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Review article

An over view on the anatomy and physiology of male one humped camel (*Camelus Dromedarius*) reproductive system

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ABSTRACT

Available literature on the Anatomy and physiology of the reproductive system of dromedary camel in Nigeria is observed to assess the current performance and productive potential of this species. The origins, distribution and classification of camel breeds are briefly discussed. The reproductive anatomy and physiology is described, and is followed by an account of breeding behaviour and performance, with special attention to fertility. A brief account on the biometry, gross anatomy,histology, morphometry and physiology in relation to reproductive performance of the one humped camel is discuss. The camel's ability to produce milk and meat is assessed in detail, together with its suitability for transport and other purposes, such as ploughing, milling and the production of hides and skins. Management and socio-economic factors are also briefly discussed. Finally, the information presented is summarized to served as an aid in teaching and as a base-line to farmers in inproving the standard of the West African specie. There is need for future research on the above mention specie in reproduction and husbandry in Nigeria.

1. Introduction

The one-humped camel (Camelus dromedarius), and the two-humped camel (C. bactrianus) from which it is thought to have evolved, are the two species comprising the genus Camelus. Together with the llamoids of South America they are members of the Camelidae family, believed to have evolved from the Protylopus which occupied the North American continent over 1 million years ago (Mobarak et al. 1990). The dromedary was probably first domesticated in southern Arabia around 3000 B.C.

Of the estimated 17 million camels of the world, 15 million are one-humped, and the vast majority of these (12 million) are found in Africa, especially in the five neighbouring East African countries of Somalia (5.4 million), Sudan (2.9 million), Djibouti (0.4 million), Ethiopia (0.9 million) and Kenya (0.5 million). The rest are mainly found in Asia. Camel populations are increasing only slightly, and in a few areas, such as northern Kenya and west african countries, the numbers are actually declining, since camels in pastoral herds are being replaced by other livestock species(Mahmoud, 2006).

Although this report will not deal in depth with camel fertility, the reproductive characteristics of both male and female camels must be examined before the importance of camel milk for human nutrition in drought areas can fully be assessed. It is often stated that the most negative argument against camel breeding is their slow and uncertain reproductive rate (Novoa, 1970; Mahmoud, 2006). In some areas camel breeding is even considered to be too hazardous to be undertaken systematically (Gast et al., 1969).

The level of fertility in domestic animals results from a number of interacting factors, some of which have a genetic basis while others are environmental in origin. In most domesticated species much research has been undertaken to discover how these factors operate, but unfortunately thorough investigations of this kind have not so far been carried out for the dromedary. Based on the available literature, an attempt is made here to explain some aspects of the reproductive anatomy and physiology of the dromedary.

1.1. The male reproductive system

Early accounts of the anatomy of the reproductive system of the male camel (Cauvet, 1925; Leese, 1927; Tayeb, 1948) continue to serve as reference works on the subject. The anatomy of the male reproductive tract includes the penis, the testes, the epididymis and the accessory sex glands. Males of different species are often referred to by specific names which reflect their reproductive status in this section the testes, tubular and copulatory organs of the male genital tract are described.

2. Gross anatomy

The posterior border of the camel testis is convex and free. The anterior surface is flattened, except where the epididymis attaches to the anterior-dorsal point. Here the efferent ducts emerge from the gonadal interior. The tail of the epididymis is very closely apposed to the testicular surface by means of the epididymal ligament. Like most domestic species, except the horse, the camel testis has a well-defined mediastinum, and rudimentary testes have also sometimes been described in a ventral-anterior position in relation to the true testes. The vas deferens of the camel is remarkably twisted for much of its initial course, but becomes fairly straight towards the end portion. This peculiarity results in a thickened spermatic cord, which is relatively long and houses the vas deferens, the pampiniform plexus, spermatic artery, nerves, lymphatics and the internal cremaster muscle. The internal inguinal ring of the camel is very narrow.

The testes of the camel are located in the perineal region, in a position similar to that of the dog (Leese, 1927) or boar. Each is contained in its own scrotum. Tayeb (1948) observed that the scrotum of the camel is generally covered by the tail but could be seen in the standing position. The scrotum is oval and sparsely covered with hair. A faint median raphe divides the two testicles. The camel testes have

been described as being broadly similar to those of the horse, although differences become obvious on careful dissection.

3. Biometry

The testes are oval in shape and in an animal of 3 years measure 7–10 cm in length, weighing 80–100 gm each. Mahmoud (2006) found the average length, breadth and thickness in 6- to 10-year-old camels to be 9.07, 5.08 and 4.43cm respectively, with an average weight of 91.71 gm. They observed that the right testicle was often slightly smaller than the left one.

The internal structure of camel testes has been studied by Adel-Raouf et al (1995), who calculated the average diameter of the seminiferous tubules to be 210. While the diameter did not significantly differ between the right and left testes, it varied significantly ($P< 0.005$) according to season, being smallest during the summer (189.40—203.26) and largest in spring (209.68—226.20). Williamson and Payne (1978) also confirm that camel testes increase in size during the breeding season.

4. Camel accessary reproductive gross anatomy

Regarding the accessory glands of the male reproductive tract, both Leese (1927) and Tayeb (1948) described the presence of the prostate gland and the absence of seminal vesicles. The prostate gland is a discoid structure made of two lobes joined by one isthmus and located on the dorsal aspect of the pelvic urethra. It averages, 3–7 × 5 cm and is dark yellow in colour. Tayeb also described a dilated end of the vas deferens in an area generally occupied by the ampulla, which is usually described in a similar manner. There is no confirmation as to whether the dilation was in fact the ampulla or not. He also notes the additional presence of the bulbo-urethral (Cowper's) gland. The two units of the gland are located on either side of the terminal portion of the pelvic urethra. They are whitish, almond-shaped organs measuring 2.5 × 1.2 cm.

4.1. Anatomy consideration of the camel accessory sex glands

The most important feature is the absence of seminal vesicles in the Camelidae family (Mobarak et al. 1990). In dromedaries the accessory sex glands are: the ampullae, the prostate, the bulbo-urethral (Cowper's glands) and the urethral glands. The size and weight of the glands are affected significantly by the age of the animal, (tending to reach a maximum between 10.5 - 15 years and the season, with maximum gland weight being recorded during the breeding season (Mobarak et al. 1990). This is concomitant with the increased activity and weight of the testis, that suggests that the activities of the accessory sex glands are regulated by androgen secretion from the testis (Mahmoud, 2006).

4.2. The ampulla

The initial part of the ductus deferens is small in diameter and very tortuous but it thickens and forms the ampulla as it approaches the pelvic urethra (Mahmoud, 2006). It averages 18 cm in length with the terminal part embedded in a deep groove located on the ventral surface of the corpus prostatae. It has been suggested that these glands may play the role of a sperm reserve before ejaculation (Ali et al.1996).

4.3. The prostate gland

This is the largest and only palpable gland in the dromedary. It has two components, a compact and a diffuse part with the two forming an L shape which lies dorsal to the pelvic urethra (Ali et al.1996).

4.4. The bulbo-urethral glands

There are two bulbo-urethral glands which are almond shaped structures that are located eitherside of the terminal portions of the pelvic urethra (Ali et al.1996 ; Mahmoud, 2006).

4.5. The urethral glands

These are located just behind the body of the prostate and extend to the level of the urethral bulb before opening into the urethral lumen via numerous ducts. These glands and the pelvic urethra are richly enervated; these nerves being responsible for the contraction of the muscle and expulsion of glandular secretion (Mahmoud, 2006).

5. Penile gross anatomy

The penis of the camel is of the fibroelastic type and relies primarily on its elasticity for erection and extension. In the absence of an erection, the penis is retracted into its sheath via a prescrotal sigmoid flexure not a post scrotal sigmoid flexure, as is the case in bulls (Ali et al.1996). The length of the penis ranges from 59 - 68 cm and it is cylindrical in shape (Ali et al.1996). At its root, at the ischial arch, it has a diameter of 2.2 cm which gradually decreases to 0.4 cm at the neck of the glans penis. The glans penis is 2.6 cm long and ends in a cartilaginous process which supposedly directs the penis through the cervix of the female during copulation (Mahmoud, 2006). The glans penis is curved along its vertical plane giving it a hook-shape with a definite neck between the glans and body of the penis. The penis of the dromedary showing the hook-like shape of the glans penis.

An interesting aspect of the copulatory organ of the male camel is the shape of its penile sheath. Early accounts of the structure present it as a voluminous, conical organ hanging from the abdomen like a large mammary gland. The point of the penile sheath is directed posteriorly and carries a very narrow orifice about 1.84 cm in diameter (Mobarak et al, 1992). Leese (1927) commented that this posterior orientation of the orifice results in the urine being directed backwards during micturition. Tayeb (1948) confirmed the above observations and added that the sheath has two pockets, one internal and one external. The sheath is dark in colour and, like the scrotum, sparsely covered with short hair. Its muscles are arranged in three groups (anterior, posterior and lateral), and their coordinated contraction and relaxation results in the forward and backward movement of the structure, or the constriction and dilatation of the preputial orifice. The anterior group of muscles is the largest and the lateral one the weakest. All insert into the inner surface of the skin covering the free part of the penis (Mobarak et al, 1992).

Within this massive casing the penis is hidden in its non-erectile state. It is a firm, cylindrical organ whose diameter generally decreases from the root towards the free end (glans penis). The average diameters of the root, middle and glans penis parts are given as 2.23, 1.64 and 0.42 cm by Mobarak et al (1990). A prescrotal sigmoid flexure is characteristic of the camel penis, dividing the organ into pre-, post- and intra-sigmoid portions. The average lengths of the three were estimated by Tayeb (1948) as 17.5, 17.5 and 25 cm, giving a total length of 60 cm. Leese (1927), and more recently Mobarak et al (1992), give average total lengths of 67.5 cm and 59.6 cm respectively. The penis originates in the region of the ischiatic arch via three cavernous bodies. The three are surrounded by a thick tunica albuginea which has a ventral urethral groove. The urethra proper is ventrally and laterally covered by the corpus cavemosum urethrae and dorsally by the tunica albuginea. Trabeculae from these outer layers penetrate the penile bodies in increasing amounts from the root end towards the glans penis. The caverns and cavities characteristic of the initial portion are therefore progressively replaced by fibrous tissue from the tunica albuginea. The septum between the two dorsal penile bodies tends to become ill defined towards the free end of the penis, which is elliptical caudally and ovoid cranially, where the cavernous nature of the caudal part of the penis is again more prominent. The urethra at this level is surrounded by the urethral body and assumes a left-sided rather than a middle position. At this level too, the urethral body is characterized by large blood vessels. The glans penis of the camel is shaped like a hook (Mobarak et al, 1992), curved along the vertical plane. Its features are a well-defined neck and a urethral process measuring 4–6 × 2 mm. This terminal portion of the penis feels cartilagenous to the touch and on cross-section a complete ring of hyaline cartilage filled with blood vessels may be revealed. On the outside of this ring there are many elastic fibres and caverns.

Muscles of the camel penis include the ischiocavernosi and the retractor penis. The blood supply of the male camel genitalia is similar to that of the bull and its nerve supply is typical of most domestic species. The camel penis is in general of the fibrous type, though some vascular elements are observed at

the root and terminal parts. Mobarak et al (1992) classify the camel penis as intermediate between the fibrous and vascular types. The urethral body, however, consists primarily of vascularized tissue.

6. Morphometric observation of external genitalia

6.1. Scrotum and testes

The scrotum is located in the perineal region in camels with the testicles directed caudo-dorsally. The scrotal skin tends to be smooth and fine during the height of breeding activity and then becomes thicker during the period of sexual inactivity because of decreased testicular size.

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. This is probably due to differences in age, breed and sexual activity at the time of measuring, but in general they vary in length from 7 - 10 cm and weigh between 80 - 100 g each (Mobarak et al. 1990). They become enlarged and protrude when the male camels are sexually active in the rutting season.

7. Microscopic observation of camel testis

7.1. Seminiferous tubules

In camels the outer diameter of the seminiferous tubules has been reported to vary between 113 - 250m in diameter and gets significantly smaller during the non-rutting season (Mahmoud, 2006). The season does not however have any effect on the size of the spermatozoa although it does on their number. For example, the estimated production of camel spermatozoa is 8.1 x 106 sperm cells per day at the end of Spring and drops to 4.2 x 106 sperm cells per day at the end of the Summer (Ali et al.1996).

7.2. Epididymis

As in other species the epididymis is composed of three distinct parts: the caput (head), the corpus (body) and cauda (tail). It is located along the dorsal border of the testis with the head curving around the cranial pole of the testis. In dromedaries, the cauda epididymis is round and well-protruded about 3 - 4 cm above the respective extremity of the testis(Mobarak et al. 1990).

7.3. Ductus deferens

The ductus (or vas) deferens are very long measuring between 45 - 50 cm in length and are enclosed within the spermatic cord (Ali et al.1996).

8. Physiological aspect of external genitalia

Testicular size is an important parameter in the evaluation of the breeding potential of males and can be used to predict daily sperm production because of the high correlation found between scrotal measurements testicular weight and total sperm production (Mahmoud, 2006).

According to Umaru 1996, Bulls become sexually mature at 3-4 years. In African countries mature bulls commence rutting around August to October. The rutting bull will return from the bachelor herd to dominate the cowherd and any other males in the area. Alternatively he will drive off some of the cows and establish his own harem. The length of an individual Camels rut varies from 2-4 months depending on, his nutritional state and dominance. Periods of rut are nutritionally and physically demanding and severe weight loss occurs. This has the effect of ceasing the rut of that bull and consequently several dominant bulls are active throughout the breeding season. Scattered small cowherds reform into large herds at the end of the rut.

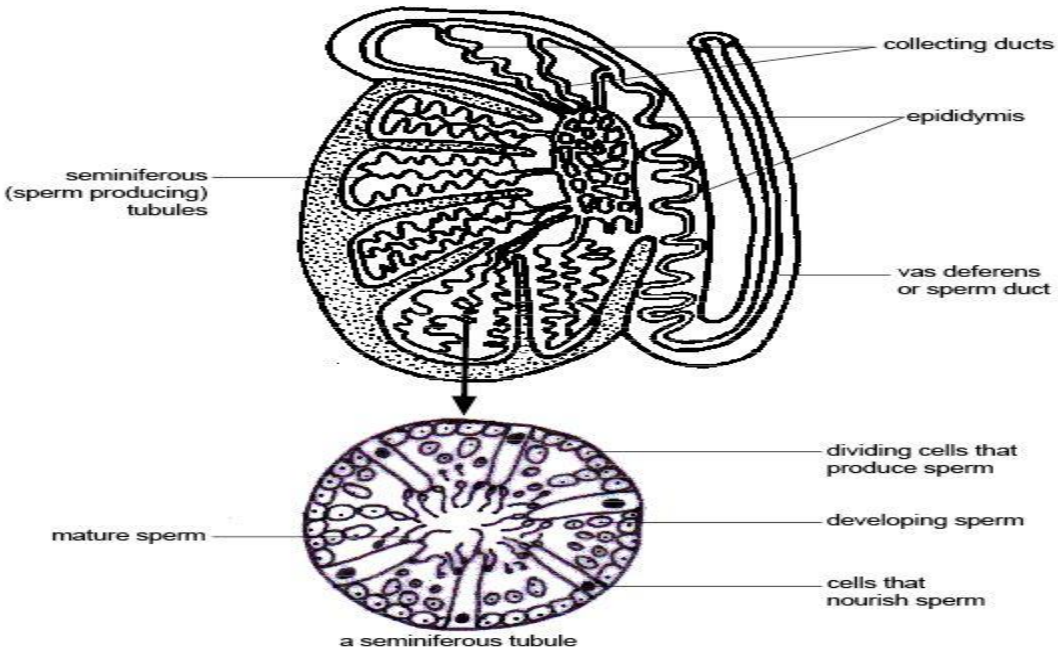

Fig. 1. Adopted from Mahmoud (2006): showing the fine structure of camel testis.

8.1. Breeding season

Aristotle reported that breeding time of camels is in November and December. However, camels, both male and female, are seasonal breeders (Yasin and Wahid, 1957), mating during the rainy, or cold season (Yagil and Etzion, 1980). Longer hours of daylight initiate the breeding season (Chen and Yuang, 1979). Must (1969) described an all-year-round oestrus in the female camel, but this was not found in any other publication.

The pattern of the reproductive cycle appears to relate to the harsh environment in which the camels live (Novoa, 1970). The calves are born in the months most suitable to quarantee their survival. The breeding season differs in various countries. In the region of Pakistan (Yasin and Wahid, 1957), China (Chen and Yuan, 1979), Egypt (Shalash, 1985) and Israel (Yagil and Etzion, 1980), the breeding season is from December to April. This is the period in which both males and females are fertile. In Somalia the male camel ruts in the spring from April to May, (Mares, 1954). In India the breeding period is from November to February (Singh and Prakash, 1964). In Morocco the rutting season occurs in winter and spring. Both rutting season and consequent births coincide with adequate water and feed supplies. In Russia the domesticated Bactrian was found to be polyoestrus, having oestrus cycles all the year round (Bosaev, 1938). The wild camel in the Gobi desert, however was a seasonal breeder (Bannikov, 1945). The rut occurring between January and February. In the Sudan, Musa and Abusinea (1978) report the season as being from March to August.

9. Conclution

In Nigeria the calving interval is 24 months. As a female can live up to 30 years, she can produce about 8 calves in a life-time (Wahid, 1987). With good feed and management the inter-calving time can be reduced to one every two years (Evans and Powys, 1979). This would mean two calves every 4 years and a total of 13 calves in a lifetime. Even two calves in 2 ½ years can be attained and this would greatly improve the fertility of these animals. At 4 or 4 ½ years of age the animals are first used for breeding (Hartley, 1979). The best male is chosen on the basis of his vigour and judged by the performance of his parents. The females should also be culled for defects, such as slow breeding, poor milk yield, bad

mothering and weak offspring (Hartley, 1979). Herds are normally too few in number, for culling to be undertaken and all females are mated.

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