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Anatomical Study of the Water Cells Area in the Dromedary Camels Rumen (Camelus dromedarius)

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Abstract

Introduction: The aim of this study was to establish a description of the water cells area in dromedary camels.

Methods: Ten clinically healthy of both sexes and different age, 4-9 years old were used in this study. The rumen was cut and opened, the contents were emptied of the rumen, then washed by running tap water to remove the ingestion. They were preserved in 10% formalin for 3-4 days to study object.

Results: This study has shown that the water cells area was consisted of many of the primary, secondary and partially folds confining the longitudinal, transversely cells.

Conclusions: The longitudinal and transverse cell forms the water cells which was considered chambers in which water was stored in camel>s stomach.

INTRODUCTION

The camels' stomach is considered as a completely functional organ. It is divided into four compartments as in typical anatomical ruminants: rumen, reticulum, omasum and abomasum [1-4]. While the camel was considered as pseudo-ruminant for it has only three compartments [5-8]. Morerver, the stomach of the camel was divided into three ventricles [9]. The camel stomach has additional glandular sacs that may have special digestive functions [9]. Engelhardt *et al.* observed a strong ventral and transverse muscular ridge, which divided compartment 1 into cranial and caudal portions [10]. The glandular areas in the camel were found in compartments 1, 2 and 3. Hegazi and Hansen stated that the camel rumen showed three groups of water sacs [2, 3]. Purohit mentioned that one of these sacs was situated at the cranioventral aspect of the rumen, being more to the right side, and the other sac was located in the medioventral aspect or lay on the floor of the abdominal cavity [11]. Abuagla et al. reported that there are two of water sacs which were the caudodorsal glandular and the cranioventral glandular sacs, they consisted of large glandular pits, each pit was bounded by pillars [12].

The present work which aimed to investigate the gross anatomy through normal appearance, size, shape, and position of various water cells and measurement of the water sacs in the camel rumen is purposed to be a further support to the functional importance of water sacs in the camel.

METHODS

Twelve rumen of apparently healthy adult camels of both sexes, and different ages between 3-5 years were collected from typical Buryda Slaughterhouse Qassim region and the veterinary teaching hospital of the faculty of agriculture and veterinary medicine in Qassim University, Saudi Arabia.

The rumen of camel was examined to describe the topographical and morphological of water cells area. The rumen was cut and opened, the contents of the rumen were emptied, it was washed and rinsed in running tap water to remove the eliminate food remains and other substances. They were preserved in 10% formalin for 3-4 days. The fixed specimens were used to study morphological features of the water cells area.

It has been calculating the ratio of the water cell area size according to the rumen size based on the water cell area and rumen sizes by using the mathematic rules (average simples measuring).

Rumen size*:* A = 4

Water cells area = A= L.W, (A) the area, (L) the length, (W) the width.

The photography were photographed digitally, using a 6 mega pixels, Dsc - w 50. Camera.

RESULTS

The present study was therefore designed for establishing of normal appearance, size, shape, and position of various water cells in rumen of the dromedary camels.

The camels had only three distinct compartments in the stomach. They differ from the ruminants in gross anatomy. There is no clear distinction between the omasum (third) and abomasum (fourth) compartments, bbecause they are somewhat incorporated. The rumen of camel differs from

other ruminants by the presence of water cells areas.
The rumen of the camel occupies the left side of the abdominal cavity, extending from the most of the left half of the abdominal cavity. It extends from the diaphragm at the level of the 7th rib to the level of the caudal border of the 12th thoracic rib. "From the ventral part of the seventh rib or eighth costal space to the entrance of the pelvis.
The rumen divides into two parts: dorsal and ventral ruminal sacs. The cranial ruminal sac located in the forward and left side of the abdomen and extends slightly to the level the ventral ruminal sac. It has a corrected mucosa membrane, smooth free fold. It forms about 30% of total size of rumen. The caudal ruminal sac is backward and dorsally and extends to the right a little of the level median plane. It divides into a dorsal part and a ventral part. The dorsal part was larger and subdivided into a non-glandular cranial part and a caudal part which was glandular forming the glandular sac. The ventral part was subdivided into a dorsal non-glandular part and a ventral glandular part forming the cranioventral glandular sac and caudoventral glandular sac.
The cranial (dorsal) and caudal (ventral) ruminal sacs contained the water cells area in three groups are cranioventral, caudoventral and caudodorsal sacs that they have a shape and structure which is different from the rest of the parts of the rumen.
The cranioventral sac of the water cells (Figures 1, 2 and 3) situated between the 5th rib cranially and 7th rib caudally, It is rectangular nearly in shape, it is surrounded by four the peripheral rows and contains numerous of pillars. It begins at the crescent-shaped, thick ruminal pillar extending transversally on the wall of the dorsal ruminal sac. It is separated the cranioventral sac from the caudodorsal sac.
It arises from the ruminal pillar which gives the primary pillars ventrally to the edge of the ventral ruminal sac, they are about were 9 ± 2 in number, its length is about 8 ± 2 cm. The primary pillars divides the glandular portion of the rumen inside the water cells area into number of longitudinal cells. Each longitudinal cells locates between two primary pillars then, each a longitudinal cells divides also transversally through secondary folds into smaller than longitudinal cells are transverse cells, they are rectangular chambers, its length is about 3 ± 2 cm, (about 5 ± 1 in number in the one Colum and are 42 ± 3 totally. Each transverse cells (chamber) each chamber was bounded by pillars; two thick longitudinal and two thin transverse pillars, which formed the four walls of the chamber. Each chamber sub-divided by partially irregular small folds into smaller glandular pits called water ruminal celluri (Celluri rumei), 3 ± 1 in number in the one chamber, they are 135 ± 6 totally in number. The water ruminal celluri represents a very small cavities containing water; especially one of the chambers in which water is stored in a camel's stomach.
The Caudoventral and Caudodorsal sacs of the water cells areas (Figure 1, 4 and 5) the structure of both sacs were similar to the cranioventral sac but relatively larger than the cranioventral sac in the area They situated between the 8th rib cranially and 12th rib caudally, It has rectangular nearly shape, it is suronded by two peripheral rows and contains numerous of folds. It begins ventrally to the crescent-shaped, thick ruminal pillar which separated the cranioventral sac from the caudodorsal sac.
They contains large folds 10 ± 2 in number. Its length is about 8 ± 2 cm from the ruminal pillar extending ventrally to the edge of the ventral ruminal sac, they are about 10 ± 2 in number. Its length is about 8 ± 2 cm. The folds divides the glandular portion of the water cells area into a number of longitudinal cells. Each longitudinal cells locates between two primary folds.
Then each longitudinal cells divides also transversally through secondary folds into smaller than longitudinal cells are transverse cells, they are numerous irregular pits between two folds about 4 ± 2 are 36 ± 3 totally in comparison to the cranioventral sac.
Table 1 shows the average measurements of the water cells area, and its size percentage to rumen size. Dependence on the calculation of the size of the rumen and the size of the water cells area in each sample, the SMA of all examination samples.

DISCUSSION

The stomach of the dromedary camel was different from some ruminants and completely different from the mammals. In this study, it had been investigated that the gross anatomy of the water cells areas by description of the normal appearance, size, shape, and position of various water cells and its measurement in dromedary camels' rumen. The results were compared with previous researches conducted on camels.

Table 1: Average Measurements of the Water Cells Area, and its Size Percentage to Rumen Size.

	Cranioventral Sac	Cranioventral Sac	Cranioventral Sac	
Number of Pillars	10 ± 2	-	-	
Number of Folds	-	8 ± 2	8 ± 2	
Cell Length	3.6 ± 0.5	4.5 ± 0.7	4.5 ± 0.5	
Cell Width	3.4 ± 0.5	2.4 ± 0.4	1.5 ± 0.7	
Cell Depth	2.3 ± 0.4	3.2 ± 0.5	4 ± 0.2	
Water cells numerous	6 ± 2, column totally 45	5 ± 2, column totally 45	3 ± 1, column totally 45	T = 1075
Area, L.W (L-W)	375 (15-25)	448 (14-32)	252 (14-18)	
Rumen Area, A = 4πr2 (r = 42)		22155.84		
Percentage Sacs to the Rumen		4.5%		

Data are presented as mean ± SD.

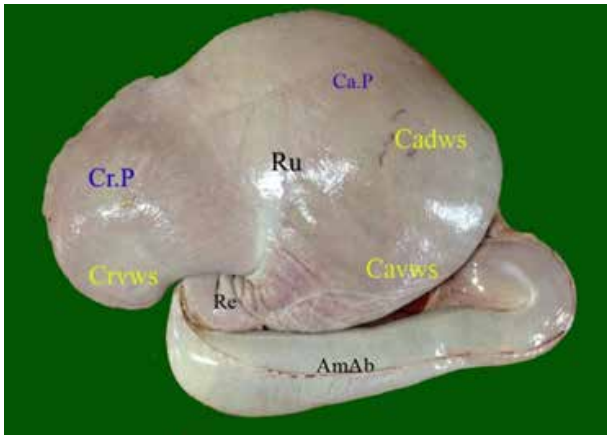

Figure 1: Left View of the Camel Stomach Showing 3 Its Compartments and the Water sac Externally; Rumen (Ru), Reticular (Re), Amasum-bomasum (AmAb), Cranial Part of the Rumen (Cr.P), Caudal Part of the Rumen (Ca.P), Cranioventral Water Sac (Crvws), Caudodorsal Water Sac (Cadws), Caudoventral Water Sac (Cavws).

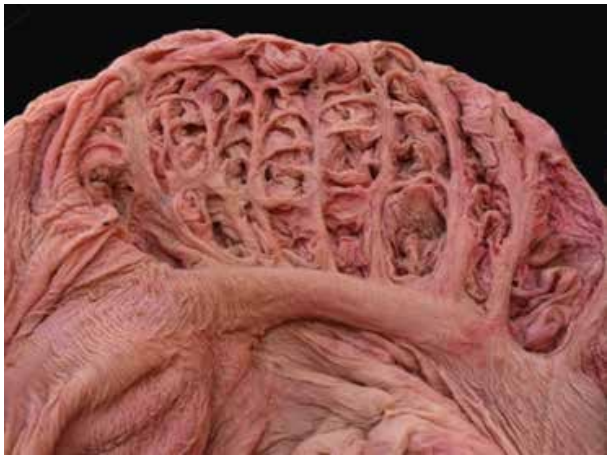

Figure 2: Internal View of the Camel Stomach Showing Cranioventral Water Sac (Crvws)

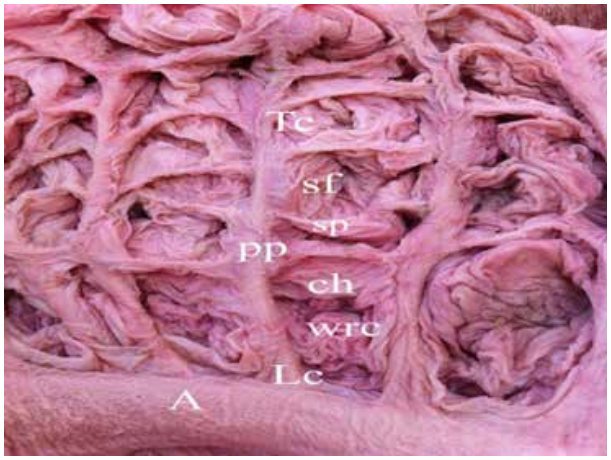

Figure 3: Internal View of the Camel Stomach Showing Cranioventral Water Sac (Crvws); Thick Pillar (A), Primary Pillar (pp), Longitudinal cell (Lc), Secondary Pillar (SP), Transverce cell (Tc), small folds (sf), chamber (ch), Water ruminal celluri (wrc)

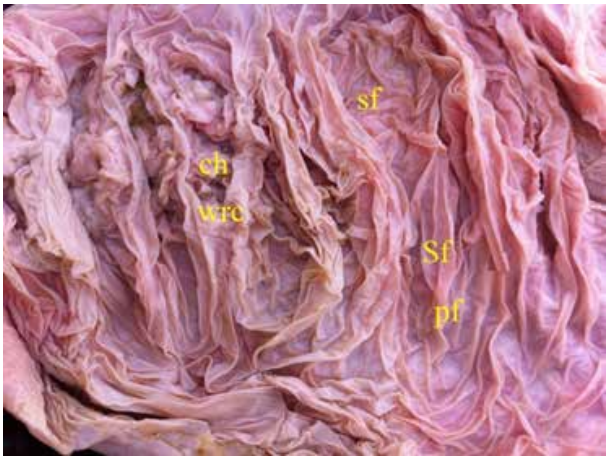

Figure 4: Internal View of the Camel Stomach Showing Caudodorsal Water Sac (Cadws); Primary Folds (pf), Secondary Folds (Sf), Small Folds (sf), Chamber (ch), Water Ruminal Celluri (wrc).

Figure 5: Internal View of the Camel Stomach Formalization Showing Caudoventral Water Sac (Crvws) with them Primary, Secondary and Small Folds and Water Ruminal Celluri.

In this study the stomach of the camel was consisted from three compartment were rumen, reticulum, omasum and abomasum. This information was agreement some authors which reported three compartments in the dromedary stomach; compartment 1, compartment 2 and compartment 3 [5, 7, 13]. Other rresearchers were considered the camel as pseudo-ruminant because it has only three compartments [5-8, 14]. On the contrary the dromedary stomach was composed of four compartments as rumen, reticulum, omasum and abomasum [1-4, 12]. Osman recorded that the stomach of the dromedary camel was formed of four compartments; compartment 1, compartment 2, compartment 3 and compartment 4 depending on the external and internal features. In the present study, the camel rumen was divided into two part cranial and caudal parts. Our findings were similar to descriptions of Engelhardt et al. who had observed a strong ventral and transverse muscular ridge which divided compartment 1 into cranial and caudal portions in camelids had observed a strong ventral and transverse muscular ridge which divided compartment 1 [10].

The results revealed that the camel rumen had special digestive functions as water cell areas or glandular sac areas were

previously considered as water stores or water cells that function as water tanks [9].

In this study the number of the water sacs in the camel rumen were three in number; cranioventral sac, caudodorsal and caudoventral sacs. Our results agreed with Hegazi and Hansen studies which stated that the camel rumen showed three groups of water sacs [2, 3], On the other hand; Tharwat, et al. reported that the cranial glandular sac, the large caudodorsal, and the small ventral part of the caudal glandular sac [15]. On the other hand; Grossman stated that there were two groups of pouches, which has been considered as water storing units [16]. While the Abuagla et al. mentioned that there were two water sacs, the caudodorsal glandular and the cranioventral glandular sacs [12]. The results revealed that the position of the water cell areas occupies the right and left side of the rumen. The cranioventral sac was located in the ventral part of the cranial ruminal sac, extending at the level the 5th rib cranially and 7th rib caudally, while the caudoventral was studied the 8th intercostal space cranially and 10th rib caudally. Moerevor, the caudodorsal extended from the 10th rib to the 12th rib externally. Hegazi and Hansen stated that the largest one was situated in front and to the right aspect of the rumen, while the second and the smallest one is located in the left side of the apex of the rumen [2, 3]. Grossman stated that the two groups of pouches which had located on the anterior portion of the floor of the rumen [16]. Purohit and Rathor mentioned that one of these sacs was situated at the cranioventral aspect of the rumen, being more to the right side, and the other sac was located in the medioventral [11].

Tharwat et al. mentioned the cranial glandular sacs were seen deep in the right and left 5th intercostal spaces, the large caudal glandular sacs were imaged in the 9th intercostal space just ventral to the abomasum [15]. The ventral parts of the caudal glandular sacs could be lying against the paramedian region 10 cm to the right of the umbilicus.

Abuagla et al. recorded that the position of the cranioventral sac was situated between the 7th rib cranially and 9th rib caudally, that disagreement with our results which mentioned extended at the level the 5th rib cranially and 7th rib caudally [12]. The authors added that the caudodorsal glandular sac was at the level of the bodies of 8th - 12th thoracic vertebrae. The present study investigated that the cranioventral sac in the camel rumen was rectangular nearly in shape, it contained numerous of pillars. They divided the glandular portion into a many of longitudinal cells. Each a longitudinal cells were divided into smaller than longitudinal cells were rectangular chambers, each chamber was sub-divided by partially irregular small folds into smaller glandular pits know water ruminal celluri. The water ruminal celluri represented a very small cavities containing water. On the other hand, our results compatible with Smuts and Bezuidenhout study, there were longitudinal pillars were interconnected by muscular folds enclosing square spaces, the latter were subdivided by folds to form smaller squares or cell, that unite was referred to as glandular sac as a water sac [4]. Moreover, this results were Agree somewhat with Abuagla et al. reported that the cranioventral sac was small and oval in shape it was consisted of large glandular pits each pit was bounded by pillars [12]. The floor is surrounded by the bases of the four walls.

On the other hand, the structure of both sacs the caudoventral and caudodorsal sacs of the water cells were similar to the cranioventral sac but relatively larger than the cranioventral sac in the area. This finding were disagree with Abuagla, et al. (2014) stated that the caudodorsal sac was relatively larger and more sacculated than the cranioventral sac [12]. About 10 small sacs; 7 horizontal and 3 ventral sacs.

The rumen of the adult dromedary were different from the ruminants in gross anatomy. It had very different characterization from other ruminants specially the water cells area. The water cells which were cconsidered as chambers in which water was stored in the camel's stomach. They consisted of the primary, secondary and partially pillars and folds. There were small cavities of different sizes between them called water cells. They were full of a clear and pure water away from mixing with the food.

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CONFLICTS OF INTEREST

Authors declare that they have no conflict of interest.

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