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PATHOLOGICAL AND BACTERIOLOGICAL STUDIES ON PULMONARY LESIONS OF ONE HUMPED CAMELS (*CAMELUS DROMEDARIUS*) SLAUGHTERED IN OROMIA ZONE OF THE AMHARA NATIONAL REGIONAL STATE, ETHIOPIA

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ABSTRACT: *The present study was carried out on 116 lungs of slaughtered camels in Oromia zone of the Amhara National Regional State, Ethiopia to investigate the type of pathological lesions encountered and aerobic bacterial species involved in pneumonic lungs of camels. The prevalence of pulmonary lesions in lungs of camel was 78.45%. The gross examination of these lesions showed; Emphysema (49.14%), Pneumonia (42.24%), Hydatid cyst (22.41%), Pulmonary hemorrhages (16.38 %), Pneumoconiosis (12.93%), Plueurisy (9.48%) and Atelectasis (6.89%). Out of the 49 pneumonic lung samples cultured for aerobic bacteria, only 81.63% (n=40) of them yielded bacteria where as the rest 18.37% (n=9) pneumonic lung samples showed no growth. In general, a total of 45 bacterial species were isolated and identified from 40 pneumonic lung samples. The bacterial species isolated and identified from those pneumonic lung samples were Staphylococcus auerus (18.37%), Coagulase negative staphylococci (16.33) Escherichia coli (16.33%), Pseudomona aeruginosa (8.16%), Klebsiella pneumonia (6.12%), Manhemia hem olytica (4.08%), Streptococcus agalactia (4.08%), Streptococcus pyogens (4.08), Arcanobacterium pyogens (4.08%), Micrococcus species (4.08%), Francisella tularensis (2.04%), Rhodococcus equi (2.04%), Salmonella species (2.04%), Proteus species (2.04%).*

KEY WORDS: aerobic bacteria, camel, pulmonary lesion, lung

INTRODUCTION

Even though, the camel is believed to be a comparatively hardy animal and less susceptible to many of the health problems (Ahmed, 2008; Dirie and Abdurahman, 2003) it has suffered from different diseases like trypanosomosis, camel pox, mange, respiratory disease complex, hemorrhagic septicemia, cephalopsis, pustular dermatitis, dermatomycosis, gastrointestinal parasites and acute plant poisoning for the past so many years (Tefera & Gebreah, 2004). Of all diseases, those affecting the respiratory system are generally the leading causes of morbidity and mortality in large domestic animals including camel and are a major source of economic loss to the farmers (Mohamed & Abdelsalam, 2008; Intisar *et al*., 2010; Lopez, 2012).

Studies conducted in Ethiopia and elsewhere have identified several pathological conditions of lungs such as, emphysema, fibrosis, adhesion, atelectasis, hydatid cyst, pneumoconiosis, interstitial pneumonia, bronchopneumonia, fibrinous pneumonia, Pulmonary hemorrhages, pulmonary abscess, foreign bodies and lymphoid tumor (Al-Tarazi, 2001; Bekele, 2008; Jenberie *et al.,* 2012; Kane *et al.,* 2005 & Zubair *et al.,* 2004). In addition, several infectious agents have been isolated from respiratory tract of clinically sick and healthy animals. Pathogenic bacteria associated with respiratory disease outbreaks of camels include; *Pasteurella multocida, Mycobacterium bovis and Streptococcus, Corynebacterium, Actinomyces and Klebsiella* species, Coagulase negative *Staphylococci, Bacillus species, Pasteurella hemolytica, Staphylococcus aureus* and *Rhodococcus equi* (Awol *et al.,* 2011; Azizollah *et al.,* 2009; Roger *et al.,* 2000 & Shemsedin, 2002). Most of them were also isolated from the respiratory tract of healthy camels (Azizollah *et al.,* 2009; Shemsedin, 2002).

The whole camel population in Ethiopia was affected during the camel respiratory disease outbreak of 1995. Even a more devastating respiratory disease outbreak of camels characterized mainly by sudden death occurred in 2005/06 in Afar and Kereyu area of Oromia region (Awol *et al*., 2011; Gluecks and Younan, 2010; Jenberie *et al.,* 2012 & Wevenery *et al.,* 2006). Additionally, in 2007 similar disease was reported from Somali region and Guji and Borena zones of Oromia region (Dawo, 2010; Gluecks & Younan, 2010 & Jenberie *et al.,* 2012). However, outbreak investigations made by different veterinary institutions and investigation centers in the country failed to isolate the exact etiological agent of the disease (Awol *et al.,* 2011; Gluecks & Younan, 2010 & Jenberie *et al.,* 2012). Yet, there is a need to identify the causes of respiratory diseases of camels. Hence, this study was conducted to identify the major gross pathologies of lungs and aerobic bacterial species involved in pneumonic lungs of camel.

MATERIALS AND METHODS

Ethical considerations

All sample collections followed scientific and basic sample collection procedures and animal handling followed the basic animal welfare regulations. Laboratory processing was in accordance with the bench protocols of national veterinary institute (NVI) and Addis Ababa University, School of veterinary medicine, Microbiology Laboratory.

Study area

The study was conducted at Bati and Kemisse municipal abattoirs. The abattoirs are situated in Bati and Kemisse towns of Oromia zone of the Amhara National Regional State in the altitude range of 1500-2600 meter above sea level. Geographically, the area is located in north eastern Ethiopia and borders the afar regional state. The area receives an annual rainfall of 1800 mm in bimodal pattern. The relative humidity ranges from 23.9-79 % (NMSA A.A/ Ethiopia, 2003). The camels slaughtered in the abattoirs were originated from the surrounding camel rearing areas of Oromia zone.

Kemise is a town and separate woreda in north-eastern Ethiopia located with an elevation of 1424 meters above sea level. Bati is a town in north-central Ethiopia located in the Oromia Zone of the Amhara Region, with a latitude and longitude of 11°11′N 40°1′E with an elevation of 1502 meters above sea level. It is the largest town in Bati district.

Study animals and study protocol

The study was conducted on 116 camels slaughtered in two abattoirs using ante mortem (AMI) and post-mortem inspection (PMI) techniques. During the AMI, general physical examination was conducted on each camel and risk factors including sex, age, body condition and origin were recorded. Data regarding current clinical manifestations of disease were recorded with special attention to the respiratory system. The body condition of camels was determined according to CACIA (1995). Study animals include 77 males and 39 female camels of different body conditions, which were originally bought and transported on foot to the abattoir from the surrounding agro-pastoral areas of Bati and Kemissie towns. The age of camels was identified using dentition (Bello *et al.*, 2013). All of the camels in the study were above thirteen years of age and were apparently healthy.

After AMI the respiratory tracts (from the laryngeal cartilage up to the lungs and associated lymph nodes) were removed and taken to one corner of the abattoir for gross pathological examination (PMI) and lung tissue sample collection. The lungs of slaughtered animals were then examined visually and through palpation for any lesion. The gross appearance, location and size of the lesions were recorded. An incision was made into the lesions for further observation (Bekele, 2008).

Study design and Sampling method

A cross-sectional study was carried out from October 2014 until, April 2015 to determine the prevalence of pulmonary lesions and aerobic bacterial species involved in pneumonia of camels slaughtered in the Oromia zone of the Amhara Regional State, Ethiopia. The study animals were sampled by systematic random sampling i.e., from N animals in the lairage, every N/nth unit of animal is sampled (Martin *et al*., 1987). Once the animal is chosen, it was identified by a number using ink on the body and after slaughter lung samples were collected from the respective camels. Accordingly, 116 camels were selected to the study from the total 464 camels brought for slaughter during the study period.

Sample collection and Sample processing

Apparently affected lung tissue samples with a size of greater than 10 x10 cm, sometimes the whole lung showing pneumonic lesion, were collected using sterile forceps and scalpel blade. The lung specimens were then placed separately in sterile plastic bags kept in an ice box and transported to Kombolcha animal disease survey, investigation and diagnostic laboratory for bacteriological examination within two hours of collection. Sampling was done according to Carter (1984) and Quinn *et al*. (1999).

The surfaces of lung specimens were seared with a hot spatula (Awol *et al.,* 2011; Carter, 1984; Quinn *et al*., 1999). Exudate was collected from the interior portion using sterile pasture pipette through the seared surface. In case when there was no exudates small pieces of lung tissue samples were collected from the sterilized surface area with the help of sterile forceps and scalpel blade and inoculated into a sterile screw capped test tube with 5ml of brain heart infusion (BHI) broth. The inoculated broth tube was incubated loose capped aerobically at 37^0C for 24 hours. After 24 hours of incubation, a loopful of the broth culture was plated onto the sheep blood agar (BBL ®, Becton Dickinson, USA) by quadrant streaking method and incubated aerobically at 37^0C for 24 hours (Sisay and Zerihun, 2003; Awol *et al.,* 2011; Carter, 1984). After 24 hours of incubation, the plates were observed for the growth of the bacterial colonies.

The size and morphology of the colony, pigment production, presence of haemolysis and the type of haemolysis were observed and noted. Then the isolated colonies were subcultured by half plating on blood agar and Mac Conkey agar (Oxoid, Basingstoke, England) and incubated at 37^0C for 24 to 48 hours. Then a single colony was subculture on blood agar and incubated for 24 hours at 37^0C. After obtaining pure colonies primary and secondary identification tests were conducted according to the standard techniques recommended by Betty *et al*. (2007); Carter (1984) & Quinn *et al*. (1999).

Statistical analysis

The data was entered in to Microsoft excel spread sheet and coded appropriately. For data analysis Statistical Package for Social Sciences (SPSS) software version 20 was used. In this data analysis, descriptive statistic was used to determine the proportion of the different lesions and bacterial isolates. Chi-square was used to test the association among risk factors and the lesions.

RESULTS

Pathological findings

Of the total 116 grossly examined lungs of camel, 91 (78.45%) were affected with one or more of the different gross lesions. The gross pathological lesions identified in this study were Emphysema (49.14%), Pneumonia (42.24%), Hydatid cyst (22.41%), Pulmonary hemorrhages (16.38%), Pneumoconiosis (12.93%), Pleurisy (9.48%) and Atelectasis (6.89%).

Camels originated from Bati area (n=58) had higher prevalence of Emphysema (*p-value* = 0.023) than those originated from Kemise area (n=58). In addition, higher prevalence of Emphysema was also recorded in camels with moderate body condition (45.6%, *p-value* = 0.020) than others. However, all the risk factors considered in this study had no significant effect (*p- value* > 0.05) on the prevalence of other lesions. The frequency of occurrence and prevalence of gross pathological lesions, and their association with different risk factors are summarized in Table 1 and 2. The sum of the prevalence of different pulmonary lesions encountered is greater than 100% implying two or more lesions could be observed on the same lung. The association of the different pulmonary lesions is described on Table 3.

Table 1: Summary of frequency and prevalence of different pulmonary lesions encountered in lungs of slaughtered camels

Lesion type	Frequency	Prevalence (%)
Emphysema	57	49.14
Pneumonia	49	42.24
Hydatid cyst	26	22.41
Pulmonary hemorrhages	19	16.38
Pneumoconiosis	15	12.93
Pleurisy	11	9.48
Atelectasis	8	6.89

N.B: Since two or more lesions were observed on the same lung, the sum of the prevalence of different pulmonary lesions encountered was greater than 100%.

Table 2. Distribution of pulmonary lesions among origin, sex and body condition score (BCS)

Variables	Category level	No. of Camels examined	No. of Camels affected	Total number of pulmonary lesions	*P-value*
	Kemissie	58	42 (72.4%)	83	**0.114**
Origin	Bati	58	49 (84.5%)	102	
	Male	77	59 (76.6%)	118	**0.502**
Sex	Female	39	32 (82.1%)	67	
	Thin	5	5 (100%)	12	**0.001**
BCS	Moderate	40	37 (92.5%)	67	
	Good	48	38 (79.2%)	65	
	Fatty	20	9 (45%)	36	
	Obese	3	2 (66.7%)	5	

At 95% confidence interval

N.B: Since two or more lesions were observed on the same lung, the sum of the prevalence of different pulmonary lesions encountered was greater than 100%.

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Table 3: Coincidence of the different lesions encountered

	Emphysema	Pneumonia	Hydatid cyst	P.hemorrhage	Pneumoconiosis	Pleurisy	Atelectasis	Pulmonary.edema
Emphysema	-	23	16	8	5	-	6	-
Pneumonia	23	-	10	10	9	9	1	-
Hydatid cyst	16	10	-	6	2	2	3	-
P.hemorrhage	8	10	6	-	2	2	-	-
Pneumoconiosis	5	9	2	2	-	2	-	-
Pleurisy	-	9	2	2	2	-	-	-
Atelectasis	6	1	3	-	-	-	-	-

3.2. Bacteriological findings

Of the total 49 pneumonic lung tissue samples collected and cultured for aerobic bacterial isolation, only 81.63% (n=40) samples yielded bacteria. In general, a total of 46 bacterial species were isolated from 40 pneumonic lung tissue samples and identified either to the genus or to the species level (Table 3). The bacterial species isolated and identified from those pneumonic lung samples were *Staphylococcus auerus* (18.37%), *Coagulase negative staphylococci* (CNS) (16.33%), *Escherichia coli* (16.33%), *Pseudomona aeruginosa* (8.16%), *Klebsiella pneumonia* (6.12%), *Mannhemia hemolytica* (4.08%), *Streptococcus agalactia* (4.08%), *Streptococcus pyogens* (4.08%), *Arcanobacterium pyogens* (4.08%), *Micrococcus species* (4.08%), *Francisella tularensis* (2.04%), *Rhodecoccus equi* (2.04%) *and Proteus species* (2.04%).

Table 4. Aerobic bacterial species isolated from pneumonic camel lungs.

Number	Bacterial isolate	Frequency	Prevalence (%)
1	*Staphylococcus auerus*	9	18.37
2	*CNS	8	16.33
3	*Escherichia coli*	8	16.33
4	*Pseudomonas aeruginosa*	4	8.16
5	*Klebsiella pneumonia*	3	6.12
6	*Manhemia hemolytica*	2	4.08
7	*Streptococcus agalactia*	2	4.08
8	*Streptococcus pyogen*	2	4.08
9	*Arcanobacterium pyogens*	2	4.08
10	*Micrococcus spp*	2	4.08
11	*Francisella tularensis*	2	4.08
12	*Rhodococcus equi*	1	2.04
13	*Proteus species*	1	2.04
Total		46	93.87

**CNS= Coagulase negative staphylococci*

DISCUSSION

Pathological Findings

In this study, out of the grossly examined 116 camel lungs, 78.45% (n=91) had one or more pulmonary lesions. This finding was comparable to previous observations of Jenberie *et al.,* (2011) and Tigani et al. (2006) who had reported a prevalence of 77.5% and 72.8%, respectively but, higher than the findings of Zubair *et al.* (2004) and Kane *et al*. (2005) who had reported a prevalence of 48.90% and 57.7%, respectively. The gross pathological lesions identified in this study were Emphysema (49.14%), Pneumonia (42.24%), Hydatid cyst (22.41%), Pulmonary hemorrhages (16.38%), Pneumoconiosis (12.93%), Pleurisy (9.48%), Atelectasis (6.03%) and Pulmonary oedema (0.86%). All these pathological lesions were also reported from slaughtered camel lungs by various studies (Bekele, 2008; Jenberie *et al.,* 2011; Kane *et al.* 2005; Zubair *et al.,* 2004). High prevalence of pulmonary lesions recorded in this and previous studies could be due to the older age of the animals at slaughter with possibility of exposure to one of the agents which cause respiratory disease through time at least once (Bekele, 2008).

Emphysema was the most frequent lesion detected in 49.14% of the examined camel lungs. This result was lower than the reports of Jenberie *et al.,* (2011), Kane *et al.,* (2005) and Bekele (2008) who had observed on 60.2%, 59.1% and 61.54% of the camels, respectively. The prevalence of

Emphysema was varied significantly (*p-value* = 0.023) with the origin and body condition which was higher in camels originated from Bati (n=35) than Kemise (n=22). Higher prevalence of Emphysema was also recorded in camels with moderate body condition score (45.6%, *p-value* = 0.020) than others. The occurrence of emphysema was highly associated with pneumonia (n=23) and hydatid cyst (n=16) (Table 3) similar to the observation of Jenberie *et al.,* (2011) in camel. This could be due to the fact that emphysema in animal is always a secondary lesion (Lopez 2001). Pneumonia was found to be the second most encountered lesion with a prevalence of 42.24%. This result was in accordance with the finding of Zubair *et al.* (2004) who reported 45% prevalence of pneumonia in camel. However, studies conducted by Jenberie *et al.,* (2011), Kane *et al.* (2005), Al-Tarazi (2001), Al-Rawashdeh *et al.* (2000) and Tigani *et al.* (2006) reported a lower prevalence of 18.6%, 24%, 10.2%, 10%, 32% pneumonia, respectively in camel. The higher prevalence of pneumonia in this study could be due to the older age of the study animals with a high probability of exposure to one or more of the etiologic factors of pneumonia throughout their long life. It is also possible that the presence of stress factors such as exposure to dust from the environment or exhaustion during long distance movement of pastoral livestock in search of pasture and water coupled with the high levels of contamination of the environment with pathogenic microbes may increase the susceptibility of the target population to pneumonia. Moreover, higher prevalence of pneumonia may be due to prior exposure of the lung to different pulmonary lesions which predispose it to opportunistic respiratory infections.

The prevalence of hydatid cyst in this study (22.41%) was in accordance with the previous report of Jenberie *et al.* (2011), who observed hydatid cyst on 21.2% of the camels. The high prevalence of hydatid cyst in the present study when compared to the observations of Dyab *et al*., (2005) who reported 8.2% prevalence in camels could be due to the presence of high population of dogs and improper condemnation of organs infected with hydatid cyst in the study areas (Bekele, 2008).
Pulmonary hemorrhages were observed in 16.38% of camel lungs which is lower than the report of Kane *et al*. (2005) who have reported a prevalence of 26.5%, in camel. This occurs when animals aspirate blood after they were slaughtered while trying to get air. Then, the air way and alveoli become filled with blood (Jenberie *et al.,* 2011). It could also be due to infection of the lungs by *Streptococcus* species particularly, *Str. Equi* spp. *equi* which is responsible to cause hemorrhagic pneumonia in camels (Sechi, *et al.*, 1999).

Pneumoconiosis was recorded in 12.93% of the examined camel lungs. It was in agreement with the reports of Jenberie *et al.*, (2011) who reported 13.9% but lower than a 29.8% prevalence report of Bekele (2008). The occurrence of pneumoconiosis in this study is probably associated with the extremely dusty environment where camels are reared in this country (Bekele, 2008).
The prevalence of pleurisy (9.48%) recorded in this study was higher than the findings of 3.45% and 1.0% prevalence of pleurisy in camel reported by Jenberie *et al.,* (2011) and Al-Tarazi, (2001), respectively. The occurrence of pleurisy was associated with pneumonia (n=9) (Table 3). This could be due to the fact that respiratory diseases such as Pasteurellosis, CBPP or CCPP are responsible to cause pleurisy secondary to pneumonia (Radostits *et al*., 2006; Lopez, 2001).

The prevalence of atelectasis in this study was 6.03%. A higher prevalence of 10.6% and 39.42% was reported by Jenberie *et al.,* (2011) and Bekele (2008), respectively. Atelectasis usually accompanies space occupying lesions in the thoracic cavity or on the lung parenchyma like neoplasia, granuloma, hydatid cyst, and the accumulation of transudate and exudates when their volume is large (Lopez, 2001).

Bacteriological Findings

Out of the total 49 grossly pneumonic lung tissue samples collected and cultured for aerobic bacterial isolation, only 81.63% (n=40) of them yielded bacteria. This isolation rate is higher than the works of Awol *et al.,* (2011) and Al-Tarazi (2001) who isolated various bacteria at a prevalence of 69.4% and 10.2%, respectively, from pneumonic lung samples of camel. The bacterial species isolated and identified from those pneumonic lung samples were *Staphylococcus auerus* (18.37%), *Coagulase negative staphylococci (CNS)* (16.33%), *Escherichia coli* (16.33%), *Pseudomona aeruginosa* (8.16%), *Klebsiella pneumonia* (6.12%), *Manhemia hemolytica* (4.08%), *Streptococcus agalactia* (4.08%), *Streptococcus pyogens* (4.08%), *Arcanobacterium pyogens* (4.08%), *Micrococcus species* (4.08%), *Francisella tularensis* (4.08%), *Rhodecoccus equi* (2.04%) *and Proteus species* (2.04%). These bacteria were also isolated from pneumonic camel lungs and reported by various studies (Awol *et al.,* 2011; Al-Tarazi, 2001; Kane *et al.,* 2005; Zubair *et al.,* 2004).

In this study, *Staphylococcus* species were the predominant bacteria isolated from 34.7 % (n= 17) of pneumonic camel lungs. Out of these, *S. aureus* and *Coagulase negative staphylococci* (CNS) were isolate from 18.37% (n=9) and 16.33% (n=8) pneumonic lungs, respectively. Many workers such as Awol *et al.* (2011) and Tigani *et al.* (2006) also isolated both *S. aureus* and *CNS* from pneumonic camel lungs at a fairly comparable rate. *Staphylococci* species occur as commensals on skin and mucous membranes and hence can cause pneumonia secondary to stressful conditions such as shipping, climatic changes and viral infections (Quinn *et al*., 2002). Higher isolation of *Staphylococcus* species from the lungs of camel in this study may be attributed to the stress of transportation and confinement. The camels are exposed to dusty conditions for prolonged periods (3 to 4 days) in the lairage without sufficient feed and water (Awol *et al.*, 2011).

Escherichia coli (E.coli) were isolated at a prevalence of 16.33% in this study. This was in agreement with Awol *et al.,* (2011) who recovered *E.coli* at a prevalence of 17.5% from pneumonic lungs of camel, But higher than the reports of Zubair *et al*. (2004) with a 3% recovery rate. *E. coli* can survive in the environment such as in faecal particles, dust and water for weeks and months (Quinn *et al.,* 1999). Azizollah *et al.* (2009) and Shemsedin (2002) could not isolate *E. coli* from lung samples of apparently healthy camels and isolation of these bacteria in this study and by other workers (Awol *et al.*, 2011; Al-Tarazi, 2001) from pneumonic lungs of camel could possibly indicate the role of these bacteria as an opportunistic pathogen in respiratory tract infection of camels following stressful conditions and viral infections.

Pseudomanas aeruginosa was isolated from 8.16% of pneumonic lung tissue sample. This result agree with Al-Tazari (2001) with an isolation rate of 9% but, higher than Tigani *et al.,* (2006) and Awol *et al.,* (2010) who recovered *Pseudomanas aeruginosa* at a rate of 1.07% and 1.8 %, respectively. *Pseudomonas aeruginosa* is isolated from cases of pneumonia in large animal species (Radostits *et al*., 2000). The finding of *Pseudomanas aeruginosa* in this study could be due to the widespread occurrence of the bacteria in water and soil (Quinn *et al.,* 2002) of pastoral settings where facilitated by the extremely dusty environment can act as a primary causative agent in respiratory tract infection.

Klebsiella pneumoniae was isolated at rate of 6.12%. This is lower than the finding of Al-Tazari (2001) who reports at 14.66%. *Klebsiella pneumoniae* inhabits the intestinal tract of animals as well as in soil and sawdust, fecal contamination of the environment accounts for wide distribution of the organism and contributes to the occurrence of opportunistic infection (Quinn *et al.,* 2002). The unhygienic conditions of animal husbandry and mixed grazing practices in pastoral herds may be accounted for infection and thus the isolation of these organisms from pneumonic camel lungs.

In the present study, *Mannheimia haemolytica*, was isolated in 4.08% of pneumonic camel lungs. Isolation of these bacteria in this study fairly correlates with the finding of Al-Tarazi (2001) who reports a 6.66% isolation rate. *Pasteurella* species are commensals on the mucosa of the upper respiratory tract of animals (Quinn *et al.,* 2002). Transition from infection to disease appears to be facilitated by various stress factors including concurrent infections, change in climate and other management factors (Radostits *et al.,* 2006). The isolation of these organisms in this study can be attributed to a multitude of stresses placed on camels associated with extreme warm, prolonged feed and water shortage and frequent mobility which predisposes them to respiratory Mannheimiosis.

Two *Streptococcus* species namely, *Streptococcus pyogenes* (4.08) and *Streptococcus agalatia* (4.08) were recovered from pneumonic lung tissues. Similar observation was made by Zubair *et al.* (2004) who recovered these bacteria at a rate of 7%. Most species of *Streptococci* live as commensals on the mucosae of the upper respiratory tract and lower urogenital tract (Quinn *et al*., 2002). Isolation of *Streptococcus* species from pneumonic lung indicates, the role of these bacteria as an opportunistic pathogen in respiratory tract infection following stressful conditions and viral infections (Melese, 2005).

In the present study *Arcanobacterium pyogenes* was isolated at a rate of 4.08% from pneumonic lungs of camel. Isolation of this bacterium was in accordance with a 6.6% report of Al-Tarazi, (2001) but, higher than the reports of Tigani *et al*., (2006) and Tarek *et al*. (2012) with recovery rates of 1% and 1.4%, respectively. *Arcanobacterium pyogenes* is commonly present on the nasopharyngeal mucosa of domestic animals and it is associated with suppurative pneumonia (Quinn *et al.,* 2002).

Micrococcus species was isolated from 4.08 % of the pneumonic camel lungs which is higher than the study of Awol *et al.,* (2011) (1.8%). Even though this bacterium is considered as non-pathogenic (Quinn *et al.,* 1999), its isolation from pneumonic lung samples of animals by various workers, such as Legesse, (2006) and Melese, (2005) in sheep, Tekleselasse, (2005) in goat, Mebratu, (2006) in cattle, could possibly indicate its potential role in the development of respiratory infections.

Francisella tularensis was isolated from (2.04 %) pneumonic lung tissue sample. *Francisella tularensis* is highly invasive and after infection a bacteraemia develops with localization and granuloma formation in parenchymatous organs and lymph nodes. They cause a disease similar to plague in numerous animal species, above all in rodents. Wild animals and domestic fowl are the reservoir of infection. *Francisella tularensis* is most frequently transmitted by biting arthropods including flies, mosquitoes, lice and ticks (Quinn *et al.,* 1999). The isolation of this bacteria in this study and by Awol *et al.,* (2011) (1.8%) could be due to the presence of high population of wildlife specifically rodents in the area which are closely associated with camels in grazing fields as well as due to high infestation of pastoral camel herds with ectoparasites.

In this study, *Rhodococcus equi* was isolated at a rate of 2.04 %. Similarly, this bacterium was isolated by Awol *et al.,* (2011) (5.3%) from pneumonic lung of camel and Melese, (2005) (8.5%) from pneumonic lungs of sheep. *Rhodococcus equi* causes two major forms of disease, one involves the intestine and the other affects the respiratory tract, resulting in a severe and often fatal bronchopneumonia (McGavin and Zachary, 2010). It inhabits soil and also the intestinal tracts of animals. It is generally acquired by inhalation of dust contaminated with *Rhodococcus equi* (Quinn *et al*., 2002). Its isolation in this study could be a result of constant exposure of the respiratory tract of camels with dust particles harboring the organism coupled with the ever presence of stressful factors in the area.

Proteus species were isolated at a rate of 2.04 % in this study. Isolation of *Proteus* species from respiratory tract of camels is also supported by the studies of Al-Tarazi (2001) (2.66%) on pneumonic lung of camels and Mesele (2005) (14.6%) from pneumonic lung of sheep. Since *Proteus* species are found in feces of mammals and environment, they are considered as opportunistic pathogens (Quinn *et al.*, 1999; Quinn *et al*., 2002).

CONCLUSION

The present study shows that pathological conditions of the lungs, particularly pneumonia in camels can be considered as one of the major constraint of camel production and even can terminate in death causing economic losses to the pastoralists. Bacterial pneumonia and hydatidosis associated with the various lung lesions accounted for majority of the cases suggesting their role in precipitating respiratory disease outbreak under the influence of stress factors such as environmental change, extremes of climatic conditions, transportation and shortage of feeds and water or alone. Hence from this specific study we can conclude that the etiology of pulmonary

disease is so complex and multi-factorial. In the present study several aerobic bacterial species were isolated from pneumonic camel lungs. The findings have shown that most of the bacteria isolated are inhabitants of the respiratory passageways of apparently healthy camels and/or the environment. Hence considering the constant exposure of the respiratory tract to those bacteria and factors which may subject the animals to stresses, the pathogenic role of these organisms could be important. The etiology of pneumonia is complex and multifactorial which are either non-infectious or microbial determinants including bacteria, viruses and fungi. Therefore failure for bacteriological isolation in nine lung samples in this study may be due to other cause incriminated as *Mycoplasma*, viruses or fungi. It can be concluded that the obtained results give focus about the importance of *Staphylococcus aureus* and *E. coli* as a possible cause of pneumonic lesions in camels.

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Conflict of interest

The authors declares that they have no actual or potential financial or personal conflict of interest