988) [11] reported that weight ranged from 59.1 to 91.7 g, differences in weight between the right and left testis were not statistically significant in one humped camels, Naggar and Rath (1990) [18] recorded that an average weight of testicles was approximately 92 g, in camel, Sellnow (1996) [24] revealed that testis weigh about 225 grams in the stallion's, Bravo *et al*. (2000) [6] mentioned that in mature alpaca and llama, the testes weigh 18 and 24 g, respectively, in dromedary and Bactrian weigh 80–100 g in Camelidae, Hafez and Hafez (2001) [9] said that the weight of each testis 80–120 g in camel, Utiger (2008) [30] described that the each testis weighs about 25 grams (0.875 ounce) in humans, Yaseen *et al*. (2010a) [31] resemble that the average weight of left testes was 97.94±1.59gm and of right testes

96.94±1.61gm the average weight of left testes were non-significantly higher than the right ones in Marwari goats, Pasha *et al*. (2011) [20] pointed out the weight of the testis were significantly higher (P<0.01) during winter season, declined in spring and summer and lowest during autumn in the camel in Punjab-Pakistan, Ibrahim *et al* . (2012) [17] explained that the paired testes weight in the three breeds Balami, UDA and Yankasa shows significant differences (p<0.05, p<0.01) the UDA has a significantly higher values (p<0.05) followed by the Balami and the Yankasa, with a significant (p<0.05) difference in the ratio of left to right testes weight, Abdulahi *et al*. (2012) mentioned that the paired testis weight had no significant difference (p >0.05) between the left and right organs, Pasha *et al*. (2013) [19] investigate that the testicular weight increase with the age, reach their maximum values at 10-15 years of age, and then start decreasing slightly, but the testicular weight varies among different breeds of camels, Saleem *et al*. (2017) [23] stated that the left testicle of adult Uttara fowl was found heavier as compared to the right one, Eljarah *et al*. (2017) [8] analysed that in different age groups, right and left testicular weight was increased significantly (p<.05) in age-dependent manner. Data summarised revealed a strong significant correlation between animal weight versus testicular weight (r=.92, p<.001) in Arabian oryx males between the ages of 3 to 10 years, Sikarwar *et al*. (2018) [25] mentioned that the weight of left testis was non-significantly higher than right one in large white yorkshire pig, Dawood *et al*. (2019) [7] said that the mean of left and right testicular weight was 1.35±0.43g and 1.36±0.33g respectively in tom cat, Karimi *et al*. (2019) [13] claimed that the weight of right testis was 158.9 ± 78.3 and left testis was 164.2 ± 78.5 respectively in Ghezel rams and Bello and Umaru (2020) [3] resemble that the testes were weighing 80–100gm each in camel.

Length of the testes (CM)

The average length of the right and left testis excluding epididymis in camel were 8.78±0.45 cm and 9.52±0.53 cm respectively (Table 1). The difference was statistically significant between right and left testis, which represent that the left testis was longer than the right. However Raghavan (1964) [22] investigated that testicle was 12.5 cm long Often the left was longer in the ox, Miller *et al*. (1965) [16] reported that the length of testes in a 25 pounds dog averages 2.8 to 3.1 cm in dog, Singh and Bharadwaj (1978a) [26] mentioned that the length of 6–13 cm in the camels, Smuts and Bezuidenhout (1987) [28] described that the length varies from 130 to 60 mm during breeding season interim period in camel, Ismail (1988) [11] said that the length of testis was 7.6 to 8.0 cm in one humped camels, Naggar and Rath (1990) [18] elucidate that each testis varies in length from 7 to 10 cm from three years of male camels had an average testicle length was 9.1 cm, Sellnow (1996) [24] reported that the testes was measure 80-140 millimetres in length in the stallion's, Bravo *et al*. (2000) [6] revealed that the camel testes vary in length from 7 to 10 cm in dromedary and 12 to 14 cm in Bactrian, Hafez and Hafez (2001) [9] pointed out the testes 120–140 mm long in camel, Utiger (2008) [30] resemble that the each testis was 4-5 cm (1.6-2.0 inches) long in humans, Yaseen *et al*. (2010a) [31] investigate that average length of left testes were 10.59±0.26 cm and of right testes were 10.16±0.24 cm Marwari goats, Ibrahim *et al*. (2012) [17] examined that in the three breeds Balami, UDA and Yankasa were observed Non significant breed differences (p<0.05) in length of testes, Pasha *et al*. (2013) [19] reported that the testicular length increase with the age, reach their maximum values at 10-15 years of age, and then start decreasing slightly in one-humped camel, Andrabi (2014) [2] delineated that in river buffalo, the average length of the right and left testicles (including the epididymis) were 14.2 and 15.0 cm, respectively and the length of the testes excluding the epididymis, as 7.60 cm for the right and 7.87 cm for the left, in swamp buffalo the average right and left testicles length including the epididymis were 11.18 and 11.27 cm, respectively, Saleem *et al*. (2017) [23] stated that the left testicle of adult Uttara fowl was found larger as compared to the right one, Eljarah *et al* (2017) [8] analysed that in different age groups, right and left testicular length was increased significantly (p<.05) in age-dependent manner in Arabian oryx males between the ages of 3 to 10 years, Sikarwar *et al*. (2018) [25] mentioned that the parameter of length of left testis was non-significantly higher than right one large white yorkshire pig, Dawood *et al*. (2019) [7] said that the mean of left and right testicular length were 2.15±0.34cm and 2.10±0.24cm respectively in tom cat, Karimi *et al*. (2019) [13] claimed the length of right testis was 8.8 ± 1.5 and left testis was 9.0 ± 1.6 respectively in Ghezel rams, Bello and Umaru (2020) [3] resemble that the length testes measure 7–10 cm in an animal of 3 years in camels and Bhagyalakshmi *et al*. (2020) [5] stated that the average length of left testis was 3.73+ 0.07 cm and right was 3.47+ 0.13 cm respectively in dog.

Width of testes

The average width of the right and left testis were 2.74±0.13 cm and 2.93±0.11 cm at cranial extremity, 3.46±0.08 cm and 3.67±0.11cm at middle region, and 3.01±0.10 cm and 2.86±0.11 cm at caudal extremity (Table 1). The difference was significantly higher at cranial extremity and middle, and negatively higher at caudal extremity between right and left testis. The negative data shows the right testis was non-significantly wider then left testis.

While Raghavan (1964) [22] observed that the testicles were 6 to 7.5cm wide in the ox, Miller *et al*. (1965) [16] mentoned that the width (dorso-ventral diameter) testis was 2 to 2.2 cm in a 25 pounds dog, Singh and Bharadwaj (1978a) [26] stated that the testes had maximum cross-diameter 3–6.5 cm in the camel, Smuts and Bezuidenhout (1987) [28] reported that the diameter of testes varies from 65 to 30 mm in camel, Ismail (1988) [11] reported that the testis was 4.1 to 4.3 cm wide, differences in size between the right and left testis were not statistically significant in one-humped camels, Naggar and Rath (1990) [18] said that three years of male camels had an average testicle width 5.1 cm in camel, Sellnow (1996) [24] resemble that the testes were normally 50-80 millimetres in width in stallion's, Hafez and Hafez (2001) [9] pointed out the testes was 45–55 mm broad in the camel, Utiger (2008) [30] described that testis about 2–3 cm (0.8–1.2 inches) in diameter in humans, Yaseen *et al*. (2010a) [31] explained that average width of left testes were 5.72±0.17 cm at W1 area and 5.75±0.16 cm at W2 area and of right testes were 5.30±0.17 cm at W1 area and 5.35±0.13 cm at W2 area in Marwari goats, Pasha *et al*. (2013) [19] noted that the testicular width increase with the age, reach their maximum values at 10-15 years of age, and then start decreasing slightly in one-humped camel, Andrabi (2014) [2] observed that in river buffalo, the average width of the right and left testicles (including the epididymis) 6.41 cm and 6.87 cm, respectively, the average right and left testicle including the epididymis width were

4.85 cm and 4.82 cm, respectively in river and swamp buffalo, Eljarah *et al*. (2017) [8] analysed that in different age groups, right and left testicular width was increased significantly (p<.05) in age-dependent manner in Arabian oryx males between the ages of 3 to 10 years, Sikarwar *et al*. (2018) [25] mentioned that the parameter of breadth of left testis was non-significantly higher than right one in large white yorkshire pig, Dawood *et al*. (2019) [7] said that the mean of left and right testicular diameter were 1.25± 0.15cm and 1.20±0.19 cm respectively in tom cat, Karimi *et al* (2019) [13] claimed the width of right testis was 6.3 ± 0.0 and left testis was 6.4 ± 0.9 respectively in Ghezel rams, Bello and Umaru (2020) [3] resemble that the testes increase in size during the breeding season in camel and Bhagyalakshmi *et al*. (2020) [5] stated that the width of left testis was 2.51+ 0.11cm and right was 2.42+ 0.08 cm in dog.

Circumference of testes (cm)

The average circumference of the right and left testis excluding epididymis at middle of testis, in camel were 11.21 ±0.42 cm and 12.01±0.51 cm respectively (Table 1). The difference was statistically significant between right and left testis. Represent the left testis circumferentially larger than right one.

However Ismail (1988) [11] said that Testicular dimensions increase with age and reach their maximum values at 10 to 15yr of age, then they decrease slightly after 15yr of age in one-humped camels, Ibrahim *et al*. (2012) [10] mentioned that the three breeds Balami, UDA and Yankasa shows significant differences (p<0.05, p<0.01) in scrotal circumference, the UDA has a significantly higher values (p<0.05) followed by the Balami and the Yankasa, Abdulahi *et al* (2012) reported that a highly significant positive correlations (p <0.05, p <0.01, p <0.001) exist between the scrotal circumference (in situ) of camels in the semi-arid environment, Pasha *et al* (2013) [19] described that the testicular circumference increase with the age, reach their maximum values at 10-15

years of age, and then start decreasing slightly in the one-humped camel, Andrabi (2014) [2] stated that the circumference of the testes, excluding the epididymis as 12.20 cm for the right and 12.29 cm for the left in river buffalo, Eljarah *et al*. (2017) [8] analysed that in different age groups, right and left testicular circumference was increased significantly (p<.05) in age-dependent manner. Data summarised revealed a strong significant correlation between animal weight versus scrotal circumference (r=.95, p<.0001) in Arabian oryx males between the ages of 3 to 10 years, Sikarwar *et al*. (2018) [25] mentioned that the parameter of circumference of left testis was non-significantly higher than right one in large white yorkshire pig and Bello and Umaru (2020) [3] resemble that the camel testes increase in size during the breeding season.

Volume of the testes (ml)

The average volume of the right and left testis, including epididymis in camel were 103.83 ±3.52 ml and 113.33 ±5.07 ml respectively (Table 1). The difference was statistically significant between right and left testis. Whereas Pasha *et al* (2011) [20] found during their research the volume of the testis were significantly higher (P<0.01) during winter season, declined in spring and summer and lowest during autumn of the camel in Punjab-Pakistan, Abdulahi *et al*. (2012) said that the testis volume was no significant difference (p >0.05) between the left and right organs, but there were numerical differences between the parameters of camels in the semi-arid environment, Moustafa *et al*. (2015) [17] examined that an increase in volume percentae on the expense of the interstitial tissue during the various postnatal ages due to increased tubular length convolutions the donkey, Eljarah *et al*. (2017) [8] analysed that in different age groups, right and left testicular volume was increased significantly (p<.05) in age-dependent manner. Data summarised revealed a strong significant correlation between animal weight versus testicular volume (r=.94, p<.001) in Arabian oryx males between the ages of 3 to 10 years and Sikarwar *et al*. (2018) [25] mentioned that the parameter of volume of left testis was non-significantly higher than right one in large white yorkshire pig.

Density of testes (GM/CC)

The average density of the right and left testis, including epididymis in camel was 1.04±0.04 gm/cc and 1.05±0.03 gm/cc, respectively (Table 1). The difference was statistically non-significant between right and left testis. Abdulahi *et al* (2012) conducted studies on testes of camels in the semi-arid environment and found no significant difference (p >0.05) between density of testis in the left and right organs, but there were numerical differences.

Table 1: Statistical analysis of the biometrical observation of various parameters of testes of camel (*Camelus dromedarious*).

Character	Testis		Range	Mean± SE	Paired 't' test
Weight of testes (GM)	Right		58-121.5	99.82 ±9.20	3.18*
	Left		65.2-131.2	110.07 ±9.66	
Length of testes (cm)	Right		6.63-12.2	8.86 ±0.82	5.26*
	Left		7.31-13.6	9.74 ±0.94	
Width of testes (cm)	Cranial extremity	Right	2.2-3.18	2.27 ±0.15	4.23*
		Left	2.3-3.23	2.89 ±0.15	
	Middle	Right	2.8-3.7	3.39 ±0.14	0.74
		Left	2.3-4.06	3.49 ±0.26	
	Caudal extremity	Right	2.3-3.4	2.93 ±0.16	-0.70
		Left	2.4-3.3	2.86 ±0.12	
Circumference of testes (cm)	Right		9.4-12.3	11.00 ±0.52	6.27*
	Left		9.9-13.6	11.82 ±0.59	
Volume of testes (ml)	Right		50-110	94.17 ±9.47	1.93
	Left		42-130	101.33±12.91	
Density of testes (GM/CC)	Right		0.97-1.27	1.07 ±0.05	1.01
	Left		0.99-1.55	1.14 ±0.09	

Note * = P (0.05) ≥ 2.571 is statistically significant

However (-) sing resembles data of right side higher than competitive data.

Reference

1. Abdullahi IA, Musa HAH, Jibril A. Scrotal Circumference and Testicular Morphometric Characteristics of the Camel (*Camelus dromedarius*) in the Semi-Arid Environment of Northern Nigeria. Int. J Morphol. 2012;30(4):1369-1372.
2. Andrabi SMH. Applied Andrology in Water Buffalo, CAB International. Animal Andrology: Theories and Applications, 2014, 380-403.
3. Bello A, Umaru MA. An Overview on the Anatomy and Physiology of Male one Humped Camel (Camelus Dromedarius) Reproductive System African Scholar Journal of African Sustainable Development. 2020;17(2):2010-1086.
4. Belloa A, Umarub MA. An over view on the anatomy and physiology of male one humped camel (Camelus

Dromedarius) reproductive system, Scientific Journal of Review. 2013;2(12):340-347.
5. Bhagyalakshmi J, Balasundaram K, Selvaraj P, Kathirvel S, Balachandran P, Chandana GSS. Gross, histology and histochemical analysis of the testis in dog (*Canis lupus familiaris*) Journal of Entomology and Zoology Studies. 2020;8(4):69-73.
6. Bravo PW, Skidmore JA, Zhao XX. Reproductive aspects and storage of semen in Camelidae. Animal Reproduction Science. 2000;62:173–193.
7. Dawood MS, Al-Aaraji A, Mohammed LE, Abood DAB. Morphological and Morphometrical Features of Testes and Penis in Indigenous Tom Cat, Indian Journal of Natural Sciences. 2019, 9(53). ISSN: 0976 – 0997.
8. Eljaraha A, Alhaiderb AK, Jawasrehc K, Ismaila ZB, Alhalahd A, El-Bahr SM. Investigation of scrotal circumference, testicular dimensions and semen characteristics of the vulnerable Arabian oryx (Oryx leucoryx): an approach supports the future use of artificial insemination Italian Journal of Animal Science. 2017;16(3):48-489.
9. Hafez ESE, Hafez B. Reproductive Parameters of Male Dromedary and Bactrian Camels. Archives of Andrology. 2001;46:85-98.
10. Ibrahim AA, Aliyu J, Ashiru RM, Jamilu M. Biometric Study of the Reproductive Organs of Three Breeds of Sheep in Nigeria. Int. J. Morphol. 2012;30(4):1597-1603.
11. Ismail STT. Reproduction in The Male Dromedary (Camelus droniedarius), Cairo University, Egypt, 1988, 29(6).
12. Jacob DJ. Avian Reproductive System of Male, Small and Backyard Flocks. University of Kentucky, 2015 May 05.
13. Karimi H, Saraskanroud MR, Koucheh FB. Influence of laterality on testis anatomy and histology in Ghezel rams John Wiley & Sons Ltd. Veterinary Medicine and Science. 2019;5:151-156.
14. Khan SA, Kalhoro IB, Gandahi JA, Tunio AN, Vistro WA, Ahmed M. Gross Anatomical Studies on Testis and Epididymis at Pre-Pubertal and Pubertal Stages of Teddy Goat, Academic Research International. 2016 January 7(1).
15. Mahmud MA, Onu JE, Shehu SA, Umaru MA, Danmaigoro A, Bello A. Comparative gross and histological studies on testes of one-humped camel bull, UDA ram and red sokoto buck, ijmri, 2015a;1(1):81-84.
16. Miller ME. Anatomy of the Dog. W. B. Saunder's company, London. 1965, 755-761.
17. Moustafa MNK, Sayed R, Zayed AE, Abd El-Hafeez HH. Morphological and Morphometric Study of the Development of Seminiferous Epithelium of Donkey (Equus asinus) from Birth to Maturity. J Cytol Histol. 1000370 an open access journal. 2015, 6(6).
18. Naggar MAE, Rath D. Described the gross anatomy and histological structure of the camel testes. Reproduction in camels Fao Animal Production and Health Paper. 1990;82:1-2.
19. Pasha RH, Qureshi AS, Rehman ZU, Khamas WA. Seasonal anatomical changes in the testis of the one-humped camel, Eur. J. Anat. 2013;17(3):132-141.
20. Pasha R, Qureshi AS, Lodhi L, Huma J, Masood A, Hamid S. Seasonal morphological and ultrastructural changes in the testis of one-humped camels. Journal of Camel Practice and Research. 2011;18(1):145-153.
21. Pathak A, Katiyar RS, Sharma DN, Farooqui MM. Postnatal Developmental Anatomy of Testes and Epididymis of Gaddi Goats. Int. J. Morphol. 2014a;32(4):1391-1398.
22. Raghavan D. Anatomy of ox. Indian Counil of Agricultural Research, New Delhi, 1964, 415-41.
23. Saleem R, Singh B, Mohd KI, Singh I, Bharti SK. Gross and Biometrical Studies on Male Reproductive System of Adult Local Fowl of Uttarakhand (Uttara Fowl), Int. J. Pure App. Biosci. 2017;5(3):634-638.
24. Sellnow L. Stallion Anatomy and Physiology, Colorado State University ("Management of the Stallion for Maximum Reproductive Efficiency"), Kansas State University (M.J. Arns, PhD), and A & M University (J. W. Evans, PhD). 1996.
25. Sikarwar S, Mathur R, Joshi S, Thanvi P, Dangi A. Gross and Morphometrical Studies on the Testes of Large White Yorkshire Pig (*Sus scrofa*). Journal of Animal Research: 2018;8(4):709-712.
26. Singh UB, Bharadwaj MB. Morphological changes in the testis and epididymis of camels (*Camelus dromedarius*). Acta Anatomica. 1978a;101(3):275–279.
27. Sisson S, Grossman JD. The anatomy of the domestic animals. 4th Edn. W. B. Sunders Company Philadelphia and London. 1953, 581-605.
28. Smuts MMS, Bezuidenhout AB. Anatomy of the dromedary, Claredon Press-Oxford, 1987, 134.
29. Tingari MD, Ramos AS, Gaili ES, Rahma BA, Saad AH. Morphology of the testis of the one-humped camel in relation to reproductive activity, J Anat. 1984;139(Pt 1):133–143.
30. Utiger RD. Anatomy of The Testes and epididymis, 2008. https://www.britannica.com/.
31. Yaseen SM, Joshi S, Mathur R, Gajbe RU. Biometrical Study on The Testes of Marwari Goatsin The Semi-Arid Region. Haryana. 2010a;49:72.
32. Zayed AE, Aly K, Ibrahim IA, Maksoud FMAE. Morphological Studies on the Epididymal Duct of the One-Humped Camel (Camelus dromedaries), Open Journal of Veterinary Medicine. 2012;2:245-254.