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Descriptive analysis of the genital tract of the dromedary (*Camelus dromedarius*) collected at a slaughterhouse

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Abstract

The dromedary is one of the few domestic animal species that multiply at a very slow rate. Several factors among others; very long gestation, simple and induced ovulation, contribute to the reduction of the reproductive efficiency of the camel. To help understand camel reproduction in Niger, this study aims to morphologically characterize the reproductive system of dromedary females slaughtered at the slaughterhouse. For this, a total of 132 genital tracts and 264 ovaries belonging to dromedaries were collected and categorized at the slaughterhouse between August and October 2019. Afterwards, these organs were weighed and measured. The average values of the weight of the genital tract were estimated at 211.57±90.68 g; 596.50±38.15 g and 2357.38±296.10 g, respectively for young, not pregnant adult and pregnant adult females. However, the mean values of the length of the right and left uterine horn were 3.95±0.003 cm vs 5.13±0.23 cm; 5.61±0.03 cm vs 8.78±0.24 cm and 18.40±5.86 cm vs 27.90±2.64 cm, respectively for the young, not pregnant adult and pregnant dromedary. The mean weight values of the right and left ovaries were 1.96±0.4 g vs 2.67±0.43 g; 4.37±0.38 g vs 4.79±0.38 g and 6.56±0.67 g vs 5.46±0.51 g, respectively for the young, not pregnant adult and pregnant dromedary. For the average number of follicles per ovary, it was found 17.77±1.75 for the right side against 20.07±1.92 for the left side in young female while it was 27.80±1, 73 vs 28.44±1.71 for the not pregnant adult female and 29.61±2.97vs 29.67±2.95 for the pregnant female. On the other hand, the mean number of corpora lutea per ovary was 0.69±0.16 vs 0.56±0.15; 2.45±0.22 vs 2.56±0.21 and 2.86±0.52 vs 1.94±0.30, respectively for the right and left ovaries of the young, not pregnant adult and pregnant dromedary female. Statically, all these differences are significant ($p<0.05$) for the factors considered, particularly the reproductive status of the female and the side of the ovary.

The results obtained confirm that the anatomical and structural characteristics of the genital tract of the female dromedary depend on the reproductive status of the animal and the ovary side.

Keywords: Genital tract; Dromedary; Camel anatomy; Corpus luteum; Follicle; Ovary

1. Introduction

The dromedary or "one-humped camel" is one of the few domestic animals that has the ability to easily withstand the aridity and the scarcity of animal feed characterizing the Sahel region, which is one of the ecosystems most inhabited by these mammals in Africa. This adaptive capacity essentially results from the adaptation of the dromedary to

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dehydration because of the mechanisms that contribute to limiting water losses by saving processes, namely: a reduction in diuresis, cutaneous evaporation, basal metabolism, respiratory rate and an increase in daily variations in body temperature (Schmidt-Nielsen *et al.* 1957, 1967, Yagil, 1993, Bengoumi *et al.* 1993, Abdoun *et al.* 2012) cited by [1]. However, from the reproduction point of view, despite the fact that significant advances have been achieved with biotechnologies which have made it possible to develop techniques adapted to produce dromedary clones [2], they are still very far from those achieved by science in the field of the reproduction of other animal species, in particular cattle. Indeed, unlike the cow, the high rate of failure observed in ovulation and the difficulty of depositing the sperm in its natural viscous state constitute the major problems for the development of artificial insemination in the dromedary [3]. Furthermore, the genital tract of the female dromedary, like that of many other mammals, includes: two oviducts, two ovaries, a uterus, a cervix and a vagina. Thus, preliminary studies have shown that the estrous cycle of the camel lasts about 17 to 23 days in India, 24 days in Egypt and 28 days in Sudan (Joshi *et al.* 1978 and Musa and Abusineina 1978) cited by [4]. Also, the ovarian cycle, which is of the follicular type, is characterized by the birth and growth of small follicles, among which around 2 follicles reach their size of maturity to ovulate. The dimensions of the ovary as well as its activity become more important during the reproductive period compared to the low reproductive period [5].

It has also been demonstrated that follicular growth takes place in the form of waves and that the interval between two follicular waves and the number of follicles recruited during a wave vary according to the female dromedary [6]. As for the uterus, it is bicornuate, with the left horn always longer than the right one because it is in the left horn that the fetus generally develops [7] and this in 98% of cases of gestation [8].

Admittedly, this scientific knowledge is advanced in several countries of the world such as India, the Persian Gulf countries, Sudan, etc., but this is not the case for Niger where no scientific production has been published so far on physiology of reproduction of camels. However, this animal occupies a preponderant place in the improvement of the living conditions of several Nigerien households by guaranteeing them either the necessary nutrients through the direct consumption of its products (milk and meat), or an income for selling these products. Thus, to contribute to the development of the very first scientific database on camel reproduction in Niger, this study is necessary.

The general objective of this study is therefore to morphologically characterize the reproductive system of female dromedaries killed at the slaughterhouse. Specifically, it involved (1) determining the weight of the genital tract in general and of the ovary in particular of the female dromedary, (2) measuring the dimensions of the organs constituting her genital tract (3) determining the anatomical structure of her ovary and (4) exploring the influence of factors: reproductive status of the animal and period of sampling on these different parameters.

2. Material and methods

2.1. Collection of biological material

Early in the morning, genitals of dromedaries were collected, weighed and measured at the Maradi slaughterhouse. In total, one hundred and thirty-two (132) camels, all categories (young and adult) combined, were sampled between August and October 2019.

2.2. Genital measurements

2.2.1. At the slaughterhouse

As soon as the complete genital tract is collected, it is weighed using a Pocket balance scale, with a capacity of 10 kg and an accuracy of 100 g. Subsequently, the length and diameter of the horns, body and cervix were measured using a flexible tape measure.

2.2.2. In the university laboratory

The collected ovaries were transported in a thermos to the Biology laboratory of Dan Dicko Dankoulodo University of Maradi to be examined individually. Thus, the ovaries were first weighed on an electronic scale of 600 g capacity with an accuracy of 0.01 g (Mark KERN EMB 600-2). Then, their dimensions, in particular the length, width and height, were measured using a STAINLESS HARDENED brand digital calimeter. The ovarian structures, namely the corpus luteum, the follicles and the cysts were also evaluated, more precisely their number was counted as well as their diameter was measured using the same calimeter.

2.3. Data processing

The Excel software was used for data entry and the production of the chronogram while all the statistical tests were carried out by the Gradpad prism 8.0 software. The data collected, in particular the weight and dimensions of the different organs of the dromedary's genital tract, were presented in the form of a chronogram.

The one-way analysis of variances (one-way Anova) was used to evaluate the effects of animal category and genital collection period on the variation of the weight and dimensions of the dromedary's genital tract. In addition, the two-way ANOVA was used to assess the interaction that would exist between the two factors category of the dromedary and period of the collection of the genital tract.

3. Results

3.1. Variations in the weight and dimensions of the genital tract of the dromedary

3.1.1. Genital tract weight

The ANOVA test revealed that the weight of the genital tract varies significantly ($p<0.0001$) depending on the month of genital collection and the animal category (Table 1). Thus, the timeline (Figure 1) indicates that the heaviest genital tract weight was recorded in August followed by that in September. And the pregnant dromedary obtained the highest values of genital weight in comparison with the youngest.

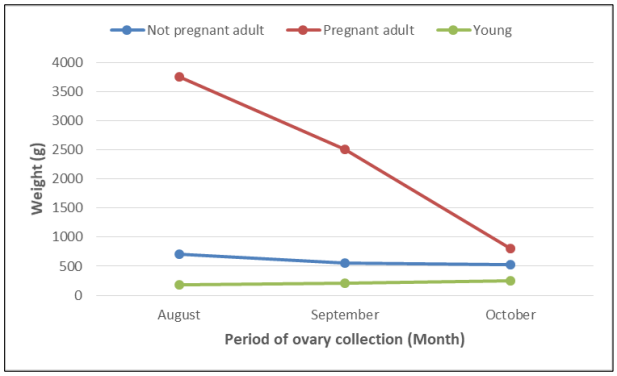

Figure 1 Chronogram of variation in the weight of the dromedary's genital tract. Each period (month) represents the mean ±SEM of the forty (young), seventy (not pregnant adult) and twenty-one (pregnant adult) independent values

3.1.2. Dimensions of the genital tract

Cervix

The diameter of the cervix varied significantly between the three categories of animals with the highest values obtained in pregnant dromedary followed by not pregnant adult and young (Figure 2). On the other hand, the values of the diameter of the uterine cervix were the lowest during the samplings made in October in the group of pregnant females.

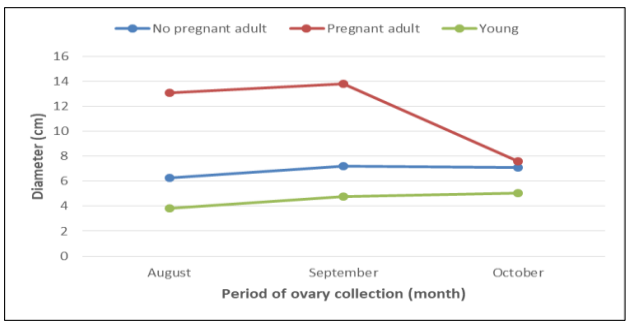

Figure 2 Chronogram of variation of the diameter of the cervix of the dromedary. Each period (month) represents the mean ±SEM of the forty (young), seventy (not pregnant adult) and twenty-one (pregnant adult) independent values

Uterine body

Statistical analysis (Table 1) showed that the diameter and length of the uterine body vary according to the sample collection period and the animal category. Thus, the chronogram (Figure 3) shows that the diameter of the uterine body appears greater in September compared to the other months, regardless of the category of animals considered.

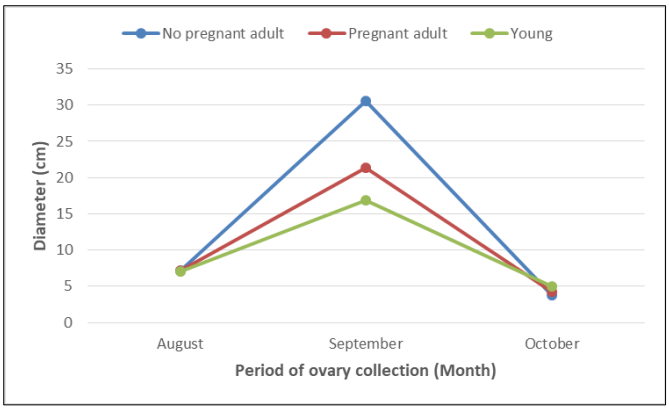

Figure 3 Chronogram of variation in the diameter of the dromedary's uterine body. Each period (month) represents the mean ±SEM of the forty (young), seventy (not pregnant adult) and twenty-one (pregnant) independent values

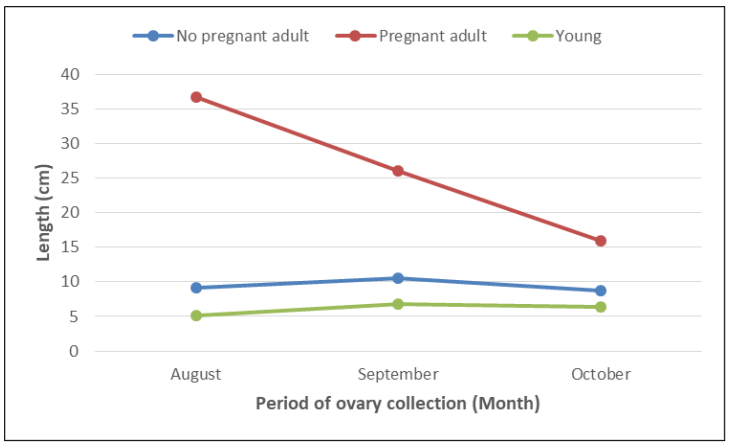

Figure 4 Chronogram of variation of the length of the uterine body of the dromedary. Each period (month) represents the mean ±SEM of the forty (young), seventy (not pregnant adult) and twenty-one (pregnant) independent values

Furthermore, the Chronogram (Figure 4) indicates that in pregnant dromedaries, the highest uterine body lengths were recorded in August. On the other hand, in young and not pregnant adults, the variations in length are less noticeable. However, the two-way analysis of variance did reveal an interaction between sample collection period and animal category in variations in uterine body length and diameters of the cervix and uterine body (Table 1). The existence of this interaction between these two factors supposes that the temporal variations of these different parameters are accentuated by the physiological state of the animals.

Horns and fallopian tubes

The analysis of Table 2 reveals that there are significant differences ($p=0.000$) between the three categories of dromedaries in terms of the average length and diameter of the uterine horn as well as the length of the uterine tube. Thus, the highest values are observed in pregnant dromedaries and the lowest in the youngest females. In addition, the results obtained between the right and left side of the animal show that the length and the diameter of the horns were greater ($p<0.05$) on the left side of the animal than on its right side. In contrast, for the length of the fallopian tube, these values remained similar between the two sides (right and left) across all animal categories.

Also, the analysis of these results shows that the dimensions of the uterine horn and fallopian tube are the most important (p=0.000) during the collections of the month of August and the least important in October. (Table 3)

3.2. Morphological characteristics of dromedary ovaries

Data show that the average values of the weight and dimensions of the different ovaries varied significantly (p=0.000) depending on the category of the dromedary (Table 4). Thus, the young dromedaries presented ovaries having the smallest weight, length, width and height in comparison with the empty and pregnant adults. In addition, the weight and dimensions of the ovary are greater (p<0.05) on the left side of the ovary than on its right side in not pregnant camels. While for pregnant, the right side had the highest values.

Table 1 Analyzes of variance of the variations in tract weight and dimensions of cervix and uterine bodies in dromedaries

	Tractus genital weight		**Uterine body weight**		**Uterine body length**		**Uterine body diameter**	
ANOVA	Category	Period	Category	Period	Category	Period	Category	Period
One-way	P < 0.0001	P < 0.0001	P < 0.0001	P < 0.0001	P < 0.0001	P < 0.0001	P < 0.0001	P < 0.0001
Two-way								
Category	P < 0.0001		P < 0.0001		P < 0.0001		P < 0.0001	
Period	P < 0.0008		P < 0.008		P < 0.001		P < 0.02	
Interaction	P < 0.0005		P < 0.002		P < 0.003		P < 0.004	

ANOVA : Analyse of variance

Table 2 Average dimensions of the different parts of the uterine horn and fallopian tube of not pregnant, pregnant and young dromedaries

Dromedary categories	**Uterine horn length (cm)**		**Uterine horn diameter (cm)**		**Fallopian tube length (cm)**	
	R	**L**	**R**	**L**	**R**	**L**
Young (39)	3.89±0.81 Aa	4.96±1.48 Ba	2.49±0.69Aa	2.91±0.85Ba	6.62±1.60Aa	7.16±1.83Aa
Not pregnant adult (72)	5.62±1.15 Ab	8.76±2.01 Bb	4.02±0.81Ab	5.19±1.24Bb	8.26±1.74Ab	9.05±2.03Ab
Pregnant adult (21)	20.97±16.77Ac	30.07±16.09Bc	13.59±6.87Ac	17.11±8.56Bc	13.64±4.38Ac	14.59±4.96Ac
P<	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Different capital letters on the same line indicates statistically significant differences (p<0.05) between the arithmetic means of the right side (R) and the left side (L) of ovary. Different lowercase letters on the same column implies statistically significant difference (p<0.05) between dromedary categories. ( ): Number of animals sampled.

Table 3 Average dimensions of the different parts of the horn and fallopian tube of the slaughtered dromedary according to the month of sampling

Month	**Uterine horn length (cm)**	**Uterine horn diameter (cm)**	**Fallopian tube length (cm)**
August (47)	11.60±14.44 a	6.63±7.45a	10.30±4.41a
September (46)	8.39±6.95b	5.42±4.11b	9.05±2.54b
October (39)	7.57±4.37b	5.07±3.09b	7.38±2.01c
P<	0.0001	0.0001	0.0001

Different letters on the same column implies statistically significant difference (p<0.05) between collection months. ( ): Number of animals sampled.

Table 4 Average weight and dimensions of ovary according to the dromedary categories

Dromedary categories	Ovary weight (g)		Ovary length (mm)		Ovary width (mm)		Ovary height (mm)	
	R	L	R	L	R	L	R	L
Young (39)	1.98±0.89 Aa	2.58±3.19 Ba	20.71±3.74 Aa	21.64±5.91 Ba	15.55±3.20 Aa	16.26±4.32 Ba	8.57±3.57 Aa	9.08±4.54 Ba
Not pregnant adult (72)	4.31±3.37 Ab	4.87±3.86 Bb	27.85±4.56 Ab	29.83±5.55 Bb	20.91±3.66 Ab	22.01±5.30 Bb	10.17±2.30 Ab	10.38±2.59 Bb
Pregnant adult (21)	6.41±2.88 Bc	5.67±2.76 Ac	33.19±5.68 Bc	31.56±6.92 Ac	21.21±2.78 Ab	21.79±2.77 Bb	14.97±5.99 Bc	14.07±7.71 Ac
P<	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Different capital letters on the same line indicates statistically significant differences (p<0.05) between the arithmetic means of the right side (R) and the left side (L) of ovary. Different lowercase letters on the same column implies statistically significant difference (p<0.05) between dromedary categories. ( ): Number of animals sampled

Table 5 Average weight and dimensions of ovary according to the sampling month

Months	Ovary weight (g)	Ovary length (mm)	Ovary width (mm)	Ovary height (mm)
August (47)	3.81±3.38	26.82±6.62	19.75±4.00	9.54±3.33b
September (46)	4.42±3.08	27.53±7.22	19.86±5.41	11.86±5.88a
October (39)	4.19±3.83	27.06±6.04	19.87±4.62	10.13±2.54b
P<	0.495	0.805	0.455	0.0001

Different letters on the same column implies statistically significant difference (p<0.05) between collection months. ( ): Number of animals sampled

Table 6 Average numbers of the different follicles present on the ovaries according to the sampling month

Month	Total of follicles	Follicle ≤4mm of diameter	Follicle ≤ 10mm and >4 mm of diameter	Follicle between 11 and 20 mm of diameter	Follicle > 20 mm of diameter
August (47)	24.50±13.01a	23.22±13.05	1.01±0.96a	0.06±0.01ab	0.00±0.00
September (46)	29.23±15.33b	27.46±15.05	1.81±1.20b	0.15±0.04b	0.02±0.01
October (39)	23.60±15.17a	23.06±15.44	0.51±0.11a	0.02±0.015a	0.00±0.00
P <	0.05	0.055	0.01	0.05	0.125

Different letters on the same column implies statistically significant difference (p<0.05) between collection months. ( ): Number of animals sampled.

Regarding to the period of samples collection, the month of dromedary slaughter did not significantly influence (p>0.05) the weight and dimensions of the ovary except for the height of the ovary which was greater (p=000) in females slaughtered in September (table 5). Indeed, the average height was 11±86±5.88 mm; 10.13±2.54 and 9.54±3.33 mm, respectively for the months of September, October and August.

Table 7 Average numbers of the different follicles present on the ovaries of the three categories of dromedaries

Dromedary categories	Total of follicles		Follicle ≤4 mm of diameter		Follicle ≤ 10 mm and >4 mm of diameter		Follicle between 11 and 20 mm of diameter		Follicle > 20 mm of diameter	
	R	L	R	L	R	L	R	L	R	L
Young (39)	18.57 ±12.35Aa	20.36 ±12.32Ba	17.90 ±12.38Aa	19.17 ±12.03Ba	0.67 ±0.04	1.07 ±0.10	0.00 ±0.00	0.09 ±0.03	0.00 ±0.00	0.02 ±0.01
Not pregnant adults (72)	27.94 ±14.90Ab	28.82 ±15.16Bb	26.57 ±15.08Ab	17.42 ±15.15Bb	1.55 ±1.42A	0.95 ±0.62B	0.10 ±0.04	0.14 ±0.09	0.00 ±0.00	0.01 ±0.01
Pregnant adults (21)	29.28 ±13.79Ab	30.61 ±14.71Bb	27.71 ±13.26Ab	29.61 ±14.80Bb	1.57 ±1.45A	1.00 ±0.51B	0.04 ±0.02	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
P <	0.001	0.001	0.001	0.0001	0.525	0.525	0.642	0.642	0.753	0.753

Different capital letters on the same line indicates statistically significant differences (p<0.05) between the arithmetic means of the right side (R) and the left side (L) of ovary. Different lowercase letters on the same column implies statistically significant difference (p<0.05) between dromedary categories. ( ): Number of animals sampled

3.3. Functional characteristics of the ovaries of the slaughtered dromedary

3.3.1. Characteristics of follicles

It emerges from the analysis of Table 6 that both the average of the total number of follicles and those of follicles whose diameter is between 5 and 10 mm and between 11 and 20 mm were statistically higher in September than during the months of August and October.

In addition, the total number of follicles and the number of follicles whose size is less than or equal to 4 mm in diameter varied very significantly (p<0.000) depending on the category of dromedary while the type of category has statistically no influence (p>0.05) on the variation in mean number of the other types of follicles (p>0.05). On the other hand, the average number of other follicles of the different types of diameters varied according to the right or left ovary of the dromedary (Table 7)

3.3.2. Characteristics of corpus luteum

It is noted that from a statistical point of view, the results obtained on the corpus luteum are not different (p≥0.05) except for the number of recent corpus luteum which varied significantly (p<0.001) and was highest during the month of September. (Table 8)

Table 8 Average number of corpus luteum on dromedary ovaries according to month of sample collection

Month	Total of corpus luteum	Eldest corpus luteum	Recent corpus luteum	Pregnancy corpus luteum
August (47)	1.58±1.26	1.33±1.09	0.13±0.01a	0.10±0.03
September (46)	2.09±2.07	1.47±1.23	0.54±0.48b	0.06±0.04
October (39)	1.91±1.71	1.53±1.47	0.33±0.27c	0.06±0.04
P <	0.053	0.404	0.0001	0. 188

Different letters on the same column implies statistically significant difference (p<0.05) between collection months. ( ): Number of animals sampled.

Also, it is noted from these results that the average number of the different type of corpus luteum varied very significantly (p<0.05) depending on the category of the dromedary. Moreover, there are statistically different differences (p<0.05) between the average number of different corpus luteum between the right and left ovaries of the dromedary. (Table 9).

Table 9 Average number of total corpuses luteum observed on the right and left ovaries according to the category of dromedaries

Dromedary categories	Total of corpus luteum		Recent corpus luteum		Eldest corpus luteum		Pregnancy corpus luteum	
	R	L	R	L	R	L	R	L
Young (41)	0.70±0.04Aa	0.53±0.32Ba	0.27±0.15Aa	0.17±0.08Ba	0.42±0.38Aa	0.36±0.26Ba	0.00±0.00a	0.00±0.00a
Not pregnant adults (70)	2.50±1.87Ab	2.25±1.75Bb	0.48±0.40b	0.41±0.37b	1.73±1.13Aa	0.36±0.26Ba	0.00±.000a	0.00±0.00a
Pregnant adults (21)	2.66±2.53Ab	2.38±1.46Bb	0.09±0.03Ac	0.28±0.26Bb	2.04±1.33Ab	1.21±1.15Bb	0.52±0.51b	0.47±0.41b
P<	0.0001	0.0001	0.0001	0.046	0.0001	0.0001	0.0001	0.0005

Different capital letters on the same line indicates statistically significant differences ($p<0.05$) between the arithmetic means of the right side (R) and the left side (L) of ovary. Different lowercase letters on the same column implies statistically significant difference ($p<0.05$) between dromedary categories. ( ): Number of animals sampled

4. Discussion

4.1. Variations in the weight and dimensions of the genital tract of the dromedary

4.1.1. Weight and dimensions of the cervix and uterine bodies

The average weight of the genital tract obtained was the smallest in young dromedary and the highest in pregnant dromedary. This variation between the three animal categories is due to animal age because, generally, a growing individual is characterized by the development of its genital organs. Furthermore, the genital tract of pregnant females was heavier than that of other animal categories because during the development of gestation, the genital tract, in particular the uterus, experiences an increase in its thickness due to the proliferation and synthesis of endometrial tissue.

The average length and diameter of the uterine body obtained in the present study were 6.07±0.20 cm and 4.22±1.34 cm respectively for young females, 9.37±2.45 cm and 7. 13±1.49 cm for not pregnant adult females and finally 29.23±15.94 cm and 24.89±12.03 cm for pregnant dromedaries. These results are different from those reported in Nigeria in the same species by [9] who found an average length and diameter of the uterine body, respectively 9.59±2.27 cm and 4.94±0, 56 cm for not pregnant females and 43.90 ± 9.03 cm and 18.13 ± 5.88 cm for pregnant females. In addition, the mean diameter of the cervix obtained in the present work is strictly greater than the values of 0.91±0.40 cm and 1.60±0.59 cm reported by the same authors, respectively, for not pregnant dromedaries and pregnant dromedaries. Furthermore, the length and diameter of the uterine body obtained in the present study are greater than the respective values of 0.67±0.0568 cm and 0.39±0.0219 cm reported by [10]. This observed difference could be due to the animal breed, the animal husbandry conditions or the measurement method applied. Indeed, in the present study, a flexible measuring tape was used whereas the other authors had used either a drape and a plastic measuring tape or a caliper for the measurements.

4.1.2. Dimensions of the uterine horn and fallopian tube of dromedaries

The average dimensions obtained from the left and right uterine horn in this study for young and adult dromedaries are similar to those found by [9] in Nigeria. Indeed, these authors reported 6.56±0.9 cm and 9.86±1.38 cm for the uterine horns and a diameter of approximately 3.39±0.7 and 4.43±2.48 cm respectively for the right side and left side of not pregnant dromedaries. On the other hand, [7] observed that the average lengths of the uterine horn were 5 to 6 cm for the right horn and 7 to 8 cm for the left horn. Moreover, the results of the present work on the dimensions of the uterine horns of pregnant dromedaries are different from those found by these same authors. This difference could be due to the difference in the stage of development of the fetus between the females of our study and those of the other research team. Because, according to [11], the dimensions of the uterine horns of camels vary according to the length of the fetus.

For the average length of the right and left uterine tubes observed during this study, it was respectively 6.62±1.60 cm and 7.16±1.83 cm for young dromedaries, 8.26±1.74 and 9.05±2.03 cm for empty adults and 13.64±4.38 and 14.59±4.96 cm for pregnant adult dromedaries. This shows that these results are much lower than those reported by [12] in

Pakistan who obtained the same tube length on both the left and right sides, i.e. approximately 9.2±0, 60cm; 23.5±0.53 cm and 25.00±0.05 cm respectively for young, adult and pregnant camels. This observed difference could be due to the measurement method and the camel breed. Indeed, in the present study, the measurements are made using a flexible tape measure whereas these authors had used the caliper method.

4.2. Morphology of dromedary ovaries

The average right and left ovary weight observed in the present study were approximately 1.96±0.4 and 2.67±0.43 g for the young; 4.37±0.38 and 4.79±0.38 g for not pregnant adult and 6.56±0.67 and 5.46±0.51 g for pregnant dromedary. This increase in gonad weight by animal category is similar to the results reported by [12] in Pakistan, who obtained 3.65±0.46; 4.52±0.12 and 4.76±0.08 g for the left ovary and 3.50±0.37; 4.24±0.11 and 4.33±0.08 g for the right ovary respectively, for young camels, heifers and adults. A similar trend had already been reported by [9] in Nigeria where they found a weight of 3.00±0.61 and 4.13±0.63 g for the ovaries of not pregnant camels and 5.48 ±0.78 and 11.13±0.52 for those of pregnant camels, respectively for the right and left ovaries. In another study carried out in North Sudan, [13] obtained 4.40±0.32 and 3.90±0.25 g of weight, respectively for the left and right ovaries of camels. In general, taking into account the animal category and the side of the ovary, there are some differences in weight per ovary between our results and those reported by the consulted bibliography. This difference could be due to the animal breed, the camel production system, the period of the year of the study and the structural characteristics of the ovary (i.e. number and type of corpus luteum present on the ovary).

About the dimensions of the ovary, [9], in Nigeria obtained 29.6±6.1 and 31.8±7.8 mm for the length; 18.9±3.5 and 22.3±5.00 mm for the width and 9.4±1.8 and 11.2±1.9 mm for the height respectively, for the right and left ovary of not pregnant camels. While for pregnant females, the values were around 31.4±5.7 and 45.1±9.7 mm for length; 23.5±5.3 and 26.2±4.0 mm for width and 9.7±2.8 and 13.3±2.2.8 mm for height respectively, for right and left ovary. In another study, [5] found values equivalent to 42.4±1.2 and 40.2±1.2 mm in length; 30.1±1.0 and 29.4±0.9 mm in width and 21.5±1.6 and 21.2±1.5 mm in height respectively, for the left and right ovaries of dromedaries. In comparison with these two works, the dimensions of the ovaries obtained in the present study were very low. This could always be justified by the factors animal breed, period of year, breeding system, structural state of the ovary and method of measuring the ovaries used. Indeed, in the present study, the dimensions of the ovary were measured using a caliper while [5] had used the technique of Khan [14] which consisted in separating the organs in their position normal on a table and take the measurements with a caliper.

In general, the weight and dimensions of the ovary reported in this work are greater on the left side of the ovary than on its right side for not pregnant camels. Such a finding is in disagreement with the observations made by [15] who did not find significant differences between the right and left ovary for the length and width of the organ being an average length of 3, 22±0.6 cm vs. 3.29 ± 0.7 cm and an average width of 2.49 ± 0.8 cm vs. 2.68 ± 1.1 cm respectively for the left and right side of the ovary.

4.3. Structural characteristics of dromedary ovaries

4.3.1. Characteristics of follicles

The follicular cycle in camels is characterized by the growth and development of follicles which are divided into different types. Indeed, the average number of different follicles recorded during the present study is higher than that found by [16] in Egypt which was 3.6 ± 0.9 and 6.4 ± 1, 2 for total follicles and 2.0±0.3 and 4.0±0.8 for follicles (1 to 3mm) in diameter, respectively for pregnant and not pregnant camels. But, it was similar to that found by these same authors for the follicles of 4 to 9 mm in diameter which was equivalent to 0.8 ± 0.2 and 1.0 ± 0.3 and for the follicles of 10 to 20 mm in diameter whose average number was 0.8±0.1 and 1.4±0.2, respectively for pregnant and not-pregnant camels. However, the results of the present work are lower than those found by [17] in Egypt who obtained 22 and 18 follicles of 3-5mm in diameter, 19 and 25 follicles of 6-9mm in diameter, 38 and 52 mature follicles and 12 and 10 follicles with cyst, respectively for the right and left ovary of the camels. This difference observed between the two studies could be linked to the study period and the animal breed. Indeed, the present study worked on dromedaries during the rainy season (August-October) and the aforementioned worked during the respective periods January-March and November-April. However, it has been shown that both the dimensions of the genital tract and the functionality of the ovary are greater during the optimal period of reproduction compared to the low period of reproduction [5].

4.3.2. Characteristics of the corpus luteum

The average number of the different corpus luteum counted on the ovary according to the different months of study was different between them. This may be due to the variability of the sexual behavior of the dromedary during these

three months of study. The present study showed the simultaneous existence of different types of corpora luteum on the same ovary, which is in accordance with the observations of [4] and [15]. The presence of different types of corpora luteum is linked to a mating which results in the formation of a recent corpus luteum which is maintained if the mating is fertile (corpus luteum of gestation) or regresses if the mating is infertile (corpus luteum old) [4].

For the average total of corpus luteum present on the ovary according to the category of dromedary, the right ovary presented the higher number of different corpora luteum compared to that of the left. This may be related to ovulation which is more important on the right side than on the left side. Which is different with the assertion of [7] who said that the left ovary has a more intense ovulatory production than the right ovary.

5. Conclusion

The results obtained during the present study have made it possible to understand that the weight and dimensions of the different organs forming the genital tract of dromedaries depend on the reproductive status of the animal and the month of genital collection at the slaughterhouse. Also, the left horn appears longer than the right and the dimensions and weight of the ovary depended of the follicular activity of the females. This follicular dynamic capacity of the ovary of the dromedary was a function not only of the animal category but also of the period of ovaries collection.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

The present research work does not contain any studies performed on animals/humans subjects by any of the authors.

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