Journal of Advanced Veterinary and Animal Research
ISSN 2311-7710 (Electronic)
http://doi.org/10.5455/javar.2017.d185
A periodical of the Network for the Veterinarians of Bangladesh (BDvetNET)

March 2017
Vol 4 No 1, Pages 22-31.

Original Article

Aerobic bacteria isolated from internal lesions of camels at Tambool slaughterhouse

Ibtihal Ibrahim Hamza, Yassir Adam Shuaib, Siham Elias Suliman and Mohamed Abdelsalam Abdalla

• **Received:** Nov 23, 2016 • **Revised:** Jan 5, 2017 • **Accepted:** Jan 26, 2017 • **Published Online:** Jan 30, 2017

AFFILIATIONS

- Ibtihal Ibrahim Hamza

Ministry of Agriculture and Animal Resources, North Kordofan State, P.O. Box: 429, El-Obied, the Sudan.

- Yassir Adam Shuaib
- Siham Elias Suliman

College of Veterinary Medicine, Sudan University of Science and Technology, P.O. Box: 204 (Hilat Kuku), Khartoum North, the Sudan.

- Mohamed Abdelsalam Abdalla

College of Graduate Studies, Sudan University of Science and Technology, P.O. Box: 407, Mugran Campus, Khartoum, the Sudan.

CORRESPONDENCE

Mohamed Abdelsalam Abdalla
College of Graduate Studies, Sudan University of Science and Technology, P.O. Box: 407, Mugran Campus, Khartoum, the Sudan.
E-mail: salamaa2000@sustech.edu
Cell: +249 9 129 43 128

ABSTRACT

Objective: This cross-sectional study was conducted from January to June 2013 to estimate the prevalence of internal lesions in slaughtered camels at Tambool slaughterhouse and to identify the aerobic bacteria colonizing these lesions.

Material and methods: A total of 280 carcasses of camels were thoroughly inspected during post-mortem examination and samples were collected from internal lesions and cultured onto different culture media. Isolated bacteria had undergone testing of several biochemical activities for species identification and susceptibility to certain antibiotics.

Results: Internal lesions were detected in 25.0% (95% CI of ±5.07) of the carcasses and were observed in the lungs, liver and heart. Statistical association analyses showed that origin, sex, breed, and body condition were related to detection of lesions. A number of 179 isolates of aerobic bacteria belonging to 9 genera were grown and included *Staphylococcus* species (32.0%), *Escherichia coli* (26.0%), *Streptococcus* species (18.0%), *Corynebacterium* species (5.0%), and *Bacillus* species, *Salmonella* species, *Pseudomonus* species, and *Klebsiella* species; each of them 4.0%, and *Shigella* species (2%). Drug susceptibility testing showed that chloramphenicol was the most effective antibiotic against *Staphylococcus* species, *Corynebacterium* species, and *Bacillus* species, while penicillin g 10 was more effective against *Streptococcus* species. Ciprofloxacin 5 µg and ampicllin/sulpactum 20 µg were effective against *E. coli, Salmonella* species, *Klebsiella* species, *Shigella* species, and *Pseudomonas* species.

Conclusion: It can be concluded that internal lesions are prevalent in camels slaughtered at Tambool slaughterhouse and many species of bacteria were colonizing these lesions, hence, evaluating the economic magnitude of internal lesions resulting in partial and/or total condemnation of organs is warranted.

KEYWORDS

Bacteria; Camel; Internal lesions; Slaughterhouse; Sudan

How to cite: Hamza II, Shuaib YA, Suliman SE, Abdalla MA (2017). Aerobic bacteria isolated from internal lesions of camels at Tambool slaughterhouse. Journal of Advanced Veterinary and Animal Research, 4(1): 22-31.

INTRODUCTION

Africa hosts the biggest camel population in comparison to other continents, with the Sudan ranking second to Somalia in terms of camel population density (Keskes et al., 2013). The country has nearly 4.5 million camel heads that are mainly found in the so-called camel belt in the arid and semi-arid zones and are primarily raised for riding, baggage carrying, pulling, and for hides, meat and milk and for social purposes (Tigani et al., 2007; Faye et al., 2011).

Like other animals, camels can be infected by many infectious diseases caused by different species of bacteria, viruses, parasites and fungi (ugrane and Higgins, 1985; Alhendi, 2000). These disease can be categorized by the infected body system or organ, e.g. digestive system diseases, cutaneous infections, respiratory diseases, and mastitis, in addition to metabolic disorders (Alhendi, 2000). Also, these diseases have a seasonal trend and associated with place (Agab and Abass, 1998). In 2004, peste des petits ruminants (PPR), a viral disease known to cause gastro-intestinal and respiratory symptoms associated with morbidities and mortalities in small ruminants, emerged in camels in the Sudan as has been reported by Khalafalla et al (2010). During the outbreak, PPR caused diarrhea, colic, respiratory distress, abortions, and sudden death of apparently healthy animals. PPR has also been recently reported in camels in Iran (Zakian et al., 2016). Another example for emerging disease in camels is the Middle East respiratory syndrome coronavirus (MERS-CoV) which was first reported in 2012 (Sharif-Yakan and Kanj, 2014).

A lesion is a damage through an injury or a disease, such as a wound, ulcer, or abscess. When it occurs in an internal organ or tissue, it's called internal lesion. *Staphylococci*, *Pasterullae*, *Escherichia coli* and *Corynebacterium* species were isolated and identified from camels' internal lesions and abscesses (Younan et al., 2005; Zubair et al., 2004; Aljameel et al., 2014). Internal lesions are economically important due to the subsequent partial or total condemnation of affected organs (Younan et al., 2005). This study was carried out to determine the prevalence of internal lesions in slaughtered camels at Tambool slaughterhouse, isolate and identify bacteria from these lesions, and to determine the antimicrobial susceptibility profile of the bacteria isolated from the lesions.

MATERIALS AND METHODS

Study area: This study was carried out in Al-Butana plains in the central region of the Sudan at Tambool slaughterhouse, Al-Gazeera State. Tampool slaughter-house is around 130 km away to the Southeast of the Sudan's capital town Khartoum.

Study design: A cross-sectional study was conducted for a period of six months, from January to June 2013 at Tambool slaughterhouse. This slaughterhouse was purposively selected because this area is known to be heavily populated with camels and the habit of eating camel meat is popular, too.

Sample size calculation and sampling strategy: The sampling size (n) was determined as per the standard formula of Thrusfield (2007), and n was calculated to be 280 animals. Moreover, animals included in the study were selected by systematic random sampling.

Post-mortem inspection: Post-mortem inspection was performed visually, by palpation and *in situ* slicing of certain lymph nodes (LN) in the head, thorax, and abdomen, and organs like lungs, liver, the heart and others following the procedure described by Asseged et al. (2004).

Specimen collection: Specimens were taken aseptically and preserved in sterile bags in ice and transported to the Microbiology Laboratory of the College of Veterinary Medicine, Sudan University of Science and Technology, where isolation and identification of bacteria were performed.

Laboratory procedures: Different types of culture media were used in this study together with biochemical tests reagents for primary isolation and identification of bacteria according to Barrow and Feltham (2003).

Preparation of bacteriological media: According to the instructions of the manufacturers, 40 gm, 59 gm, and 25 gm powder bases of blood agar, MacConkey agar, and nutrient agar were, respectively, weighted, dissolved, and autoclaved at 121°C/15 pound per square inch for 15 minutes. The dissolved powder bases were poured into Petri dishes, dispensed properly, and conserved at 4°C in a refrigerator until used. Mannitol agar, egg yolk agar, deoxycholate citrate agar (DCA), eosin methylene blue agar (EMB), and Simmons citrate agar were prepared according to the instructions of the manufacturers as well.

Bacteriological protocol: Blood agar, MacConkey agar and nutrient agar were streaked on by swabs from the specimens and incubated at 37°C for 24 h. Gram stained smears were made from grown colonies, besides to observing hemolysis patterns, colony size, color, surface and shape. Sub-cultures were made onto special media for purification of the isolates.

Identification of the isolated bacteria : Gram staining was carried out according to Barrow and Feltham (2003). The prepared slides were examined microscopically under oil emersion objective lens. Biochemical tests, as shown in **Table 1** and **2**, for identification of the species of the detected isolates were carried out as described by Barrow and Feltham (2003), and included oxidase, catalase and motility tests as well as Indole, Vogas Prokauer, nitrate reduction and urease tests. In addition to Lactose, Sucrose, Trehalose, Xylose, Raffinose, Maltose, Mannitol, Sorbitol, Simmons's citrate and O/F reactions and H_2S production tests.

Antimicrobial susceptibility testing: The drug susceptibility profile of the isolated and identified bacteria was tested on nutrient agar. A bacterial suspension was cultured by streaking all over the agar, then sensitivity discs were placed on top of the cultured agar. Penicillin 10, Amoxicillin 10, and Chloramphenicol efficacy was tested against Gram positive bacteria while Tetracycline 30 µg, Ciprofloxacin 5 µg, Ampicillin/Sulbactam 20 µg efficacy was tested against Gram negative bacteria. After incubation in a humidity chamber for 24 h at 37°C, the clear zone surrounding the antimicrobial disc was recorded in millimeter (mm).

Statistical analyses: Appropriate statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS) version 18.0 (SPSS Inc, USA).

RESULTS

Internal lesions were detected in camels slaughtered at Tambool slaughterhouse with variations between different age groups, breeds, sexes, and origin of animal as presented in **Table 3**. The overall prevalence was 25.0% (n=70/280) with 95% CI of ±5.07. The prevalence of internal lesions in camels from Darfur, Rezaigy camels, she-camels, and camels with poor body condition was significantly higher than camels from other locations, breeds, male camels, and camels with good and moderate body condition.

The *Chi*-square test showed that origin (x^2=49.6, df=3, *P-value*=0.001), sex (x^2=29.9, df=1, *P-value*=0.001), breed (x^2=35.1, df=3, *P-value*=0.001), and body condition (x^2=26.5, df=2, *P-value*=0.001) were significantly associated with the detection of internal lesions, nonetheless, age (x^2=2.56, df=1, *P*-value=0.110) was not (**Table 3**).

The logistic regression analysis revealed that geographical origin (Darfour) sex (she-camels), breed (Rezaigy), and body condition (poor) were associated with odds of observing internal lesions in camels' carcasses (**Table 4**). Lesions were detected in different internal organs including lungs, liver and heart (**Table 4**). Lungs inflammation (pneumonia) (51.4%) was the most observed pathology followed by hepatic lesions (45.7%) and the least (2.90%) was inflammation of the heart muscle (myocarditis). However, no other internal organs showed any kind of pathologies during the period of the study.

A total number of 179 aerobic bacteria belonging to 9 genera were isolated and identified (**Table 5**). Most of the isolates (n=107; 59.8%) were Gram positive bacteria (cocci and bacilli), whereas the rest (n=72; 40.2%) were Gram negative rods. As **Table 6** and **7** depicted, *Staphylococcus* species were the most frequent bacteria, followed consecutively by *E. coli*, *Streptococcus* spp, *Corynebacterium* spp., *Bacillus* spp., *Salmonella* spp., *Pseudomonus* spp., *Klebsiella* spp., and *Shigella* spp.

As displayed in **Table 8** and **9**, chloramphenicol was the most effective antibiotic against *Staphylococcus* spp., *Corynebacterium* spp., and *Bacillus* spp., each with an inhibition zone of 10 mm, while Penicillin g 10 showed more efficacy against *Streptococcus* spp. with an inhibition zone of 10 mm. Ciprofloxacin 5 µg and Ampicllin/Sulpactum 20 µg were effective against *E. coli*, *Salmonella* spp., *Klebsiella* spp., *Shigella* spp., and *Pseudomonas* spp. with inhibition zones of 8 and 10 mm.

DISCUSSION

The camel is a hardy animal when compared to other domestic animals and is less susceptible to many of the diseases that affect other livestock species in the same ecosystem or geographical area (Awol et al., 2011). Many apparently healthy slaughtered camels were found to have one or more internal lesion in one or more organ (Bekele, 2008; Awol et al., 2011). In this study, a quarter of the examined carcasses of camels had internal lesions in the lungs, livers, and hearts and this was lower than the reports of Awol et al. (2011) and Bekele (2008) who found

Table 1: Characters and biochemical reactions of the isolated Gram positive bacteria from internal lesions of lungs, livers, and hearts of camels in Tambool slaughterhouse (January to June 2013)

BCT	1	2	3	4	5	6	7	8	9	10	11	12
Gram stain	+	+	+	+	+	+	+	+	+	+	+	+
Acid fast	-	-	-	-	-	-	-	-	-	-	-	-
Shape	coccus	coccus	coccus	coccus	coccus	coccus	coccus	bacillus	bacillus	bacillus	bacillus	bacillus
Motility	-	-	-	-	-	-	-	-	-	-	-	+
Catalase	+	+	+	+	-	-	-	+	+	+	nd	nd
F/O	F	F	F	F	F	F	F	F	F	F	nd	nd
Oxidase	-	-	-	+	nd	nd	nd	-	-	-	different	-
Coagulase	+	+	-	-	nd	nd	nd	-	-	-	nd	nd
Sucrose	+	+	+	+	+	+	+	-	-	-	nd	nd
Glucose	nd	nd	nd	nd	nd	nd	nd	+	+	+	+	+
V.P	+	-	+	-	-	+	-	-	-	-	+	d
Lactose	+	+	different	-	+	inferred	+	-	-	-	nd	nd
Maltose	+	+	+	+	nd	nd	nd	+	different	+	nd	nd
Mannitol	+	+	-	+	different	-	-	-	-	-	nd	nd
Fructose	+	+	+	+	nd	nd	nd	nd	nd	nd	nd	nd
Trehalose	+	+	-	+	+	+	+	-	different	-	nd	nd
Xylos	-	-	-	-	nd	nd	nd	-	-	+	-	+
Nitrat reduction	+	+	+	+	nd	nd	nd	+	-	-	-	+
Mannose	+	+	+	inferred	nd	nd	nd	nd	nd	nd	-	+
Raffinose	nd	nd	nd	nd	-	-	inferred	nd	nd	nd	-	+
Arabinose	nd	nd	nd	nd	-	-	-	nd	nd	nd	nd	nd
Sorbitol	nd	nd	nd	nd	-	-	-	nd	nd	nd	nd	nd
Ribose	nd	nd	nd	nd	-	+	-	nd	nd	nd	nd	nd
Haemolysis	nd	nd	nd	nd	ß	ß/−	α	different	-	-	nd	nd
Metachromatic granules	nd	nd	nd	nd	nd	nd	nd	different	+	+	nd	nd
Urease	nd	nd	nd	nd	nd	nd	nd	-	+	+	different	-

BCT=biochemical test, 1=*Staphylococcus aureus*, 2=*Staph. intermedius*, 3=*Staph. epidermidis*, 4=*Staph. citreus*, 5=*Strept. pyogenes*, 6=*Strept. agalactiae*, 7=*Strept. pneumoniae*, 8=*Corynebacterium pseudotuberculosis*, 9=*Coryn. renale* type 1, 10=*Coryn. diphtheria*, 11=*Bacillus mycoides*, 12=*B. subtilis*, and nd=not done.

Table 2: Characters and biochemical reactions of the isolated Gram negative bacteria from internal lesions of lungs, livers, and hearts of camels in Tambool slaughterhouse (January to June 2013)

BCT	1	2	3	4	5	6
Gram stain	-	-	-	-	-	-
Acid fast	-	-	-	-	-	-
Shape	bacillus	bacillus	bacillus	bacillus	bacillus	bacillus
Motility	+	+	-	-	-	+
Oxidase	-	nd	nd	nd	nd	+
Macconkey growth	+	+	+	+	+	+
Nitrate reduction	nd	nd	nd	nd	nd	+
Simmon's citrate	-	+	+	+	-	different
Urease	-	-	-	+	-	nd
H_2S	-	-	different	-	-	+
Gase from glucose	nd	+	different	+	-	-
Maltose	+	+	-	+	different	+
Mannitol	+	+	+	+	different	-
Lactose	+	-	-	+	-	-
Raffinose	different	-	-	+	different	-
Sorbitol	nd	+	-	+	different	-
Sucrose	+	-	-	+	-	-
Trehalose	+	+	+	+	+	+
Xylos	+	-	different	+	-	+
V.P	nd	-	-	-	-	nd
Indol	+	-	-	-	different	nd

BCT= biochemical test, 1= *Escherichia coli*, 2= *Salmonella paratyphi* A, 3= *Salmonella pullorum*, 4= *Klebsiella pneumoniae*, 5= *Shigella sonnei*, 6= *Pseudomonas aeruginosa*, and nd= not done.

Table 3: Observed prevalences of internal lesions of camels by origin, sex, age breed, and body condition and univariate associations of risk factors with internal lesions in camels in in Tambool slaughterhouse (January to June 2013)

Factor	No. inspected	No. with lesions	%	95% CI	x^2	df	*P-value*
Origin					49.6	3	0.001
Algazira	123	24	19.5	12.5-26.5[a]			
Kordofan	38	10	26.3	12.3-40.3[a]			
Darfour	37	26	70.3	55.6-85.0[b]			
Kassala	82	10	12.2	5.12-19.3[a]			
Sex					29.9	1	0.001
male	95	5	5.30	0.79-9.81[a]			
female	185	65	35.1	28.2-42.0[b]			
Age					2.56	1	0.110
≤ 4	123	25	20.3	13.2-27.4[a]			
> 4	157	45	28.7	21.6-35.8[a]			
Breed					35.1	3	0.001
Anaafi	123	24	19.5	12.5-26.5[a]			
Rezaigy	37	26	70.3	55.6-85.0[b]			
Kabashi	38	10	26.3	12.3-40.3[a]			
Rashiadi	82	10	12.2	5.12-19.3[a]			
Body condition					26.5	2	0.001
good	69	9	13.0	5.06-20.9[a]			
moderate	159	34	21.4	15.0-27.8[a]			
poor	52	27	51.9	38.3-65.5[b]			
Total	**280**	**70**	**25.0**	19.9-30.1			

Table 4: Multivariate associations of risk factors with internal lesions in camels in in Tambool slaughterhouse (January to June 2013)

Risk factor	No. inspected	No. with lesions	Exp(B)	*P-value*	95% CI forExp(B)
					Lower - Upper
Origin					
Kassala	82	10	ref		
Algazira	123	24	1.74	0.171	0.786 - 3.876
Kordofan	38	10	2.57	0.057	0.966 - 6.846
Darfour	37	26	17.0	0.001	6.473 - 44.74
Sex					
male	95	5	ref		
female	185	65	9.75	0.001	3.773 - 25.20
Breed					
Rashiadi	82	10	ref		
Anaafi	123	24	1.74	0.171	0.786 - 3.876
Rezaigy	37	26	17.0	0.001	6.473 - 44.74
Kabashi	38	10	2.57	0.057	0.966 - 6.846
Body condition					
good	69	9	ref		
moderate	159	34	1.81	0.143	0.818 - 4.022
poor	52	27	7.20	0.001	2.966 - 17. 48

Table 5: Number of camel carcasses with internal lesions in lungs, livers, hearts and other organs in Tambool slaughterhouse (January to June 2013)

Organ	No. of lesions	%
Lung	36	51.4
Liver	32	45.7
Heart	2	2.90
Other organs	0	0.00
Total	**70**	**100**

Table 6: Number of Gram positive bacteria isolated from internal lesions of lungs, livers, and hearts of camels in Tambool slaughterhouse (January to June 2013)

Gram positive bacteria	No.	%
Staphylococcus aureus	28	26.2
Staphylococcus intermedius	8	7.50
Staphylococcus epidermidis	18	16.8
Staphylococcus citreus	4	3.75
Streptococcus pyogenes	15	14.0
Streptococcus agalactiae	13	12.1
Streptococcus pneumoniae	5	4.67
Corynebacterium pseudotuberculosis	4	3.75
Corynebacterium renale type 1	4	3.75
Corynebacterium diphtheria	1	0.93
Bacillus mycoides	3	2.80
Bacillus subtilis	4	3.75
Total	**107**	**100**

that 77.5% and 98.0% of the camel carcasses had lesions in Ethiopia and the report of Abubakar et al. (2010) who saw lesions in 64.0% of the carcasses in Nigeria. These observed difference in occurrence of internal lesions could be due to variation in sample size (number of examined carcasses) or due to variation among geographical areas from where the camels originated or even due to previous diseases affected the animal in the past.

The prevalence of internal lesions in carcasses of camels from Darfur was significantly higher than in carcasses of camels from other geographical areas. The same was observed for Rezaigy camels when compared with camels from other breeds. This might be due to the stress of the long-distance travel. These animals had walked for a distance of 1000 km, at least, to arrive in Tambool before being slaughtered.

The difference between the prevalences reported from males and females were significantly different. This was in contrast to the findings of Tenaw et al. (2015) who found no significant difference in the prevalence of lungs lesions between sexes. The significant difference reported herein, might likely be due to the big number of female camels investigated in comparison to the number of male camels.

Significant difference in the prevalence of internal lesions in camels with different body conditions was observed in the present study. Camels with poor body condition were showing the highest prevalence, however, camels with good body condition were showing the lowest prevalence. Tenaw et al. (2015) made the same observation and reported that the lungs of camels having poor body condition score were found to be highly

affected with pneumonia when compared to camels with medium and good body condition score. The immune competence of the animal and resistance to disease are probably reduced as result of the poor body condition score and hence this situation increases the vulnerability of the animal to infections and formation of internal lesions.

Origin, sex, breed, and body condition were associated with the detection internal lesions in the univariate analysis using chi square. However, age was not significantly associated with internal lesions detection. Prevalence of lesions due to hydatid cyst in the lungs of slaughtered camels was related to body condition score ($P \geq 0.000$) while it was not influenced by sex. And, lesions due to hydatid cyst in the livers were not associated with body condition score and sex (Tenaw et al., 2015). Prevalence of emphysema and pneumonia in the lungs of slaughtered camels was not related to body condition score and sex (Tenaw et al., 2015). Cultural variations as well as social activities, animal production and improper disposal of dead animals could probably lead to noticed variation (Yifat et al., 2011; Tenaw et al., 2015).

The prevalence of lesions in the lungs herein was higher than the prevalences reported by Aljameel et al. (2013) in slaughtered camels in Nyala, the Sudan, and by Al-Tarazi, (2001) in Jordan which were 13.3% and 10.2%, correspondingly, while it was lower than the prevalence reported by Tenaw et al. (2015) in Ethiopia which was 59.7%. The respiratory tract is one of the main portals for entrance biological organisms (bacteria and viruses) and physical bodies, objects, and masses and probably chemicals into the body through inhalation. The inhaled organisms, bodies or masses and chemicals might reach the lungs causing damage and lesions formation. Moreover, adverse weather condition and accidental inhalation of liquid may cause pneumonia as well as stress factors including exposure to dust and starvation (Amene et al., 2012; Tenaw et al., 2015). The percentage of hepatic lesions in the present study coincided with the findings of Nuseba et al. (2014) who found a prevalence of 50.0%. However, other researchers like Ahmedullah et al. (2007), Cadmus and Adesokan (2009), Mellau et al, (2010), and Tenaw et al. (2015) found hepatic lesions in 3.8% to 29.0% of the livers of the slaughtered camels in Nigeria and Bangladesh. Hepatocytes destruction induced by worms like liver flukes and the metabolism of toxic materials that have been absorbed from the gut and their removal enhance formation of liver lesions and colonization of the lesions by opportunistic and pathogenic bacteria (Scanlan and Edwards, 1990).

Condemnation of hearts due to myocarditis was observed in low percentage in this study typifying the findings of Tenaw et al. (2015) who reported that 1.55%(n=6) of the hearts of slaughtered camels were found with lesions. However, no other internal organs showed any kind of pathologies during the period of the study.

A number of aerobic bacteria, Gram positive cocci and bacilli and Gram negative rods, belonging to 9 genera were detected in this study. Nuseba et al. (2014) was able to grow 81 isolates of different micro-organisms, of which 56 (76.0%) were Gram-positive bacteria, 20(24.0%) were Gram negative bacteria, and 5(7.0%) were fungi.

Table 7: Number of Gram negative bacteria isolated from internal lesions of lungs, livers, and hearts of camels in Tambool slaughterhouse (January to June 2013)

Bacteria	No.	%
Escherichia coli	46	64.9
Salmonella paratyphi A	4	5.56
Salmonella pullorum	3	4.17
Klebsiella pneumoniae	8	11.1
Shigella sonnei	3	4.17
Pseudomonas aeruginosa	8	11.1
Total	**72**	**100**

Table 8: Bacterial growth inhibition zones (mm) showing susceptibility and resistance of the Gram positive bacteria isolated from internal lesions of lungs, livers, hearts and other organs of camels in in Tambool slaughterhouse (January to June 2013)

Gram positive bacteria	Penicillin G 10	Amoxi-cillin 10	Chloramp-henicol
Staphylococcus spp.	5	7	10
Streptococcus spp.	10	8	8
Corynebacterium spp.	2	7	8
Bacillus spp.	0	2	10

Table 9: Bacterial growth inhibition zones (mm) showing susceptibility and resistance of the Gram negative bacteria isolated from internal lesions of lungs, livers, and hearts of camels in in Tambool slaughterhouse (January to June 2013)

Bacteria	Tetracy-cline 30 µg	Ciproflo-xacin 5 µg	Ampicllin/ Sulpactum 20 µg
Escherichia coli	7	8	8
Salmonella spp.	2	10	8
*Klebsiella*spp.	4	5	8
*Shigella*spp.	2	8	8
Pseudomonas spp.	0	3	8

Staphylococcus spp. were the most frequent bacteria, followed by *E. coli*, *Streptococcus* spp., *Corynebacterium* spp., *Bacillus* spp., *Salmonella* spp., *Pseudomonus* spp., *Klebsiella* spp. and *Shigella* spp.. Among the Gram positive bacteria isolated from the hepatic lesions by Nuseba et al. (2014), 31.3% (n=25) were *Staphylococcus* spp., 12.3% (n=10) *Streptococcus* spp., 12.3% (n=10) *Micrococcus* spp, 6.1% (n=5) *Corynebacterium* spp., 3.7% (n=3) *Bacillus cereus*, 1.2% (n=1) *Clostridium novyi*, 1.2% (n=1) *Listeria monocytogenes* and 1.2% (n=1) were *Lactobacillus plantarum*. Gram-negative isolates were 8.6% (n=7) *Pseudomonas aerogenosa*, 7.4% (n=6) *E. coli,* 4.9% (n=4) *Acinetobacter* and 3.7% (n=3) *Klebsiella pneumonia*. Moreover, 4.9% (n=4) yeast and 1 isolate of *Actinomyces viscosus* fungus (1.2%) were recovered. Aljameel et al. (2013) isolated the following bacteria from the lesions of the lungs: *Staphylococcus aureus*, *Streptococcus* spp., *C. pseudotuberculosis*, and *A. pyogenes* while Al-Tarazi (2001), Azmi (2008), Abubakar et al. (2010) and Kinne et al. (2011) detected *Staphylococcus* spp., *Streptococcus* spp. and *Corynebacterium* spp. The isolation of *C. pseudotuberculosis* serotype I in this study, coincided with the findings of Aljameel et al. (2013).

Other bacterial isolates in this study, such as *Pseud. aeruginosa*, *M. luteus*, *E. durans*, *B. cereus*, *Prot. vulgaris*, *Enter. aerogenes*, *Past. multocida* and *K. pneumoniae* subsp. *pneumoniae* were previously reported as having association with pneumonia in the dromedary camel (Bekele, 1999; Younan et al., 2005). Afzal et al. (1996) and Abraheem (2009) reported *Staphylococcus, Corynebacterum, E. coli, Stretococcus* spp. and *Pasterulla* spp., in camel lungs. Isolation of *Bacillus* spp, *Micrococucus* spp. and *E. coli* from abscesses go with the work of Eltigani (2004), Mohamed and Farah (1994). Abraheem (2009) isolated different organisms from abscesses from Tampool and Al-Gedarif slaughterhouses that constituted 45.0% and 40.1% of total organisms, whereas *Streptococcus* species constituted 2.5%, from Tampool and 3.7% from Al-Gedarif. These results indicate that *Staphylococcus* species was the predominant organism.

The growth inhibition efficiency of penicillin G 10, amoxicillin 10, and chloramphenicol was tested against Gram positive bacteria and of tetracycline 30 µg, ciprofloxacin 5 µg, and ampicllin/sulpactum 20 µg against Gram negative bacteria. Chloramphenicol was the most effective antibiotic in inhibiting the growth of Gram positive bacteria, amoxicillin 10 was fairly effective and penicillin G 10 did not inhibit the growth of *Bacillus* species. Ampicllin/sulpactum 20 µg was the most effective antibiotic inhibiting the growth of Gram negative bacteria, ciprofloxacin 5 µg was fairly effective and tetracycline 30 µg did not inhibit the growth of *Pseudomonas* species. This was similar from the findings of Tiwari et al. (2015) who found that chloramphenicol was among the highly sensitive drugs and conversely amoxycillin and ampicillin/sulbactum were resisted in most cases. Shuaib et al. (2016) found out that ciprofloxacin (5 µg), amikamicin (30 µg), cephalexin (30 µg), and impenen (10 µg) efficiently inhibited the growth of most isolated bacteria in their study while cefotaxime, ampicillin/sulbactam (30 µg), bactricin (10 µg), ceftizoxime (30 µg) and amoxacillin (30 µg) were the less effective or totally ineffective antibiotics in inhibiting bacterial growth. Cholaramphenicol (30 µg) and penicillin-G (10 unit) inhibited bacterial with varying degrees. Shuaib et al. (2016) mentioned that the dynamic of drug-resistant bacteria in animals in the Sudan is most likely related to the storing conditions of veterinary drugs, liberated uncontrolled trading, and arbitrary use of these drugs by animal owners.

CONCLUSION

It can be concluded that internal lesions are prevalent in camels slaughtered at Tambool slaughterhouse. Geographical origin, sex, breed, and body condition were significantly associated with the detection internal lesions. Many Gram positive bacteria and Gram negative bacteria were isolated from the samples collected from these lesions including *Staphylococcus* species, *E. coli*, *Streptococcus* species, *Corynebacterium* species, *Bacillus* species, *Salmonella* species, *Pseudomonus* species, *Klebsiella* species, and *Shigella* species. Chloramphenicol and penicillin G 10 were effective against most Gram positive bacteria and ciprofloxacin 5 µg and ampicllin/sulpactum 20 µg were effective against Gram negative bacteria. The economic magnitude of internal lesions resulting in partial and/or total condemnation of organs should be evaluated. Molecular epidemiology of the isolates needs to be investigated.

ACKNOWLEDGEMENT

The assistance provided by the technical staff of the Microbiology Laboratory of the College of Veterinary Medicine, Sudan University of Science and Technology, during carrying out this work is valued.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

AUTHORS' CONTRIBUTION

Field and lab works: IIH conducted the lab works. YAS conceptualized, drafted and edited the manuscript. SES and MAA supervised the work.

REFERENCES

1. Abraheem HH (2009). Studies on camel (*Camelus dromedarius*) abscesses in internal organs in Butana and Eastern Sudan. MVSc thesis, Sudan Academy of Science, Khartoum, the Sudan.
2. Abubakar MS, Fatihu MY, Ibrahim ND, Oladele SB, Abubakar MB (2010). Camel pneumonia in Nigeria: Epidemiology and bacterial flora in normal and diseased lung. African Journal of Microbiology Research, 4: 2479-2483.
3. Afzal M, Sakir M, Hussian MM (1996). *Corynebacterium pseudotuberculosis* infection and lymphadenitis (Taloa or Mala) in the camel. Tropical Animal Health and Production, 28: 158-162. https://doi.org/10.1007/BF03030838
4. Agab H, Abbas B (1998). Epidemiological studies on camel diseases in Eastern Sudan. World Animal Review, 92: 42-54
5. Ahmedullah FM, Akbor MG, Harder MA, Khan HN (2007). Pathological investigation of liver of slaughtered buffaloes in Barisal district Bangladesh. Bangladesh Journal of Veterinary Medicine, 5: 81-85. http://dx.doi.org/10.3329/bjvm.v5i1.1321
6. Alhendi AA (2000). Common diseases of camels (*Camelus dromedarius*) in eastern province of Saudi Arabia. Pakistan Veterinary Journal, 20(2): 97-99.
7. Aljameel MA, Halima MO, ElTigani-Asil EA, El-Eragi AM (2013). Bacteriological and histopathological studies on pulmonary abscesses in camels (*Camelus dromedarius)* slaughtered at Nyala slaughterhouse, South Darfour State, Sudan. University of Khartoum Journal of Veterinary Medicine and Animal Production, 4(2): 26-38.
8. Aljameel MA, Halima MO, ElTigani-Asil AE, Abdalla AS, Abdellatif MM (2014). Liver abscesses in dromedary camels: Pathological characteristics and aerobic bacterial etiology. Open Veterinary Journal, 4(2): 118-123.
9. Al-Tarazi YH (2001). Bacteriological and pathological study on pneumonia in the one humped camel (*Camelus dromedarius*) in Jordan. Revue d'élevage et de médecine vétérinaire des pays tropicaux, 54(2): 93-97.
10. Amene F, Eskindir L, Dawit T (2012). Cause, Rate and Economic Implication of Organ Condemnation of Cattle Slaughtered at Jimma Municipal Abattoir, Southwestern Ethiopia. Global Veterinaria, 9(4): 396-400.
11. Asseged B, Woldesenbet Z, Yimer E, Lemma E (2004). Evaluation of abattoir inspection for the diagnosis of *M. bovis* infection in cattle at Addis Ababa Abattoir. Tropical Animal Health and Production, 36: 537-546. https://doi.org/10.1023/B:TROP.0000040934.32330.44
12. Awol N, Ayelet G, Jenberie S, Gelaye E, Sisay T, Nigussie H (2011). Bacteriological studies on pulmonary lesions of camel (*Camelus dromedarius*) slaughtered at Addis Ababa abattoir, Ethiopia. African Journal of Microbiology Research, 5(5): 522-527.
13. Azmi DH (2008). *Corynebacterium pseudotuberculosis* infection (caseous lymphadenitis) in camels (*Camelus dromedarius*) in Jordan. American Journal of Animal and Veterinary Science, 3: 68-72. https://doi.org/10.3844/ajavsp.2008.68.72
14. Barrow GI, Feltham RK (2003). Cowan and Steels, Manual for the identification of medical bacteria (3rd ed). Cambridge University Press, Cambridge, UK.
15. Bekele ST (1999). Studies on the respiratory disease 'Sonbobe' in camels in the eastern lowlands Ethiopia. Tropical Animal Health and Production, 31: 333-345. https://doi.org/10.1023/A:1005290523034
16. Bekele ST (2008). Gross and microscopic pulmonary lesions of camels from Eastern Ethiopia. Tropical Animal Health and Production, 40(1): 25-28. https://doi.org/10.1007/s11250-007-9046-9
17. Cadmus SI, Adesokan HK (2009). Causes and implications of bovine organs/offal condemnations in some abattoirs in Western Nigeria. Tropical Animal Health and Production, 4: 1455-1463. https://doi.org/10.1007/s11250-009-9334-7
18. Eltigani A (2004). Studies on pathological changes of condemned lungs of one humped camel. *MVSc Thesis, University of Khartoum,* Khartoum North, the Sudan.
19. Faye B, Abdelhadi OM, Ahmed AI, Bakheit SA (2011). Camel in Sudan: future prospects. Livestock Research for Rural Development. Volume 23, Article #219. Retrieved November 18, 2016, from: http://www.lrrd.org/lrrd23/10/faye23219.htm
20. Keskes S, Ibrahim M, Tessema TS, Tamir B, Regassa F, Kassa T, Dawo F (2013). Production systems and reproductive performances of *Camelus dromedarius* in Somali regional state, eastern Ethiopia. Journal of Agriculture and Environment for International Development, 107(2): 243-266.
21. Khalafalla AI, Saeed IK, Ali YH, Abdurrahman MB,

Kwiatek O, Libeau G, Obeida AA, Abbas Z (2010). An outbreak of peste des petits ruminants (PPR) in camels in the Sudan. Acta Tropica, 116(2): 161-165. https://doi.org/10.1016/j.actatropica.2010.08.002
22. Kinne J, Madarame H, Takai S, Jose S, Wernery U (2011). Disseminated *Rhodococcus equi* infection in dromedary camels (*Camelus dromedarius*). Veterinary Microbiology, 149: 269-272. https://doi.org/10.1016/j.vetmic.2010.09.037
23. μgrane JJ, AJ Higgins (1985). Infectious diseases of the camel: viruses, bacteria and fungi. British Veterinary Journal, 141: 529-547. https://doi.org/10.1016/0007-1935(85)90049-1
24. Mellau LS, Nonga HE, Karimuribo ED (2010). A slaughterhouse survey of liver lesions in slaughtered cattle, sheep and goats at Arusha, Tanzania. Research Journal of Veterinary Sciences, 97: 77-82. https://doi.org/10.3923/rjvs.2010.179.188
25. Mohamed BA, Farah IO (1994). Isolation of bacterial species from dromedary camels. The Sudan Journal of Veterinary Science and Animal Husbandry, 33(1.2): 58-64.
26. Nuseba HM, Halima MO, Sabiel YA (2014). Bacterial and pathological studies on condemned livers of one humped camels (*Camelus dromedarius*) slaughtered in tambool slaughterhose, Sudan. University of Khartoum Journal of Veterinary Medicine and Animal Production, 51(1): 85-93.
27. Scanlan CM, Edwards JF (1990). Bacteriologic and pathologic studies of hepatic lesions in sheep. American Journal of Veterinary Research, 51: 363-366.
28. Sharif-Yakan A, Kanj SS (2014). Emergence of MERS-CoV in the Middle East: Origins, Transmission, Treatment, and Perspectives. PLoS Pathogens, 10(12): e1004457. https://doi.org/10.1371/journal.ppat.1004457
29. Shuaib YA, Gareeball OA, Eman MO, Namarig AM, Shimaa ME, Saad EM, Siham ES, Mohamed AA (2016). Bacteria associated with skin wounds of equines and their antimicrobial susceptibility in Sharg Alneel, Khartoum State: a short communication. Scholars Journal of Agriculture and Veterinary Sciences, 3(2): 140-146.
30. Tenaw M, Feyera T, Abera B (2015). Major causes of organ condemnation in camels slaughtered at Akaki Abattoir, Addis Ababa, Ethiopia. Journal of Animal Health and Production, 3(1): 14-20. https://doi.org/10.14737/journal.jahp/2015/3.1.14.20
31. Thrusfield M (2007). Veterinary Epidemiology. United Kingdom, Black Well Science ltd, Ed. (3), Chap. 15; pp 220-221.
32. Tigani TA, Hassan AB, Abaker AD (2007). Bacteriological and pathological studies on condemned lungs of one humped camels (*Camelus dromedarius*) slaughtered in Tamboul and Nyala abattoirs, Sudan. Sudan Journal of Science and Technology, 8(2): 1-15.
33. Tiwari R, Yadav SK, Singh S, Gangwar NK (2015). Bacterial etiology of skin and wound infections along with antibiogram profiling in reference to emerging antibiotic resistance in animals. Advances in Animal and Veterinary Sciences, 3(5): 259-268. https://doi.org/10.14737/journal.aavs/2015/3.5.259.268
34. Yifat D, Gedefaw D, Desie S (2011). Major causes of organ condemnation and financial significance of cattle slaughtered at Gondar Elfora Abattoir, Northern Ethiopia. Global Veterinaria, 7(5): 487-490.
35. Younan M, Estoepangestie AT, Cengiz M, Alber J, El-Sayed A, Lammler C (2005). Identification and molecular characterization of *Streptococcus equi* subsp. *zooepidemicus* isolated from camels (*Camelus dromedarius*) and camel milk in Kenya and Somalia. Journal of Veterinary Medicine, Series B, 52: 142-146. https://doi.org/10.1111/j.1439-0450.2005.00828.x
36. Zakian A, Nouri M, Kahroba H, Mohammadian B, Mokhber-Dezfouli M (2016). The first report of peste des petits ruminants (PPR) in camels (*Camelus dromedarius*) in Iran. Tropical Animal Health and Production, 48(6): 1215-1219. https://doi.org/10.1007/s11250-016-1078-6
37. Zubair R, Khan AZ, Sabri MA (2004). Pathology in camel lungs. Camel Science, 1: 103-106.

****