

Original Article

Seroprevalence of chlamydiosis in Abu Dhabi dromedary camel (*Camelus dromedarius*) and its association with hematobiochemical responses towards the infection

Hany A. M. Zaher^{1,2}, Ayman Abdel-Aziz Swelum^{1,3,#}, Sawsan A. M. Alsharifi², Ayman H. Alkablawy² and Alaa B. Ismael⁴

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AFFILIATIONS

¹Department of Theriogenology, Faculty of Veterinary Medicine, Zagazig University, Zagazig 44519, Egypt.

²Abu Dhabi Food Control Authority (ADFCA), United Arab Emirates.

³Department of Animal Production, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, Kingdom of Saudi Arabia.

⁴Department of Medical Biotechnology, Faculty of Applied Medical Sciences, Taif University, Turrabah, 21995, Kingdom of Saudi Arabia. &
Department of Animal Medicine, Faculty of Veterinary Medicine, Zagazig University, Zagazig 44519, Egypt.

CORRESPONDENCE:

#Ayman Abdel-Aziz Swelum,
Department of Animal Production, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, Kingdom of Saudi Arabia.
E-mail: aswelum@ksu.edu.sa

ABSTRACT

Objective: Chlamydiosis is of great global public health, veterinary and economic importance. This study aimed at determining the seroprevalence of chlamydiosis in Abu Dhabi camel (*Camelus dromedarius*) and its association with hematobiochemical responses towards the infection.

Materials and methods: Blood samples (n=245) were collected from both housed and nomadic herds of camels. Anti-chlamydia antibodies were detected by an indirect enzyme-linked immunosorbent assay (ELISA). Camels had history of reproductive failure as abortion and repeat breeding. Besides, clinical reproductive examination was done with the camels.

Results: Based on the results of ELISA, the overall seroprevalence of chlamydiosis was 19.59% (n=48/245). The hematological results revealed significant increase in the total hemoglobin concentration (15.65±0.28 gm/dL), hematocrit % (36.65±2.66%), mean corpuscular volume (37.35±0.83 U) and neutrophils % (72.05±0.89%) in the affected camels. The biochemical results revealed significant increase of the levels of alkaline phosphatase (61.50±3.56 IU/I), creatinine kinase (184.00±3.35 IU/I), and aspartate aminotransferase (64.50±3.42 IU/I). Nevertheless, significant reduction in glucose (42.25±1.97 mg/dL), chloride (107.03±0.53 mmol/L), and zinc (43.00±3.36 ug/dL) levels were observed in the affected camels.

Conclusion: Chlamydiosis is prevailing among the Abu Dhabi camel. Chlamydiosis has great effect on the hematobiochemical parameters and reproductive performance of dromedary camels. Affected camels are suffered from reproductive failure manifested by abortion and/or repeat breeder.

KEYWORDS

Biochemistry; *Camelus dromedarius*; Chlamydia; Hemogram; Seroprevalence

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INTRODUCTION

Camel (*Camelus dromedarius*) plays a vital role in the social and economic life of nomads' tribes in the harsh dry environmental areas of the world. Although infectious diseases cause more than 50% of fatalities in camels, the adequate description and prevention of these diseases, as well as general health surveillance, remains relatively limited (Wernery and Kaaden, 2002). Recently, a good description for some important infectious diseases in *C. dromedarius* was reported (Ismael et al., 2014, 2016a; Swelum et al., 2014; Abdel-Hafez et al., 2015).

Chlamydiosis is one of the greatest important causes of infectious abortion as well as fetal death in mammals including humans. Its etiological agent, *Chlamydia abortus* (*C. abortus*), is a Gram-negative intracellular organism (Radosits et al., 2007). In ruminants, *C. abortus* infection manifested clinically by abortions at late pregnancy that reached 20-50% in sheep (Aitken, 2008), stillbirths infertility, polyarthritis, pneumonia, enteritis, mastitis, encephalitis and conjunctivitis (Aljumaah and Hussein, 2012). Moreover, placentitis, necrotic changes in the cotyledons and drop in milk production may also observe (OIE, 2012). Chlamydiae can infect the male reproductive organs of ruminants, and may transmit the disease to females by coitus at the the breeding time (Teankum et al., 2007). In human, the organism may cause death of fetus, abortion and some other complications in pregnant woman (Jorgensen, 1997). While in men, it may cause inflammation of the prostate gland and epididymis (Wagenlehner et al., 2006). In dromedary camel, very few reports gave short description for natural chlamydiosis in camels and focused mainly on seroprevalence of *C. abortus*. From these reports, the study of Elzlitne and Elhafi (2016) who reported that the seroprevalence of chlamydiosis in dromedary camel was 12.25% while Wernery and Wernery (1990) stated that the seroprevalence of chlamydiosis is about 24% in the racing camels. *C. abortus* is the main agent causing ovarian hydrobursitis disease in *C. dromedarius* (Ali et al., 2012).

Serological diagnosis represents the most widely used approach to define the *C. abortus* infection using an indirect enzyme-linked immunosorbent assay (ELISA) (Elzlitne and Elhafi, 2016). Hematobiochemical parameters have been widely used in attempts to provide information about disease states, performance problems and fitness in animals. A deviation of certain blood parameters from their normal limits might serve a guide for diagnosis or for the differential diagnosis of a disease condition (Ismael et al., 2014, 2016a). The aim of this investigation was (i) to describe the natural infection of chlamydiosis in dromedary camels, (ii) to determine its

seroprevalence in Abu Dhabi dromedary camel, and (iii) to study its effect on hematological and biochemical parameters.

MATERIALS AND METHODS

Animals and ethical statement: The present study was conducted on 245 female dromedary camels, aged 5-8 years, had history of reproductive failure including repeat breeder and abortion. These animals were housed in open yards in Abu Dhabi, United Arab Emirates (UAE) under the same managemental and nutritional condition. All these animals were proven to be free from brucellosis. The experimental protocol regarding the care and handling of animals had been approved by the Ethics Committee of the Abu Dhabi Food Control Authority, Abu Dhabi, UAE.

Clinical examination: Camels were clinically examined for temperature, pulse, respiration, mucous membrane color and others.

Ultrasonography: The ultrasound was used to make full reproductive examination for camels using multi-frequency linear trans-rectal probe (Prosound 2, Model UST-660-7.5, Aloka, Japan).

Samples: Blood samples were collected from all animals via Jugular vein into plain and EDTA vacutainer tubes (Becton-Dickinson Co[®], USA). Blood samples collected in EDTA tubes were used to estimate various hematological parameters. Serum was separated by centrifugation at 3000 rpm for 15 min, transferred into 1.5 mL Eppendorf tubes and stored at -20°C until assay for seroprevalence and estimation of Biochemical parameters.

Determination of chlamydiosis seroprevalence by enzyme-linked immunosorbent assay (ELISA): Levels of *C. abortus* antibodies in serum samples were determined by ELISA using an ELISA kit (VLD-DPM-MBM-30 by IDEXX ELISA, ADFCA accredited by UKAS, UK), following the procedure described by the manufacturer. The antigen-specific antibody titer is given as the reciprocal of the highest dilution producing an absorbance (OD) that was >40% than that of the serum of control at the same dilution (Samkange et al., 2010). Results are expressed as the means of titers \pm standard deviations (SD).

Hematological analysis: A complete blood count was conducted using an Automatic Blood Cell Counter (Hem. Analyzer/VLD-DPM-CBC-06 using Sysmex XT 2000i, ADFCA accredited by UKAS, UK) as previously described (Feldman et al., 2000).

Biochemical analysis: The biochemical analysis including liver, kidney and muscle function in addition to elements was performed in accordance with the Chem. Analyzer/VLD-DPM-CBC-02 Using Beckman Coulter analyzers, ADFCA accredited by UKAS, UK.

Statistical analysis: Statistical Products and Service Solutions (SPSS) program version 18.0 computer software (SPSS, Chicago, IL, USA) was used for all data analysis. A difference was considered to be significant at $P<0.05$.

RESULTS

Clinical findings and ultrasonography: The general health condition of the infected camels was not affected. The clinical reproductive examination of camels revealed the presence of endometritis (Figure 1) and/or hydrobursitis (Figure 2). Overall, 19.59% (n=48/245) camels were clinically affected by chlamydiosis. The main owner complains were repeat breeder and/or abortions (Figure 3). The results suggested that the camel abortion and repeat breeder might be associated with Chlamydia infection.

Results of ELISA in naturally infected animals by chlamydiosis: Analysis of serum antibody responses by qualitative or quantitative ELISA in naturally infected camels eliciting serum IgG responses ($\geq 1:80$) suggested that Chlamydia was incriminated.

Hematological findings: The hematological results revealed significant ($P\leq 0.05$) increases in the total hemoglobin concentration (15.65 ± 0.28 gm/dL), hematocrit % ($36.65\pm 2.66\%$), mean corpuscular volume (37.35 ± 0.83 U) and neutrophils % ($72.05\pm 0.89\%$) in the affected camels (Table 1).

Biochemical consequences: The biochemical results exposed significant ($P\leq 0.05$) increase in alkaline phosphatase (61.50 ± 3.56 IU/I), creatinine kinase (184.00 ± 3.35 IU/I), and aspartate aminotransferase (64.50 ± 3.42 IU/I) levels. Nevertheless, significant reduction in glucose (42.25 ± 1.97 mg/dL), cholorida (107.03 ± 0.53 mmol/L), and zinc (43.00 ± 3.36 ug/dL) levels were observed in the affected camels. (Table 2).

DISCUSSION

The current work presents, to our knowledge, the first description of serological, hematological and biochemical picture of natural chlamydiosis of *C. dromedarius* in the UAE. In this study, 19.59% (n=48/245) camels were cli-

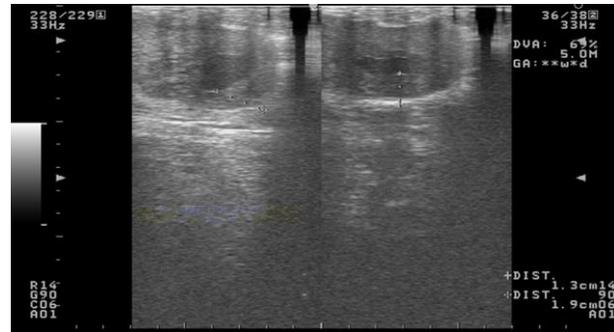


Figure 1. Endometritis observed in camel suffered from chlamydiosis



Figure 2. Hydrobursitis extracted from camel suffered from chlamydiosis



Figure 3. Abortion case recorded in camel suffered from chlamydiosis

Table 1. Hematological parameters (Mean \pm SE) of clinically healthy and chlamydia-infected camels

Parameters	Positive (n=48)	Negative (n=197)
HCT %	36.65 \pm 0.82*	32.18 \pm 2.66
HGB g/dL	15.65 \pm 0.28*	13.73 \pm 1.19
RBCs 10 ⁶ /uL	9.83 \pm 0.25	8.96 \pm 0.74
MCV fl	37.35 \pm 0.83U*	35.98 \pm 0.90
MCH pg	15.95 \pm 0.22	15.30 \pm 0.28
MCHC g/dL	42.73 \pm 0.35	42.58 \pm 0.45
WBCs 10 ³ /uL	12.75 \pm 0.23	14.80 \pm 1.87
NEUT%	72.05 \pm 0.89*	67.68 \pm 3.16
LYMPH%	21.1 \pm 0.79	20.90 \pm 2.09
MONO%	2.65 \pm 0.30	3.25 \pm 0.88
EOSINO%	3.5 \pm 0.36	7.03 \pm 2.20
BASO%	0.7 \pm 0.13	1.15 \pm 0.13

HCT: haematocrit, HGB: haemoglobin concentration, RBCs: Red blood cells, MCV: mean corpuscular volume, MCH: mean corpuscular haemoglobin, MCHC: mean corpuscular haemoglobin concentration, WBCs: White blood cells, NEUT: neutrophils, LYMPH: lymphocytes, MONO: monocytes, EOSINO: eosinophils, BASO: basophils. *=significant ($P<0.05$).

Table 2. Biochemical parameters (Mean SE) of clinically healthy and chlamydia-infected camels

Parameters	Positive (n=48)	Negative (n=197)
Glucose mg/dL	42.25±1.97*	56.23±9.66
BUN mg/dL	13.80±2.04	17.10±1.91
Creatinine mg/dL	1.37±0.06	1.53±0.09
Total Protein g/dL	6.91±0.04	6.57±0.10
Albumin g/dL	4.02±0.07	3.77±0.21
Alkaline Phosphatase IU/L	61.50±3.56*	53.50±4.80
CK IU/L	184.00±3.35*	148.50±1.89
ALT IU/L	7.70±1.26	10.33±1.06
AST IU/L	64.50±3.42*	59.18±13.99
LDH IU/L	569.00±7.05	604.33±33.35
Calcium mg/dL	10.19±0.14	10.05±0.31
Phosphorus mg/dL	5.83±0.32	5.75±0.62
Sodium (Na) mmol /L	150.25±0.97	150.50±0.43
Potassium (K) mmol/l	6.49±0.27	6.36±0.30
Choloride (Cl) mmol/L	107.03±0.53*	101.53±0.87
Zinc ug/dL	43.00±3.36*	41.25±6.17
Iron ug/dL	122.00±11.04	100.00±5.40
Cu ug/dL	83.00±1.32	83.50±3.29

BUN: blood urea nitrogen, CK: Creatinine Kinase, ALT: alanine aminotransferase, AST: aspartate aminotransferase, LDH: lactate dehydrogenase, Cu: Copper, *=significant ($P<0.05$).

nically infected with *C. abortus* and showed the clinical signs of chlamydiosis. Most of the relevant previous studies described the clinical findings of chlamydiosis in cattle, sheep and other species ([Aitken, 2008](#); [Aljumaah and Hussein, 2012](#); [OIE, 2012](#)); however, very few studies had described the clinical pictures of chlamydiosis in camels ([Ali et al., 2012](#)). Moreover, *C. abortus* was accompanied with many reproductive problems in animals worldwide other than camels. Furthermore, chlamydial infection has been accompanied with abortion in New World camelids, for example llamas and alpacas ([Wernery and Wernery, 1990](#)).

C. abortus has a significant zoonotic important, mostly as a work-related risk and to pregnant women who are exposed to aborting animals. Human infections with *C. abortus* have different clinical signs ranging from a flu-like disease to pneumonitis, as well as gestational sepsis, stillbirth and abortion in pregnant women ([Pospischil et al., 2002](#); [Walder et al., 2005](#)).

[Elzlitne and Elhafi \(2016\)](#) reported an overall 12.25% prevalence of antibodies against chlamydiosis in the Libyan dromedary camel, which was lower than that of this study. Definitive diagnosis has been reported by identification of *C. abortus* using ELISA in sheep ([Donn et al., 1997](#)). Additionally, ELISA is reasonably of lower cost and easy to perform. Chlamydial infection can be diagnosed using the blood samples ([Baud et al., 2010](#)). Anti-chlamydial antibodies were detected in 11% of the serum of camels in Egypt ([Hussein et al., 2008](#)), while a

serological prevalence in Tunisia was 7.6% ([Burgemeister et al., 1975](#)). [Wernery and Wernery \(1990\)](#) detected antibodies in the serum of racing and breeding camels in the UAE, with respective prevalence rates of 15 and 24%, respectively. A serological prevalence of for chlamydiosis in Saudi Arabia was 19.4% with a lower prevalence in male than female ([Hussein et al., 2008](#)).

The hematological results revealed significant increases in the total HGB concentration, HCT%, MCV and neutrophils % in the affected camels. These alterations could be attributed to stimulation of stem cells in the bone marrow by Chlamydial infection ([Ismael et al., 2016b](#)).

The biochemical results exposed significant increases in Alkaline Phosphatase, CK and AST were detected. Nevertheless, significant reduction in Glucose, Choloride, and Zinc levels were observed in the affected camels. The increased level of CK nitrogen in this work may indicate indirect damage of renal tissue by Chlamydial infection ([Ismael et al., 2016c](#)). Moreover, the increased level of AST and Alkaline Phosphatase may indicate indirect damage of hepatic tissues by Chlamydial infection ([Ismael et al., 2014](#)).

CONCLUSION

The seroprevalence of chlamydiosis in Abu Dhabi camel is 19.59%. Chlamydiosis has great effect on the hemato-biochemical parameters and reproductive performance of dromedary camels. The affected camels are suffered from reproductive failure manifested by abortion or repeat breeding. Further studies can be carried out to increase the knowledge associated between susceptibility of chlamydiosis and the regulatory cytokines. An improved and efficient control strategy of camel chlamyphilosis are suggestive.

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CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

AUTHORS' CONTRIBUTION

HAMZ and AAS contributed equally, where both the authors coordinated the study design, and carried out the

field and laboratory works. ABI made statistical analysis of the information and wrote the manuscript. SAMA and AAH conceived the study and acquired the funding. All authors were involved in revising the manuscript.

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